Essays on tax avoidance and tax havens

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Essais sur l'Évasion Fiscale et les Paradis Fiscaux

Thèse de doctorat de l'université Paris-Saclay

École doctorale n°630 Droit, Économie, Management (DEM)
Spécialité de doctorat: Économie
Graduate School : Économie-Management Référent : ENS Paris-Saclay

Thèse préparée dans l' unité de recherche "Centre d'Économie de l'ENS Paris-Saclay" (CEPS), sous la direction de Farid Toubal, Professeur des Universités.

Thèse soutenue à Paris-Saclay, le 29 Août 2022, par

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THESE DE DOCTORAT
NNT : 2022UPASI005

L'acte est vierge, même répété.

René Char, Feuillets d'Hypnos, 1946

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Remerciements

Écrits à la hâte, dans l'urgence du premier dépôt, ces remerciements ne seront probablement pas assez bien écrits et trop pudiques pour exprimer le fond de ma pensée. Cette mise en garde établie, je souhaite adresser mes remerciements à l'ensemble des personnes qui m'ont accompagné ces dernières années.

Mes premiers remerciements vont à Farid Toubal qui a encadré cette thèse et qui accompagne mon travail depuis bien plus longtemps. Depuis notre rencontre, il y a presque 10 ans, nous avons activement collaboré et travaillé ensemble, mais surtout Farid a énormément contribué à ma formation en tant que chercheur. À ma formation tant sur le plan des savoirs et savoir-faire que sur celui, plus informel, de l'éthique du chercheur. J'ai beaucoup appris et ai encore beaucoup à apprendre. Ton exigence, ta rigueur et ton attention ont été des forces dans l'écriture de cette thèse et ma formation de jeune chercheur.

Je souhaite également remercier Mathieu Parenti, qui a joué durant cette thèse le rôle d'un conseiller précieux sur mes travaux et au-delà. Merci pour toute ton aide. Merci aussi pour m'avoir accueilli à Bruxelles de nombreuses fois et pour encore m'y accueillir dès l'année prochaine.

I would like to thank all the members of my jury who have been very helpful in the last stages of this dissertation. Many thanks to Gabriel Zucman who hosted me in Berkeley. Thank you for all your support, availability and for the challenging discussions. I would also like to thank Juan Carlos Suàrez-Serrato, Niels Johannessen, Nadine Riedel and José de Sousa, for their time and their many very valuable comments on my work. Many thanks to Pierre Boyer who has followed and supported my work in the last few years. I could not have dreamed of a better jury for my dissertation and I look forward to exchanging with you in the future. I would also like to thank Isabelle Méjean who took the time to follow my work through the Comités de thèse and whose comments have been vary valuable.

An important collaboration in my early career has been the several papers I have written with Gianmarco Ottaviano. When he hosted me at the LSE, even before my PhD, I knew very little about research. Making my first steps in the world of research with Gianmarco have been an enlightening and helpful experience. Thank you again for your continuous support over the years. I also thank to Ester Faia and Maximilian Mayer that have been wonderful coauthors.

J'aimerais remercier également les nombreuses personnes avec qui j'ai pu collaborer ou échanger au cours de cette thèse, dans le cadre des travaux au Conseil d'Analyse Économique (Phillipe Martin, Hélène Paris, Samuel Delpeuch), des visites de recherche (Emmanuel Saez à Berkeley en particulier), de nombreux séminaires et conférences. Je souhaite également remercier mes co-auteurs Julien Martin et Alessandro Ferrari pour leur disponibilité et leur travail précieux sur nos projets. In particular, I thank Alessandro for his help, rigor, and valuable work in the last moments of my PhD.

Je souhaite remercier l'ensemble de l'équipe de l'ENS-Cachan-Paris-Saclay

avec qui j'ai eu plaisir à partager les bureaux du bâtiment Laplace. Merci pour le soutien et pour les discussions intéressantes. Je pense en particulier à Emmanuelle Taugourdeau et Olivier Bos ainsi qu'au personnel administratif (Augustin, Eva et Linda) qui ont fait en sorte que cette thèse se déroule dans les meilleures conditions. Une pensée pour les doctorants passés et présents : Loïc, Samuel, Ninon, Julien, Florian, Daniel, Alix, Thibault. Un grand merci également à la direction et à l'administration de l'École Doctorale, en particulier Hubert Kempf et Noémie Mouty, pour toute l'aide apportée au cours de cette thèse et particulièrement dans ses derniers instants.

Cette thèse a été jalonnée de visites qui ont contribué à me former en tant que personne et en tant que chercheur : je souhaite remercier les doctorants rencontrés à la LSE qui m'ont accompagné lors de mes premiers pas dans la recherche (Clément, Clémentine, Malka), ceux de l'ULB, en particulier Baptiste pour nos nombreuses discussions, nos travaux ensemble et plus généralement sa gentillesse et sa rigueur, et bien sûr ceux rencontrés à Berkeley. Merci aux copains de l'IRLE pour leur présence, leur soutien ainsi que toutes les discussions passionnantes : Morten, Luis, Venance, Olatz, Claire, Thomas et tout les autres. Un grand merci pour Wouter et Eva, qui ont contribué à rendre cette année à Berkeley heureuse. Merci pour les moments de recherche (quoi de mieux qu'un groupe de lecture sur les paradis fiscaux ?) et de détente partagés.

Ces dernières années auraient été plus compliquées à vivre sans tous les amis avec qui je les ai partagées. Merci à tous. Une pensée en particulier pour Flore, Louise, Alex, Danaé, Richard, Elie, Mathilde, Pauline, Lambert, Eva, Laurent, Samuel, Chloé, Edgard, Lucie, Anne-Rose, Max, Florimond, Clémence, Jean-Christophe, Nadège, Guillaume, Anna, Louise, Yanis, Yannis, Hervé, Clélia et tous les autres. Une pensée également pour les amis du foyer, Laurie, Bonnie, Céline et Nada. Enfin, un second merci pour les précieux relecteurs, Eva, Wouter, Pauline, Samuel et Flore.

Merci à toute ma famille pour le soutien constant. Mes parents, Nathalie et Patrick, m'ont incroyablement soutenu toutes ces années et encore plus dans les derniers moments de cette thèse. Merci aussi à Marion et Stéphanie pour leur soutien exprimé ces dernières années. Merci à mon grand-père, Sacha, pour m'avoir introduit à la pensée scientifique il y a de longues années, pour m'avoir de cette manière indirecte donné le goût de la recherche et enfin pour m'avoir depuis constamment soutenu. Enfin, je pense fort à Liliane et Mizette.

Enfin, Pauline, merci pour ta présence et ton soutien sans faille, même à l'autre bout du monde. Nous nous sommes accompagnés et soutenus pendant nos thèses respectives. Les voici terminées. Le reste est à écrire.

1 - Introduction

Cette thèse s'intéresse à la taxation internationale sous l'angle de l'évasion et de l'évitement fiscal. Elle est composée de trois chapitres. Le premier chapitre porte sur la formation des paradis fiscaux et leurs déterminants. Le second chapitre s'intéresse aux liens entre l'activité des entreprises multinationales états-uniennes et leurs stratégies d'évitement fiscal. Le troisième chapitre propose un modèle calibré de localisation des entreprises avec un environnement fiscal riche qui autorise le déplacement des profits dans les paradis fiscaux. Le modèle est utilisé pour simuler les conséquences de plusieurs types de réformes de la taxation internationale sur les revenus fiscaux, l'évitement fiscal, la production et la consommation.

Dans ce résumé, nous mettons d'abord en perspective les spécificités de la taxation internationale. Nous introduisons ensuite les paradis fiscaux et discutons leur usage par les entreprises multinationales. Nous explorons ensuite différents enjeux de la taxation des entreprises multinationales et abordons ses réformes possibles. Enfin, nous présentons brièvement chacun des trois chapitres composant cette thèse[1].

La taxation, outil central des États modernes. La taxation est l'un des principaux outils de politique économique des États modernes. C'est un élément essentiel de leur constitution qui leur permet de financer un large ensemble de biens publics ainsi que leurs politiques de redistribution. Comme l'écrit Margaret Levi pour signifier leur étroite connexion : « L'histoire de la production des revenus publics est l'histoire de l'évolution de l'État » (Levi, 1989, page 1).[2] Selon l'*OECD Tax Database*, les revenus fiscaux correspondent en moyenne à 33,4 % du PIB dans les pays de l'OCDE (Modica, Laudage et Harding, 2018, OECD, n.d.). À titre de comparaison, durant la période 1830-1839, la taxation représentait 6,6 % du PIB dans les pays à haut-revenus (Cagé et Gadenne, 2018).

Dans les États modernes, la taxation sert plusieurs objectifs. Elle permet premièrement de financer la production de biens publics par l'État. Les historiens de l'État moderne se sont appliqués à montrer l'apparition et la modernisation de la taxation durant les périodes de guerre (Tilly, 1993). Au-delà des périodes de guerre, la démocratisation et la modernisation des États ont également permis l'augmentation progressive des revenus fiscaux entre le XIXème et le XXème siècle (Aidt et Jensen, 2009a ; Aidt et Jensen, 2009b). Cette croissance s'est également appuyée sur une augmentation constante de la demande pour le financement de biens publics tels que l'éducation, les infrastructures ou les dépenses sociales (Kiser et Karceski, 2017, Lindert, 2010).

L'État fiscal est donc une constante des États modernes. Même les approches philosophiques les plus opposées à l'État tendent à approuver l'existence de la taxation pour le financement de ses activités régaliennes (Vallentyne, 2018). Au-delà des secteurs régaliens, la taxation sert à finan-

[1] Certaines parties de cette introduction sont basées sur Laffitte (2019).

[2] Traduction de l'auteur.

cer un certain nombre de biens publics tels que l'éducation, la santé, les infrastructures, etc. Ces objectifs répondent à des principes d'équité ainsi que d'efficacité économique. Le modèle de Barro (1990) illustre le rôle de la dépense publique pour l'efficacité économique. Il propose un modèle de croissance endogène simple dans lequel il incorpore un service public dans la fonction de production privée. Sous cette hypothèse, la taxation et la dépense publique servent l'efficacité économique en permettant le financement d'un bien public productif. Ainsi, les dépenses publiques permettent de compenser le sous-investissement privé dans les biens publics. Les résultats de ce modèle, dans lequel la dépense publique permet de corriger des externalités, rejoignent les remarques d'Adam Smith sur le rôle de l'État dans la vie économique : « Le troisième et dernier des devoirs du souverain ou de la république est celui d'élever et d'entretenir ces ouvrages et ces établissements publics dont une grande société retire d'immenses avantages, mais qui sont néanmoins de nature à ne pouvoir être entrepris ou entretenus par un ou par quelques particuliers, attendu que, pour ceux-ci, le profit ne saurait jamais leur en rembourser la dépense. » (Smith, 1843, p.65).

Un deuxième objectif important de la taxation est la redistribution. Une taxation et une redistribution progressives permettent de redresser les inégalités. En France, sur la période 2010-2018, Bozio, Garbinti, Guillot, Goupille-Lebret et Piketty (2020) montrent par exemple que la redistribution issue du système de taxation a permis d'augmenter de 50 % la part de revenus détenue par les 50 % les plus pauvres, tout en diminuant de 25 % la part de revenus détenue par les 10 % des individus les plus riches. Ces deux derniers objectifs sont associés depuis Mirrlees (1971) dans la théorie de la taxation optimale qui étudie les caractéristiques d'une politique de redistribution optimale dans le cadre d'un arbitrage entre équité et efficacité économique.

Les États combinent ces divers objectifs selon les préférences politiques et sociales et fixent ainsi le niveau de taxation. La taxation a pris plusieurs formes au cours de l'histoire, les formes de taxation modernes se développant à partir du début du XXème siècle. La taxation moderne se distingue par trois caractéristiques (Seelkopf et al., 2021). Premièrement, les taxes modernes ont une assiette large au contraire des taxes pré-modernes qui sont souvent assises sur des bases resserrées, facilement observables par l'administration fiscale. Un exemple frappant est par exemple celui de l'impôt sur les portes et les fenêtres en place en France de 1798 à 1926. Au contraire de tels impôts, les taxes modernes visent l'ensemble des revenus et sont plus à même de rapporter des recettes conséquentes aux États. Deuxièmement, les taxes modernes reposent sur une complexité administrative particulière. En effet, les autorités fiscales sont tenues de collecter des quantités d'information élevées afin d'observer les revenus, les biens ou les transactions à taxer. C'est ainsi que naît une large administration fiscale. Enfin, les taxes modernes permettent la redistribution à travers des taxes progressives ou forfaitaires associées à des dépenses redistributives alors que les taxes pré-modernes apparaissent souvent régressives.

Il convient de noter que les premières expériences de taxation moderne n'ont pas affecté les entreprises dans un premier temps. C'est la progression

des revenus issus de l'activité des entreprises qui pousse à la taxation des profits des entreprises. Si celles-ci n'étaient pas taxées, les propriétaires d'entreprises pourraient être tentés de conserver leurs revenus dans la trésorerie de leur entreprise afin d'éviter la taxation. C'est d'ailleurs ce qu'on observe quand les taux de taxation des revenus individuels divergent du taux de taxation des entreprises : les entreprises accumulent plus d'épargne pour éviter leur taxation (Weichenrieder et Weichenrieder, 2005)[3].

Les spécificités de la taxation internationale. Jusqu'à présent, la taxation a été présentée dans son aspect domestique uniquement. Deux difficultés apparaissent lorsque l'on prend en compte les interactions entre plusieurs pays, potentiellement différents en termes de préférences fiscales. En effet, dès lors que l'activité économique est mobile, c'est-à-dire que les individus et entreprises peuvent se déplacer internationalement, les États peuvent être tentés de diminuer leur niveau de taxation afin attirer l'activité économique étrangère.

Si deux pays ont des niveaux de taxation différents, certains agents, individus ou entreprises, peuvent souhaiter être assujettis à la fiscalité la plus légère en y localisant leur domicile fiscal. Le pays à la taxation la plus élevée perdrait alors des ressources à cause d'une base fiscale plus faible. Ce pays peut donc souhaiter compenser cette perte en augmentant son niveau de taxation, au risque de perdre à nouveau de la base fiscale. Une autre solution serait de diminuer son niveau de taxation à un niveau qui permettrait à la base fiscale d'augmenter tout en ne diminuant pas trop les recettes fiscales. Empiriquement, c'est plutôt ce second effet qui domine avec les tendances régulièrement notées à la diminution conjointe des niveaux de taxation dans les pays développés.

Cette compétition fiscale internationale est grandement étudiée (voir Genschel et Schwarz, 2011, Keen et Konrad, 2013 ou Kleven, Landais, Muñoz et Stantcheva, 2020 pour des revues) et les observations empiriques tendent à confirmer que la baisse observée des niveaux de taxation est bien le résultat de la compétition fiscale entre États (Devereux, Lockwood et Redoano, 2008). L'existence de la compétition fiscale exerce donc une contrainte sur les politiques fiscales par rapport à une situation autarcique. Cela constitue cependant un phénomène relativement récent dans l'histoire de la taxation comme le rappellent Genschel et Schwarz (2011).

Une seconde difficulté liée à la taxation internationale apparaît lorsque les agents, en plus d'être mobiles, ont des activités économiques dans plusieurs pays. Se pose alors la question centrale de la répartition des droits à taxer leurs revenus. Le droit à taxer les revenus des agents doit-il être attribué au pays de résidence de cet agent, c'est-à-dire au pays d'origine de cet agent (l'endroit où il passe plus de la moitié de l'année par exemple pour un individu, ou le lieu de localisation de la tête de groupe d'une entreprise)? Ou doit-il être attribué au

[3]Plus généralement la problématique du déplacement des revenus entre les bases fiscales de l'impôt sur les revenus et de l'impôt sur les sociétés est identifiée dans plusieurs article. Voir les contributions de Gordon et Slemrod (1998), Harju et Matikka (2016), Alstadsæter et Jacob (2016) par exemple.

pays à la source de la création de revenus, par exemple le lieu où l'entreprise produit des biens, ou celui dans lequel l'individu travaille ? Lorsque le pays de résidence et de source sont différents, leur manque de coordination peut entraîner la double taxation lorsque les deux pays réclament des droits à taxer sur les mêmes profits. Une autre possibilité est l'absence de taxation, ou la double non-taxation. Dans ce cas, l'absence de coordination ouvre des failles juridiques exploitées par les agents afin d'éviter l'impôt dans les deux pays.

Les paradis fiscaux dans la taxation internationale. C'est dans ce contexte qu'apparaissent les paradis fiscaux, acteurs centraux de cette thèse. Les paradis fiscaux sont des États qui établissent une architecture légale offrant des taux de taxation faibles ainsi qu'un secret administratif et légal afin d'attirer avoirs et revenus générés dans d'autres pays. En général, les paradis fiscaux n'optent pas pour cette structure dans le but d'attirer une activité réelle (à travers une fuite des cerveaux ou la localisation d'entreprises) mais dans le but d'attirer des revenus dont la source se situe à l'étranger. Plusieurs caractéristiques peuvent être ajoutées comme l'existence du secret bancaire, la (non-)présence d'accords d'échange d'informations avec d'autres pays, des procédures administratives d'enregistrement d'une entreprise simplifiées, etc.

Les paradis fiscaux adoptent plusieurs types d'architecture légales afin d'attirer différents types de revenus. Les entreprises vont plutôt rechercher des faibles taux de taxation ainsi que des législations flexibles leur permettant par exemple de faire circuler leurs revenus entre plusieurs pays (Garcia-Bernardo, Fichtner, Takes et Heemskerk, 2017, Damgaard, Elkjaer et Johannesen, 2019) ou de négocier leur niveau de taxation[4]. De leur côté, les individus utilisant les paradis fiscaux sont plutôt à la recherche d'environnements fiscaux et administratifs secrets permettant de dissimuler leurs avoirs et revenus à leur administration fiscale d'origine tout en profitant de taux de taxation limités.

De nombreux travaux étudient les paradis fiscaux et leur utilisation par entreprises et individus – et cette thèse y participe. En revanche, peu de travaux étudient les déterminants des paradis fiscaux[5]. Pourquoi certains pays deviennent-ils des paradis fiscaux ? Dans le premier chapitre de cette thèse, nous construisons une base de données qui enregistre la date où les paradis fiscaux actuels sont devenus paradis fiscaux et la date où ils ont renforcé leur architecture légale de paradis fiscaux. Cette nouvelle base de données permet dans un premier temps de décrire précisément l'émergence des paradis fiscaux au XXème siècle. Dans un second temps, nous nous intéressons aux déterminants des paradis fiscaux et montrons le rôle de la demande pour les

[4] En 2014, le Consortium international des journalistes d'investigation (ICIJ) a révélé les LuxLeaks montrant que le gouvernement Luxembourgeois avait négocié avec plusieurs centaines d'entreprises des taux de taxation très faibles. Cette pratique est étendue à d'autres pays avec des exemples identifiés en Irlande ou aux Pays-Bas, voir par exemple le suivi de certains cas par la Commission Européenne : https://ec.europa.eu/competition-policy/state-aid/tax-rulings_en.

[5] De récents travaux sur l'histoire mondiale des paradis fiscaux, plutôt produits par des historiens ou des politistes, participent à ces recherches. Voir notamment, Palan, Murphy et Chavagneux (2009), Zucman (2015), Ogle (2017) et Ogle (2020).

paradis fiscaux émanant des pays à haute taxation ainsi que de la compétition des paradis fiscaux entre eux. Nous montrons également que la compétition entre les paradis fiscaux joue un rôle important sur leur développement, avec l'aide de nouvelles technologies légales, qui permettent aux paradis fiscaux de bâtir des architectures légales plus agressives.

Les problèmes de la taxation des entreprises multinationales. Les deux chapitres suivants de cette thèse portent sur l'utilisation des paradis fiscaux par les entreprises. Afin de régler les questions de double taxation et double-non taxation, les États ont commencé à se coordonner à travers des traités fiscaux bilatéraux permettant d'établir les droits à la taxation de chaque pays. Ce sont les origines du régime de taxation international actuel qui repose sur les traités fiscaux (voir le travail historique détaillé de Baistrocchi, 2021 pour une introduction plus complète à l'histoire du régime de la taxation internationale). Il est rapidement apparu, dans la mise en place des premiers arrangements, que les pays de source devaient avoir une forme de priorité dans la mise en place des droits à taxer. Comme le résume l'OCDE, « le système de taxation international doit permettre aux profits d'être taxés là où les activités économiques sont réalisées et où la valeur est créée » (OECD, 2015, traduction de l'auteur).

Une fois cette première question résolue, certains enjeux demeurent. En particulier, comment déterminer où se situe la « vraie » source des revenus ? Prenons le cas d'une entreprise française produisant des téléphones en Chine et réalisant sa recherche et développement (R&D) en Allemagne. Supposons que le téléphone soit vendu 1000 euros à la sortie de l'usine. Quelle part doit-on attribuer à chaque pays sur ces 1000 euros ? Quelle part doit revenir à la France, où le marketing est réalisé et où les décisions stratégiques sont prises ? Quelle part de ces revenus sont attribuables aux efforts de recherche et développement produits en Allemagne ? Quelle part est attribuée à la valeur ajoutée par les ouvriers lors de la production en Chine ? La Chine, par les infrastructures de production, de transport, d'éducation qu'elle propose doit-elle se voir attribuer une valeur supplémentaire à la valeur ajoutée par ses ouvriers ? Cet exemple simple illustre les questions au cœur de la taxation internationale des entreprises, des conflits qu'elle génère et des réformes proposées pour l'améliorer.

C'est cette question à laquelle les économistes de la Société des nations ont essayé de répondre en 1923 (Einaudi, Bruins, Stamp et Seligman, 1923). La solution trouvée par la Société des Nations est théoriquement parfaite : les transactions au sein de l'entreprise doivent être valorisées au même prix que si la transaction avait lieu à l'extérieur de l'entreprise. C'est le principe de pleine concurrence (*Arm's Length Pricing*, ALP) qui s'applique aux prix de transfert[6]. Dans l'exemple précédent, la filiale de recherche et développement allemande doit faire payer à la maison-mère en France ses services de R&D au même prix que si cette filiale était en fait une entreprise indépendante. Ainsi le mécanisme des prix permet théoriquement d'allouer la valeur là où elle est créée[7].

[6] Les prix de transfert sont les prix pratiqués par une entreprise lors de ses échanges intra-firme.

[7] Nous pouvons aussi noter que la théorie de la firme sous-jacente au système de taxa-

Il suffit alors aux pays d'appliquer le principe de la taxation territoriale pour garantir une allocation évitant la double taxation et la double non taxation. Lorsque le bien ou service en question est échangé de manière compétitive à un prix observable, le principe de pleine concurrence semble raisonnable. En revanche, dès lors que la structure de marché n'est plus compétitive mais est un oligopole ou un monopole, le prix entre filiales devient plus compliqué à fixer. En effet, il n'existe plus forcément de prix de marché. Il en est de même lorsque le bien ou le service est unique ou même qu'il n'est jamais échangé en dehors de la firme. C'est le cas par exemple pour certains brevets, droits d'utilisation de marque ou de logo ou certains biens intermédiaires spécifiques à des produits finaux. Puisque le prix de marché est difficile à définir, cela ouvre des brèches qui permettent aux entreprises de localiser leurs profits dans des pays à faible taxation ou des paradis fiscaux. Ces problèmes sont exacerbés par plusieurs phénomènes économiques récents : le développement d'une industrie numérique puissante, basée sur des actifs incorporels dont le prix est difficile à établir, la concentration des activités au sein d'un petit nombre d'entreprises et la complexification des structures légales des entreprises.

La solution de la Société des Nations se heurte en fait à l'un des premiers problèmes que se sont posés les économistes, depuis les scolastiques (Roover, 1958, Schumpeter, 1996) : la question du juste prix. C'est parce qu'il n'y a pas de réponse certaine ni universelle à cette question que les entreprises peuvent utiliser leurs prix de transfert afin de jouer sur l'allocation des profits entre les filiales. Lorsque ces filiales sont soumises à des taux de taxation différents, il est profitable à l'entreprise d'y déplacer ses profits.

Pour déplacer ses profits dans les pays à faible taxation, le principe est simple : il s'agit de créer une filiale dans un paradis fiscal qui importera aux autres filiales des biens et services à un prix faible et exportera aux autres filiales à un prix élevé. Cela permet de localiser les profits dans cette filiale et donc de réduire leur niveau de taxation global de l'entreprise[8]. En important biens et services à des prix faibles et en les revendant à des prix élevés, la filiale dans le paradis fiscal deviendra une plateforme de vente. Nous étudions ces plateformes de vente dans le deuxième article de cette thèse et montrons notamment que les biens importés et exportés par les paradis fiscaux souvent ne transitent pas physiquement par ces pays, mais font uniquement l'objet d'une opération comptable[9].

Réformer la taxation internationale. Le principe de pleine concurrence est actuellement le principe central de la taxation des entreprises multinationales. Ce système est fortement sujet au déplacement de profits dans les paradis fiscaux. Le manque à gagner lié à la présence des entreprises dans des paradis fiscaux a fait l'objet d'une large littérature. Celui-ci n'est pas facile à estimer

tion imaginé par la Société des Nations est relativement peu développée. Cette solution ne reconnaît pas la spécificité d'une firme qui est justement d'éviter la coordination par les prix de marchés (Coase, 1937, Williamson, 1981). Voir à ce sujet le travail de Pellefigue (2012).

[8]Voir à ce propos les analyses de Davies, Norback et Tekin-Koru (2009), Cristea et Nguyen (2016), Hebous et Johannesen (2015).

[9]Pour une analyse plus complète des mécanismes d'évasion fiscale voir Gravelle (2013) et Beer, Mooij et Liu (2020).

car ces pratiques sont le plus souvent cachées. Il faut procéder à des détours, ce qui produit une large variété de méthodologies aboutissant à des résultats différents. Les études chiffrent entre 80 et 647 milliards de dollars le manque à gagner fiscal lié au déplacement de profits dans les paradis fiscaux. De manière certaine, on peut remarquer qu'en 2016 les profits enregistrés par les entreprises états-uniennes dans les paradis fiscaux correspondaient à 40 % de leurs profits à l'étranger alors que l'emploi dans ces pays était de seulement 7 % de leur emploi total à l'étranger. Si tous ces profits ne sont pas forcément le fruit d'évasion fiscale, ils ne résultent pas uniquement de l'activité productive de ces territoires, comme le révèle la grande différence entre part des profits et part de l'emploi. Dans le troisième chapitre de cette thèse, nous estimons à plus de 350 milliards de dollars le montant annuel des profits déplacés par les entreprises multinationales dans les paradis fiscaux sur la période 2010-2014.

Afin de lutter contre la mise en place de législations agressives dans les paradis fiscaux et contre leur utilisation par les entreprises multinationales, l'OCDE a mis en place en 2013 un programme de travail contre l'érosion des bases fiscales et le déplacement de profits (*Base Erosion and Profit Shifting*, BEPS)[10]. À partir de 2016, la création du cadre inclusif permet d'incorporer des pays non-membres de l'OCDE. C'est au sein de cette structure qu'une perspective de réforme de la taxation internationale a émergé. La solution choisie à laquelle 135 pays ont accepté de participer se base sur deux piliers (OECD, 2020).

Le premier pilier cherche principalement à traiter la taxation des entreprises du secteur digital. La solution choisie consiste à accorder des droits de taxation aux pays de consommation des biens et services. Cela permet de sortir ces profits du système des prix de transfert et de prendre en compte les spécificités des entreprises du digital, notamment le fait que les consommateurs eux-mêmes participent à la création de valeur par une entreprise.

Le second pilier cherche à agir sur le déplacement des profits dans les paradis fiscaux en mettant en place un système de taxation minimum. De manière simplifiée, il s'agit de faire en sorte que chaque entreprise soit au minimum taxée à un certain niveau quel que soit le lieu de localisation de ses profits. Ainsi, si un taux de 15 % est mis en place, aucune entreprise ne pourrait théoriquement payer moins de 15 % d'impôts sur ces profits, même si ceux-ci sont localisés dans un paradis fiscal où le niveau de taxation est 0 %. Les modalités d'application pratique de cette règle restent cependant en cours de définition et risquent d'affecter la pleine application de ce principe (Baraké, Theresa, Chouc et Zucman, 2021).

Dans le troisième chapitre de cette thèse, nous construisons un modèle de localisation de firmes multinationales avec un environnement fiscal riche. Dans ce modèle, les entreprises peuvent déplacer leurs profits dans les paradis fiscaux pour diminuer leur taxation. En plus des frictions au commerce international et à l'investissement international, nous montrons que les coûts bilatéraux au déplacement de profits dans les paradis fiscaux influencent la localisation des entreprises multinationales. Lorsque l'environnement fiscal

[10] L'OCDE a historiquement joué un rôle important dans l'établissement du régime de taxation international (Kudrle, 2014).

mondial change, les entreprises ajustent leur activité réelle ainsi que leur comportement d'optimisation fiscale agressive. Ces deux effets ne sont en général pas pris en compte dans les simulations de l'impact de réformes du système de taxation international. Ce modèle est ensuite calibré finement afin de simuler des changements dans le système de taxation international. Nous simulons notamment l'impact de la mise en place de la taxation minimale sous plusieurs conditions d'application de la taxation minimale et montrons ses effets sur le déplacement de profits dans les paradis fiscaux, les revenus fiscaux, la production et la consommation. En particulier, nous montrons l'importance des effets réels pour comprendre les conséquences de cette réforme.

Résumé des chapitres. Cette thèse contribue à la recherche sur certaines de ces questions à travers trois chapitres abordant la question de la formation des paradis fiscaux (chapitre 1), les stratégies fiscales utilisées par les entreprises multinationales pour déplacer leurs profits dans les paradis fiscaux (chapitre 2) et la réaction des entreprises multinationales à des changements de leur environnement fiscal dans le cadre des réformes de la taxation internationale (chapitre 3).

La recherche est un processus collectif. Toujours indirectement car chaque travail s'inscrit dans une filiation méthodologique et intellectuelle liée à un champ de recherche particulier. Il est aussi le résultat d'interactions et de discussions constantes et participe à un effort collectif cherchant à apporter des réponses à des interrogations communes. L'aspect collectif de la recherche est aussi souvent direct, par la collaboration scientifique. Ainsi le deuxième chapitre de cette thèse est le résultat d'un travail mené conjointement avec Farid Toubal et sera publié en 2022 dans la revue *American Economic Journal : Economic Policy*. Le troisième chapitre est co-écrit avec Alessandro Ferrari, Mathieu Parenti et Farid Toubal.

Dans le premier chapitre de cette thèse, nous proposons une analyse des déterminants des paradis fiscaux. Quels pays deviennent des paradis fiscaux ? Pourquoi ? Quelles sont les conséquences en termes de développement ? Afin de répondre à ces questions, nous construisons une nouvelle base de données portant sur l'apparition des paradis fiscaux et leur développement. Le point de départ de cette collecte de données est l'idée que pour devenir un paradis fiscal, un pays doit mettre en place une architecture légale et fiscale qui permettra aux individus et entreprises étrangères d'y localiser les avoirs et revenus. La construction de cette architecture légale est réalisée à travers de nouvelles régulations. Nous suivons la mise en place de ces régulations dans 48 paradis fiscaux afin d'étudier les causes et conséquences de leur mise en place. Nous analysons le développement des paradis fiscaux sous l'angle du marché des services *offshore*. Dans ce marché, les paradis fiscaux sont les offreurs, alors que la demande pour ces services provient des pays à taxation élevée. En utilisant la nouvelle base de données, nous montrons que le développement des paradis fiscaux est lié à i) leurs caractéristiques individuelles comme leur taille et leur histoire coloniale, ii) la croissance de la demande pour les services *offshore* et iii) l'augmentation de la compétition entre les paradis fiscaux. Afin d'expliquer ces régularités empiriques, nous construisons un cadre théorique

où un pays peut choisir de devenir un paradis fiscal en fonction de la demande qui lui est adressée et de ses caractéristiques. Les prédictions théoriques sont ensuite testées. L'augmentation de la demande d'un écart-type augmente la probabilité d'un pays de devenir un paradis fiscal de 33 %. Cet effet est plus fort pour les petits pays ainsi que pour les colonies anglaises. Nous étudions ensuite le rôle de la compétition entre les paradis fiscaux sur leur développement. Pour cela, nous utilisons le choc exogène de la décolonisation. Une augmentation de la compétition pousse les pays qui sont déjà des paradis fiscaux à mettre en place de nouvelles régulations. Cet effet est renforcé par l'apparition de nouvelles technologies légales. Enfin, nous montrons que devenir un paradis fiscal tend à augmenter le PIB par habitant. Ce résultat suggère que devenir un paradis fiscal peut-être un choix rationnel du point de vue de ces pays.

Dans le second chapitre, nous nous intéressons au comportement d'évasion fiscale des entreprises multinationales états-uniennes. Nous montrons que celles-ci enregistrent leurs ventes et leurs profits dans les paradis fiscaux alors que les biens et services qu'elles produisent sont physiquement vendus dans d'autres pays. Nous nommons ce comportement le « déplacement de ventes » (*sales shifting*). Les paradis fiscaux attirent une fraction disproportionnée des ventes mondiales par rapport au niveau des facteurs de production qui y sont situés. Nous montrons qu'une partie de ces ventes correspondent à des opérations comptables qui ne sont pas liées au déplacement physique des biens dans les paradis fiscaux. Ces pratiques ont pour effet de déplacer les profits dans les paradis fiscaux et donc de réduire les assiettes fiscales des autres pays. Nous estimons que les entreprises états-uniennes ont déplacé autour de 80 milliards de dollars dans les paradis fiscaux en 2013 par l'intermédiaire des plateformes de vente. Ce résultat peut être interprété à la lumière des discussions portant sur la réforme de la taxation internationale. En effet, le Pilier I de la réforme fiscale proposée par l'OCDE consiste à attribuer une partie des droits à taxer les entreprises multinationales aux pays de destination des ventes de ces entreprises. Les pays de destination de ces ventes seraient donc autorisés à taxer une partie des profits des entreprises, même si celles-ci n'ont pas de présence fiscale dans les pays en question. Notre travail montre qu'une attention particulière doit être portée à la définition des règles permettant de déterminer le pays d'origine d'une vente. Dans le cas contraire, les pratiques de déplacement de ventes pourraient biaiser l'allocation des droits à taxer en faveur des paradis fiscaux.

Dans le troisième chapitre de cette thèse, nous construisons un modèle quantitatif d'équilibre général des décisions de localisation d'entreprises multinationales dans un environnement où les taux de taxation diffèrent entre les pays et où il existe des paradis fiscaux. Les entreprises choisissent alors où localiser leurs profits, dans le lieu de production ou dans un paradis fiscal. En particulier, nous introduisons dans ce modèle des frictions bilatérales associées au déplacement de profits dans les paradis fiscaux et montrons leur importance dans les choix de localisation des entreprises. Le modèle est organisé autour de deux élasticités différentes régissant la localisation de la base fiscale et la localisation des profits déplacés dans les paradis fiscaux. Un changement

dans l'environnement fiscal va affecter à la fois le déplacement de profits dans les paradis fiscaux et la localisation des activités de production des entreprises. Le modèle est ensuite calibré pour une période récente afin de simuler des réformes de la taxation internationale. Nous proposons une nouvelle méthodologie pour estimer les profits déplacés par les entreprises multinationales qui utilise des identités comptables. Nous simulons de nombreuses réformes, en particulier celles introduisant la taxation minimum et étudions leurs effets sur les revenus fiscaux, les profits déplacés dans les paradis fiscaux, la production et la consommation. Nous soulignons l'importance des effets réels sur les résultats obtenus.

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2 - The Market for Tax Havens

Despite being generally perceived as detrimental to other countries, tax havens have flourished during the last century. [1] There are now more than 40 of them, including a wide range of countries from small islands and territories in the Caribbean, Indian and Pacific oceans to larger countries such as Ireland, Switzerland, the Netherlands, or wealthy city-states such as Singapore or Hong Kong.[2] These small countries, primarily located at the periphery of large markets, offer opacity and low tax rates. If several papers have studied the consequences of the existence of tax havens on tax systems, little is known about their determinants.

In this paper, I investigate the determinants of the birth and development of tax havens. To do so, I build on two main ideas. First, tax havens result from the building of a *legal architecture*, *i.e.* legal, political and economic institutions that enable their use for offshore activities.[3] The concept of legal architecture helps to understand the roots of tax havens' activity and, therefore, to describe them more precisely than only through their tax rates. The second main idea is that tax havens can be studied through the lens of market forces. They are the key suppliers in the offshore services market. On the other side of this market, the demand comes from tax evaders in non-haven countries that seek low tax rates, advantageous regulations, and secrecy. Demand shocks and supply shocks will therefore affect the incentives of countries to enter this market by becoming tax havens.

One of the challenges faced when studying tax havens is the unobserved nature of transactions in the market for offshore services. I circumvent it by focusing on the construction of tax havens' legal architectures, which allow them to participate to this market. I build a new dataset that tracks the moment when today's tax havens became tax havens and when they have updated their legal architecture. To become a tax haven, a country must pass new regulations through legal reforms to supply offshore services. These reforms are diverse and can consist, among others, in implementing banking secrecy, allowing the use of tax-exempt companies, or providing tax advantages to offshore trusts.

[1] For instance, it has been shown that tax havens affect the tax revenues collected from both individuals (Zucman, 2013 and Alstadsæter, Johannesen, and Zucman, 2018) and firms (Hines and Rice, 1994, Torslov, Wier, and Zucman, 2022, Garcia-Bernardo and Janský, 2022 or Ferrari, Laffitte, Parenti, and Toubal, 2022). In addition, the use of tax havens by firms and individuals also affects the measurement of macroeconomic aggregates (Zucman, 2013, Guvenen, Mataloni Jr., Rassier, and Ruhl, 2018), of portfolio holdings (Coppola, Maggiori, Neiman, and Schreger, 2021) and allows avoiding financial risk regulation (Alfaro, Faia, Judson, and Schmidt-Eisenlohr, 2020). They are also used by elites to capture revenues (Andersen, Johannesen, Lassen, and Paltseva, 2017, Andersen, Johannesen, and Rijkers, 2022) or avoid regulations (see for instance Kollewe, 2022 on sanctions against Russia), thereby generating detrimental effects on the perception of government and elites in many countries (Louis-Sidois and Mougin, 2020 and Guriev, Melnikov, and Zhuravskaya, 2021).

[2] Figure 2.C.1 in Appendix draws a map of the current tax havens studied in this paper.

[3] The term legal architecture has also been used by Ogle (2017).

On the intensive margin, the legal architecture can be updated to attract more demand or to adapt to new regulations in non-havens countries. When updating its legal architecture, a tax haven can reinforce its current regulation or diversify its offshore activity by targeting different types of income. To my knowledge, this dataset is the first to provide a time-varying account of the existence of tax havens, while the literature generally relies on a constant tax haven indicator variable (Dharmapala and Hines, 2009, Slemrod, 2008).

To construct it, I use the information provided by tax lawyers in tax havens guidebooks. These books advise potential offshore users (firms or individuals) about the opportunities offered by each tax haven. Importantly, their authors carefully describe the legal features that allow tax haven use. The information from these guidebooks is completed with other sources such as academic papers, policy reports, books, and offshore firms' websites to provide a picture of the legal architecture developed by tax havens.

Throughout the paper, I adopt a comprehensive definition of tax havens. I define them as countries that deliberately set up a specific *legal architecture* characterized by secrecy and low tax rates to attract foreign assets and revenues generated elsewhere. I consider the use of tax havens both by firms and by individuals. Individuals tend to look for low tax rates and secrecy, while corporations look for low tax rates and advantageous regulations. Tax havens seek to generate revenues by attracting offshore users in both cases. In the case of individuals, revenues arise directly through the fees paid for the use of secretive legal structures or indirectly through spillovers on the domestic economy, particularly the legal industry and the tourism industry.[4] The mechanism is similar for firms. Direct benefits arise from tax and fee collection, and indirect benefits arise from residual real activity or through spillovers to the domestic economy. As described later, some tax havens might also provide offshore services to both types of users.

Using the new database, I first provide key facts about the development of tax havens. I proceed in three steps. First, I describe the long-term development of tax havens. I describe the geographical, temporal, and sectoral patterns of tax havens' expansion. Beginning in Europe during the interwar, the offshore world quickly spread to small countries, often (current and former) U.K. colonies, in the wake of the decolonization wave. I show a sizeable causal impact of becoming independent from the U.K. on the probability of becoming a tax haven. This first descriptive analysis provides three important results: i) country characteristics such as size and colonial history are important supply-side determinants of the choice of becoming a tax haven, ii) decolonization has

[4]It is sometimes assumed that providing secrecy for individuals does not come with tax revenue collection. However, the users of offshore entities generally pay fees to establish trusts, exempt companies, or other structures. For instance, registering a trust in the Cayman islands costs 500$ at registration and 500$ in annual fees (see https://www.ciregistry.ky/trusts-register/trusts-fees/). According to the 2020 Compendium of Statistics of the Cayman Islands (Cayman Islands Economics and Statistics Office, 2021), *Financial Services Licenses*, that covers the revenues generated by the offshore activity, accounted for 33% of tax revenues in 2020. *Banks and Trust Licenses* account for 27.5% of the receipts in this category, and Company fees account for 42% of it. Individuals use trusts and companies in the Cayman Islands to shelter their revenues from taxation.

been a major exogenous shock that transformed the history and development of tax havens, and iii) competition between tax havens, that is limited before WWII, increased following the decolonization shock.

Second, I study the demand for tax haven services. I show a graphical correlation between the introduction of direct taxes in non-tax-haven countries and the rise in the number of tax havens. This correlation is observed at the continent level, suggesting that tax havens appear when taxes increase in neighboring countries. This intuition about a geographical component of demand is confirmed using Offshore leaks data that allow observing at the micro-level the offshore entities opened in a tax haven by individuals from non-haven countries. Using this bilateral data, I find an elasticity of the use of tax haven entities to distance of one suggesting a strong geographical content of demand for tax haven's operations. This geographical aspect of demand is later used to identify the impact of demand on the probability of becoming a tax haven.

Third, I connect the rise of tax havens to the expansion of the offshore services market. Using Offshore leaks data, I can observe the number of offshore entities opened each year in each tax haven covered by the leaks. Concentrating on reforms that enable the use of exempt companies (which correspond to the type of entities covered in the Offshore Leaks data), I show a causal effect of new reforms on the creation of offshore entities in tax havens. It establishes a tight connection between the building of the legal architecture and the provision of offshore services. Then I concentrate on the biggest market for offshore services in the 20th century, the Swiss market, and show that the size of this market increased at the same time as new tax havens appeared in the newly-decolonized world. New tax havens did not substitute for old tax havens by appropriating their market shares. This last fact makes the connection between the rise of tax havens and the size of the offshore market.

To rationalize these facts, I build a theoretical framework inspired by the literature on legal capacity building (Besley and Persson, 2011). This framework looks at the decision of a government to become a tax haven given its own characteristics and the external demand for tax haven operations. The demand for tax haven operations is similar to the market access in the economic geography literature (Redding and Venables, 2004). In this framework, the demand depends negatively on bilateral evasion costs. Building on the fact established before that evasion costs increase with distance, I find that tax havens receive more demand from closer countries. The main testable implication of the framework is that the probability of becoming a tax haven increases when taxes around increase, more so for small countries. It provides theoretical underpinnings to the geographical component of demand.

I then turn to the empirical exercise. In order to establish a causal link between the rise in demand through higher taxes and the increase in the probability of becoming a tax haven, I construct the demand addressed to a country i as the average level of taxation in surrounding countries weighted by their distance to country i and their size. In a regression framework, I then explain the tax haven status of a country or its probability of passing a new reform by the level of demand it receives. The identification relies on the fact that the level of taxation changes differently in different countries, which affects the

demand exogenously through geography.

However, the level of taxation in surrounding countries and reforms in tax havens might be affected simultaneously by external shocks. It may constitute a threat to identification by introducing endogeneity. To circumvent it, I use an IV strategy. I first predict the level of taxation in a country using variables exogenous such shocks. These variables come from the political science literature that shows that taxation increases with the level of development and with democracy (Kiser and Karceski, 2017). Then, I construct the demand variable using this predicted level of taxation. I confirm the OLS results and find that increasing demand by one standard deviation increases the probability that a country becomes a tax haven by 33%. This effect is larger if the country is small or a former U.K. colony. I also find that demand particularly matters for the first reform rather than for other reforms. The robustness of the estimation is assessed through different tests, in particular by using different variables for demand. This exercise identifies the supply elasticity to demand by observing demand shocks.

Then, I estimate the sensitivity of reforms to supply-side conditions. To do so, I use the quasi-natural experiment of decolonization. I have shown that decolonization increased the probability of newly independent countries becoming tax havens. It creates a supply shock, exogenous to the level of demand. In particular, this shock increased the number of tax havens competing which each other. The role of competition between tax havens is a question that has received very little attention in the literature. To my knowledge, this subject has not been explored in any empirical study. I first show that increased competition pushes tax havens to update their legal architecture. In the market vocabulary, tax havens update their products when competition increases. This is an essential driver of reform adoption in tax havens in the second part of the twentieth century.

In terms of channels, tax havens mostly update their legal architecture by implementing new regulations that are not yet implemented in their country. I show that this result is driven by the diffusion of a new legal technology, the International Business Companies (IBCs). This new legal form has diffused quickly since the success of the IBC law of 1984 in the British Virgin Islands. Its implementation costs are likely limited and allow "learning" from other countries, which can easily copy a law, as it is public and not protected (as is generally the case for new technologies in product markets). It suggests that the legal technologies used by tax havens are essential to understanding their dynamics.

To sum up, my empirical analysis provides results that explain the variation of policies in tax havens using external conditions such as changes in demand and changes in the competitive environment. I find that changes in demand explain the reform that makes countries tax havens but not changes in new reforms, conditional on being a tax haven. Such updates of the legal architecture are driven by supply-side shocks such as increases in competition and are facilitated by the availability of new legal technologies.

Finally, I study the consequences of becoming a tax haven on its economic development. If countries become tax havens, this should be due to expected

economic gains. This is also what I assume in the theoretical framework. Using a dynamic difference-in-difference framework and accounting for heterogeneous treatment effects, I estimate the causal impact of becoming a tax haven on GDP per capita. I find positive growth gains of 4.9% per year during 7 years resulting in long-term gains of 40% compared to non-haven counterparts. After 7 years, the effect tends to stabilize. This confirms that becoming a tax haven may be a rational strategy from the point of view of tax havens.

This paper is related to several strands of research. A key contribution of this paper is the construction of a new dataset of reforms in tax havens. This dataset is the first attempt to follow the tax haven status of many countries along time. Providing temporal and spatial variation also enables the use of causal inference methods, in particular the generalized differences-in-differences.[5] This approach complements the more descriptive approaches from history or political science (see Palan, Murphy, and Chavagneux (2009), Ogle (2017) and Ogle (2020), Hollis and McKenna, 2019, or Farquet, 2021 for general approaches; for country-specific approaches see Guex, 2021 on Switzerland, Rawlings, 2004 on Vanuatu or Beurden and Jonker, 2021 on Curaçao) and allows for quantitative comparative history of tax havens. Zucman (2014) provides an interesting approach by constructing a long-run series of offshore wealth held in Switzerland. Here, I follow a different approach by bringing more countries into the analysis to bring more representativity: I can cover very different countries that become tax havens at different times and places. This general approach allows for finding common factors to the rise of tax havens. This new database will also be useful to future research by enabling more panel data analysis of tax havens.

Second, my paper is related to the public finance literature that studies the role of tax havens in the world economy.[6] The tax haven literature is generally interested in the effects of tax havens on other countries. However, the determinants of tax havens and their domestic consequences are less studied. Some theoretical papers in the tax competition literature are interested in the causes of tax havens (Kanbur and Keen, 1993, Hansen and Kessler, 2001, Slemrod and Wilson, 2009). On the empirical side, few papers study the determinants of tax havens. An exception is Dharmapala and Hines (2009) who study the correlation between governance institutions and the tax haven status using cross-sectional data. They argue that better-governed countries are more likely to be tax havens and that this is likely driven by initial higher governance in tax havens. My paper is different as it aims at providing a broader picture of the emergence of tax havens by insisting on the role of market forces. Besides, I construct and use time-varying data about the development of tax havens which allows me to study a broader range of potential causes and propose a causal analysis. By analyzing tax havens through the lens of the market for offshore services, I propose a unifying framework to understand them. To the best of my knowledge, this analysis is the first attempt to establish a causal link

[5] See the recent papers of Chaisemartin and D'Haultfœuille (2020), Sun and Abraham (2021), Callaway and Sant'Anna (2021).

[6] General reviews of tax havens include Palan, Murphy, and Chavagneux (2009), Zucman (2014) and Zucman (2015), Hebous (2014).

between the rise in demand and new tax havens reforms.[7] In my paper, demand is identified thanks to geographic variation. This is connected to recent papers insisting on the importance of gravity links between high-tax countries and tax havens (see for instance Ferrari, Laffitte, Parenti, and Toubal, 2022).

I also contribute to the literature that studies the consequences of being a tax haven. The impact of being a tax haven on GDP has been discussed by Hines, 2005 or Butkiewicz and Gordon, 2013. They provide suggestive evidence of a positive impact on GDP. Using a time-varying tax haven variable and recent methodological innovations for two-way fixed effects models, I show a causal impact of becoming a tax haven on GDP per capita.

Importantly, I also show the importance of competition between tax havens, which has been mostly overlooked in the literature. If taken into account in some theoretical frameworks (Slemrod and Wilson, 2009 or Johannesen, 2010 for instance), only Elsayyad and Konrad (2012) focus their argument on it. By affecting rents, competition between tax havens impacts their behavior. It pushes them to adapt by reinforcing their legal architecture, which can be made possible by legal technology innovations. I insist on the importance of these legal tools and show their key roles in tax havens' dynamics.[8] From a policy point of view, these mechanisms are important to understand the consequences of tax reforms. These reforms should aim at preventing legal innovations from tax havens.

Finally, I contribute to the literature that studies regulatory competition. Tax havens bear similarities with other types of regulatory competition. In particular, the concept of legal architecture can be extended to other forms of regulatory competition. Besides, studying the building of tax haven's legal architecture through the market lens is also generalizable. For instance, these concepts can be used to study the competition for capital in general (see Genschel and Schwarz, 2011 Keen and Konrad, 2013 for tax competition and Flamant, Godar, and Richard, 2021 for new forms of tax competition), pollution havens (Copeland, 2008), subsidy competition (Ossa, 2015, Slattery, 2018), legal opacity provision (Moreau-Kastler and Toubal, 2021). My results also inform on how countries choose their (economic and legal) institutional settings. It contributes to the literature interested in the determinants of institutional choices (Besley and Persson, 2011) and the role of foreign countries in these choices (Aidt, Albornoz, and Hauk, 2021).

The rest of the paper is constructed as follows. Section 2.1 provides more institutional details and describes the construction of the data. Section 2.2 presents three stylized facts about the development of tax havens. In section 2.4, I study the role of demand shocks on the development of tax havens. Section 2.5 studies the role of competition between tax havens, and section 2.6 provides new results on the impact of becoming a tax haven on GDP per capita. Section 2.7 concludes.

[7] While Desai, Foley, and Hines (2006) discuss the "demand for tax haven operations", their paper is mostly interested in who demands tax havens operations rather than its consequences on tax havens.

[8] This approach is also linked to the study of policy diffusion. See for instance Shipan and Volden (2008), Cao (2010), Zhukov and Stewart (2013), Elkink and Grund (2022), or DellaVigna and Kim (2022).

2.1 . The legal architecture of tax havens.

I construct a new dataset on the legal architecture of countries before and after becoming tax havens over the 20th century. I use both qualitative and quantitative assessment methods to gain a thorough understanding of how countries become tax havens. The new dataset is the result of a careful analysis and classification of the legal environment of tax havens. The existence of specific laws is necessary to the tax haven activity of a territory as it provides stability and predictability to its users. My methodology is new and relies on a limited set of public information that is observable by the researcher. It recognizes the fundamental role of law in wealth-creation processes (see Deakin, Gindis, Hodgson, Huang, and Pistor, 2017 and Pistor, 2019).

This data collection is motivated by the lack of time-varying, detailed and measurable information about tax havens. There are at least three reasons for this. First, tax havens operate secretly and do not disclose essential information on their activities as offshore centers. Second, many tax havens are small countries with small statistical offices or territories depending on other jurisdictions. Third, the extent of comparability across different sources and over a long period is limited.

Before describing in details the construction of the database, I make explicit the institutional context that underlies it.

Institutional Context. Following Ogle (2017)'s terminology, the *legal architecture* of a tax haven is the set of laws that provide legal instruments to supply offshore services. Low or no tax rates for specific types of incomes is a necessary condition to become a tax haven.[9] However, it is not sufficient as an offshore legal architecture is necessary to provide tools to create secrecy, provide flexibility and blur the links between ultimate wealth owners and their offshore assets and revenues. The legal architecture provided by tax havens is specifically designed to circumvent high-tax countries' regulations.[10] The new dataset informs on the development of such an architecture and on the rise of tax havens.

Tax havens can use many tools to build their legal architecture. For instance, one of the most prominent examples of these instruments are International Business Companies (IBC, hereafter).[11] IBCs can have only one founder, shareholder, and director who can be the same person and do not need any annual meeting. They are tax-free and require limited reporting and disclosure (e.g., financial statements are not necessary, and incorporation documents do not include the identity of the company's ultimate owners). The only condition for registering an IBC is that it cannot have any domestic activity. The history of the British Virgin Islands, especially the *International Business Companies Act* of 1984, has proven the profound role of IBCs in the transformation of the

[9] Note that having a low tax rate on all types of income is not necessary. Some tax havens can have large tax rates for incomes not covered by their specialization as tax havens.

[10] See for instance the case of the Cook Islands described in Harrington (2016).

[11] The importance of IBCs is recognized both by scholars (Palan, Murphy, and Chavagneux, 2009 or Harrington, 2016 for instance) and professionals (see for instance Riegels, 2014 from the offshore law firm Harneys).

island and other countries into tax havens.[12] Within a few years, the British Virgin Islands became a leader in offshore company registration, with more than 130,000 IBCs registered in 1994, representing almost half of the market (Darius and Williams, 1997).

Trusts, exempt corporations, or holdings are other examples of legal instruments implemented in tax havens.The example of New Caledonia, a Pacific French territory, illustrates why such regulations are necessary to make a country a tax haven, beyond low tax rates. New Caledonia was a no-tax jurisdiction but such offshore instruments have never been implemented. On the contrary, France was reluctant to make it a jurisdiction to book offshore revenues (Rawlings, 2004). Consequently, New Caledonia has never been considered a tax haven.

Therefore, the legal reforms are the main building blocks of the legal architecture of a tax haven. Many different types of reforms are available to tax havens, determining their offshore specialization. Table 2.1 summarizes the different types of laws that I record. I classify them into five broad categories that follow their different possible uses. There are the instruments that are used to directly circumvent personal taxation ("Personal") or corporate taxation ("Corporate"). However, in a world where a large share of income consists of business income or capital income, the frontier between personal and corporate taxation is thin and opens optimization and evasion opportunities (Love, 2021).[13] Some instruments widely implemented by tax havens are classified as "Dual" as they are equally used to circumvent corporate and personal taxation. It is for instance the case of IBCs.

For offshore strategies to work efficiently, the tax avoider must maintain secrecy and hold its offshore revenues and wealth in a bank. Offshore banking therefore greases the wheels of the offshore industry. It is classified apart as it appears complementary to other types of structures because it allows holding revenues while maintaining secrecy for the owners. Finally, the "Other" category includes regulations that do not follow the most classical categories, illustrating the diversity of options that countries have to become tax havens.

To be more precise, the category "Individual" gathers either trust laws, which constitute one of the primary instruments used in the offshore industry (Harrington, 2016) or specific regulations targeting individuals, in particular tax abolition. This latter category covers only a few reforms, trust laws constituting the bulk of this category. The category "Corporate" gathers different types of reforms. First, some reforms target multinational companies, such as the Irish Export Profit Tax Relief of 1956 or "Holding company" regulations

[12]Appleby, a leading international law firm incorporated in Bermuda, wrote a blog post to celebrate the 30th anniversary of the law in 2014, recognizing that "one would be hard-pressed to find an example of a similar law that has had such profound and positive implications for the jurisdiction in which it was promulgated." (Kirk, 2014).

[13]This is the problem of income shifting across the individual tax base and the corporate tax base. Gordon and Slemrod (1998) have documented its existence in the U.S. since at least 1965. Smith, Yagan, Zidar, and Zwick (2019) estimate that three-quarters of U.S. S-corporation business income (a specific legal form of corporation in the U.S.) is actually wages. Income shifting across tax bases has also been documented in other empirical setting, see for instance Harju and Matikka (2016) or Alstadsæter and Jacob (2016).

Table 2.1: Types of tax havens' reforms

Category	Regulation type	Description	Examples
Individual 38 reforms	- Trust laws ($\star$)	Allow legal disconnection between asset use and ownership	*Turks and Caicos Islands' Trust Ordinance 1990*
	- Other ($\star$)	For instance, tax abolition	*Monaco's Abolition of personal income taxes 1869*
Corporate 37 reforms	- MNE	Attraction of MNEs activities and profits	*Ireland's Export Profits Tax Relief 1956*
	- Holding	Special regimes for holding companies	*Luxembourg's Loi sur le régime fiscal des sociétés de participations financières (Holding companies) 1929*
	- Offshore Insurance and Captives	Self insurance allowing revenue transfers to tax havens	*Barbados' Exempt Insurance Act 1983*
	- Flag of convenience	Limited regulations and tax rates for ships registered in an offshore maritime registry.	*Panama's Law/63 on foreign Ships Registration*
Dual 65 reforms	- IBC	Tax-neutral companies with no domestic activities and limited legal requirements	*British Virgin Islands' International Business Companies Act 1984*
	- Other exempt companies	Similar as IBC	*Jersey's 1940 Corporation Tax Law*
Banking 38 reforms	- Offshore banking ($\star$)	Unregulated banks with limited taxation and legal requirements	*Anguilla's Banking Ordinance, 1991*
	- Bank secrecy ($\star$)	Protects account holders from investigations	*Switzerland's Banking Act, 1934*
Other 16 reforms	- Tax treaties ($\star$)	Limit bilataral taxation, allow conduit entities to benefit from treaties	*Netherland Antilles' tax treaty with Netherlands (Belastingregeling Koninkrinjk) 1964*
	- Specific regulations ($\star$)	Country-specific rules, not classified elsewhere.	*Bahamas' Hawksbill Creek Agreement 1955*

Note: This table classifies reforms by broad categories. The number displayed after the category name counts the number of reforms that have been adopted in each category at the end of the sample in 2000. The total exceeds the number of reforms recorded in the database as some reforms belong to several categories. Regulation types highlighted with the symbol $\star$ are grouped together within a broad category to form a subcategory.

that provide a differential tax treatment for holding companies. I add to this category reforms that target the activity of insurance companies, in particular captive insurances.[14] Finally, this category also gathers "flag of convenience" regulations that provide limited regulations and taxation to (commercial) ship owners (Vuillemey, 2020).

The category "Dual" encompasses a large number of reforms and corresponds to exempt-company regulations. These regulations aim at creating tax-exempt companies with limited administrative requirements and high secrecy. As described later, they are among the most spread tools offered by tax havens. Despite creating international companies, these regulations might equally be used by companies to channel offshore profits or by individuals to own their offshore wealth. This is why it is classified as "Dual". This category is sub-divided between IBCs and other exempt companies in order to insist on the importance of IBCs.

As underlined above, offshore banks and banking secrecy are critical instruments of offshore schemes because they are often complementary to other offshore activities. Offshore banking includes lightly regulated banks that benefit from low-tax rates and low restrictions. Banking secrecy is a key tool of tax havens as it generally prevents any investigation into the bank accounts of firms and individuals.

Finally, the category "Other" aggregates reforms not classified elsewhere. In particular, some tax treaties, by providing bilateral tax exemption, are used in tax avoidance and tax evasion schemes. For instance, the treaty between the Netherlands and the Netherlands Antilles has allowed many companies (North Americans in particular) to avoid paying some taxes by using the Netherlands Antilles as a conduit. Specific regulations, less common than those classified elsewhere, have also been used to build the legal architecture of some tax havens. This is the case of the Hawksbill Creek Agreement of 1955, which established a large free-trade and free-tax zone in the Bahamas until 2054. Different sources have recognized that this agreement spurred the development of the Bahamas as a tax haven (Ogle, 2017).

In sum, my approach relies on the reforms implemented in tax havens to build and develop their legal architecture. A potential downside of this approach is that the supply of tax haven services may not be mediated through new regulations or that my data collection might miss some significant laws. This latter case is especially relevant for countries with a long and complex offshore history. It also occurs when tracking legislation in federal countries, where offshore legislation can be enacted at sub-national levels (see for instance the case of Switzerland, described in Guex, 2021). Note that it is the case for a very limited number of countries among tax havens. In this case, one advantage of my approach, which can alleviate this bias, is that it relies on reports written by tax lawyers that advise potential users of tax havens. It allows me to include in my sample only laws that the users perceive to be the most relevant if one wants to use a tax haven. In particular, the laws not re-

[14] Companies open captive insurances to work as self-insurance companies. By playing with the insurance premium paid to their captives, firms can shift their revenues to tax havens with advantageous fiscal conditions.

ported might not be of high importance in building the haven's legal structure.

A second potential limitation is that the introduction of new legal instruments through reforms does not directly capture the supply of tax haven services but measures the activity of their suppliers. For instance, tax havens can write laws that are not followed by an increase in the production of tax havens' services because of poor quality for instance. Importantly, I show in the next section that new reforms causally increase (on average) the supply of tax havens services. Besides, the purpose of this database is to record the construction of offshore architecture. In this regard, it is crucial to record any important law, even of low quality as it marks a significant change in the willingness of a country to be a tax haven.

Construction I collect new data on major reforms undertaken by tax havens to build their legal architecture. The dataset informs on reforms that made countries tax havens (called the extensive margin) and on subsequent reforms, which update their legal architecture (called the intensive margin). Countries may update their legal architecture to reinforce existing legal instruments or create new opportunities for offshore users.

The dataset includes 50 jurisdictions covering different types and sizes of tax havens worldwide. These countries constitute today the bulk of offshore services providers. It closely matches the tax havens' list used in the literature. Appendix table 2.B.1 lists the countries included as tax havens in this paper. It also compares this list to eleven other lists aggregated by Palan, Murphy, and Chavagneux (2009). These lists of tax havens were established by different institutions and for different purposes between 1977 and 2008. Except for Costa Rica, which is absent from the list of this paper, it covers all tax havens mentioned in at least 4 of the 11 sources. [15] The data collection stops in 2000 as it marks the end of the expansion of tax havens and the beginning of a phase of regulation in high-tax countries (Sharman, 2019).

The construction of the dataset relies on a wealth of information provided by the *Guide Chambost des Paradis Fiscaux* (Chambost, 2000) and the *Guide Mondial des Paradis Fiscaux* (Beauchamp, 1992).[16] Both books scrutinize the legal architecture of tax havens and carefully describe their different possible uses. They provide a detailed description of laws and regulations that allow a potential tax evader to move its assets and revenues to the territory. Both guides

[15] More precisely, I first relied on the list of tax havens established by Dharmapala and Hines (2009). To this list, I added the Netherlands and Malaysia (in particular the Federal Territory of Labuan), which have been considered as tax havens but are not included in their list. I did not include Belgium due to conflicting information on its role as a tax haven. Watteyne (2022) argues that the history of Belgium as a tax haven stopped after WWI. I did not include U.S. States such as New Jersey or Delaware either. These states have mainly been considered as local tax havens (see for instance Dyreng, Lindsey, and Thornock, 2013) even though this might be changing.

[16] These books are available in French only. André Beauchamp and Édouard Chambost are international tax lawyers specialized in the use of tax havens. Chambost has written eight different editions of his book from 1977 to 2005. He is specialized in the creation of tax (avoidance) schemes between jurisdictions (http://www.edouard-chambost.com/picture_library/chambost_articles_recadrer/1998-1999/1998_paradis_fiscaux_ou_sanctuaire_suisse.pdf).

describe the banking system meticulously along with the existence *de jure* or *de facto* of banking secrecy. The authors also provide information on the territory – geography, population, economy, living cost, history and political system.

For each country, I collect the key dates that the authors identify as important in the construction of the tax haven's legal architecture. I then compare these dates between both sources to ensure that any date obtained can be perceived as significant. This alleviates the potential bias of relying on only one source. This is also done to recover information about some regulations when the original text is not precise enough. Indeed, both sources often do not provide the same information. For instance, one source might not give the name of the original regulation, might give the name but not the date of the regulation, might be imprecise about some regulations, or might not cover a regulation covered in the other source. For some countries, especially minor tax havens, descriptions are shorter, and information might be missing.

To deal with these issues, I cross-check these sources and collect more information using external sources such as the guides written by Starchild (1994) and Barber (2007) and different editions of Doggart (1975)'s guide to tax havens. I also relied on academic papers on specific countries or regions (Mendis, Suss, and Williams, 2002 and Fossen, 2002 provide important and useful information for the Caribbean and Pacific tax havens). Palan, Murphy, and Chavagneux, 2009 provided additional information on several tax havens. I also use information from various *Financial Secrecy Index*'s reports (Tax Justice Network, 2020). Finally, I consulted several documents written by offshore service providers to advise their clients or inform them of different offshore opportunities.[17]

These alternative sources are used to systematically confirm the existence of laws identified in the two main sources. They sometimes reveal the existence of reforms not mentioned in the main sources. In this case, the date obtained is also cross-checked in the other external sources. This is for example the case for Vanuatu. Both main sources describe Vanuatu as a tax haven but do not provide precise information on its offshore legal architecture. In this case I relied on two academic articles about the formation of the tax haven in Vanuatu (Connell and Pritchard, 1990 and Rawlings, 2004). Rawlings (2004) identifies the formation of the tax haven in 1970-1971 and refers to the *Banks and Banking Regulations* of 1970, the *Companies Regulations* of 1970 and the *Trust Companies Regulations* of 1971. These laws are also identified by Connell and Pritchard (1990), which allows me to validate these reforms and add them to the dataset.[18]

[17]For instance Trident Trusts provides "Fact Sheets" about many offshore jurisdictions: https://www.tridenttrust.com/knowledge/brochures-fact-sheets/. Trident Trust is one of the world's largest offshore providers, according to ICIJ. It operates in 19 tax havens present in my list of tax havens, besides having offices in the U.S., the U.K. and Canada. It has been exposed in the Pandora Papers, with more than 3.3 million records leaked.

[18]The two sources are actually divergent about the date of the Company Regulations that are either attributed to the year 1970 or the year 1971. According to the Pacific Island Legal Information Institute (http://www.paclii.org/vu/legis/consol_act/ca107/) there are two Companies Regulations in 1970 (*New Hebrides Companies Regulation*) and 1971 (*Companies Regulation*). Only the first one is kept; see below for more details when two laws closely follow each other.

When a law is closely followed by a new one with the only purpose of correcting the first one, I disregard the second law. This is for instance the case of the Cyprus law of 1975 that created offshore companies and was immediately corrected in 1977. When different dates are given for the same regulation in the sources, I record the date that is present in most sources. To follow up on the case of Cyprus, Beauchamp (1992) gives the date of 1978 for the first Offshore Banking Units, with an authorization given to the *Banque Nationale de Paris Intercontinentale*. However, I could not find other sources referring to this fact. On the contrary, different other sources give the date of 1981 for the establishment of Offshore Banking Units following the *Guidelines on Offshore Banking* issued by the government (Phylaktis, 1994 p.125, Roussakis, 1999). I, therefore, follow this date of 1981, which appears more reliable.

Finally, I could not find reliable and precise information on the offshore legal architecture of two minor tax havens, San Marino and the Maldives.[19] Consequently, my dataset includes information about 48 tax havens.

Additional data I complement information on the legal architecture of tax havens with additional data. Appendix 2.A provides a list of all data sources used in this paper.

I first associate each territory with a status relative to its sovereign history. Each country or territory can be either independent, non-independent and a colony, or non-independent and not a colony. This last status is created to deal with specific cases treated differently by different databases about colonial history. For instance, the islands of Jersey and Guernsey, despite being under the actual control of the United Kingdom, are generally not considered as colonies. However, for the purpose of this paper, it is important to highlight their link with the United Kingdom. To this purpose I use information from the Colonial Dates Dataset (Becker, 2020), the Cepii Gravity Dataset (Head and Mayer, 2014) and the ICOW colonial dataset (Hensel, 2018). The data is then manually completed when information is missing for a given territory using worldstatesmen.org, rulers.org, and wikipedia.org.

To measure the level of taxation worldwide, I combine two types of sources. First, I use the Tax Introduction Dataset that has been compiled by Seelkopf et al. (2021). This dataset provides for 220 countries and territories in the world the date of introduction of six different modern taxes: personal income taxes, corporate income taxes, inheritance taxes, social security contributions, general sales taxes, and value-added taxes. The authors distinguish modern taxes, compared to pre-modern taxes, by their simple and broad tax bases, their administrative complexity (they require information-intensive processes), and their redistributive potential. This database allows me to observe the extensive margin of taxation at the tax level for virtually all countries in the world. I complement this data source with information on the intensive margin of taxation. I use data from the Government Tax Revenue dataset created by Andersson

[19]As illustrated by appendix table 2.B.1, the Maldives appear in only three tax havens lists and San Marino in only one. Chambost (2000) only devotes two lines to San Marino to write that he does not consider it as a tax haven while Beauchamp (1992) writes that "If San Marino has an old reputation of tax haven, the republic has taken very few actions to justify it" (p.549, own translation). The Maldives are not covered in any of the main sources.

and Brambor (2019a) and Andersson and Brambor (2019b). The dataset covers 31 countries between 1800 and 2012 (non-square) and provides information on their tax revenues as a share of GDP. I use this information as a proxy for the effective tax rate. Interestingly, the data distinguish between direct and indirect tax revenues. Despite covering fewer countries than the Tax Introduction dataset, this data covers a large share of the world economy. In 1950 it covered 66% of the World's GDP. Missing data, in particular during world wars, is linearly interpolated when it occurs between two dates where I observe the level of taxation. It allows me to gain coverage. Data is used from 1920 onwards. Before this date, the coverage is too restricted. For instance, the U.S. entered the data in 1916. Overall, both sources provide a different but complementary view on world taxation.

2.2 . The development of tax havens

I observe 143 reforms in 48 countries. The new dataset allows me to provide new information related to the rise of tax havens in the 20th century. In particular, my approach visualizes the key supply and demand forces underlying the market for offshore tax haven services.

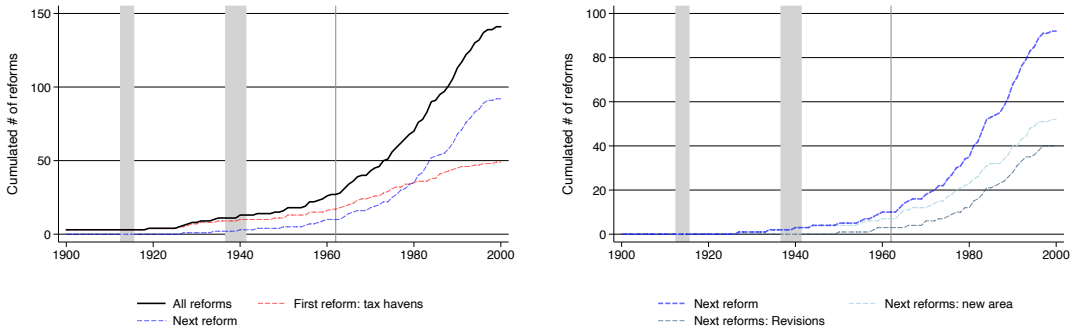
This section proceeds in three steps. First, I detail the characteristics and long-run evolution of tax havens (*the supply*). Then, I show the correlation between the rise of tax havens and the rise of taxation in other countries (*the demand*). Finally, I link the development of tax havens through new reforms to the supply of offshore services (*the market*).

2.2.1 . The suppliers of offshore services

I first document the striking increase in the number of tax havens in the 20th century. I describe the type of reforms implemented and their differential use over time. Then, I show the different geographic trends by broad world regions. I finally show that country size and colonial history are two critical determinants of the choice of becoming a tax haven.

The rise of tax havens In figure 2.1, I describe the development of tax havens in the 20th century, distinguishing between the extensive and intensive margins in panel (a). In panel (b), I decompose subsequent reforms between reforms occurring in a new type of activity (labeled *new area*) and reforms occurring in an area in which the country is already specialized (labeled *revisions*). This distinction is important as it illustrates one of the fundamental trade-offs faced by suppliers that face competition in a market. They can either specialize and therefore try to compete vertically or diversify their activity to compete horizontally.

Panel (a) describes the significant rise of tax havens in the 20th century, from almost none to 48. The figure reveals that the first rise of tax havens happened during the interwar period. As discussed in the following subsection, this rise is associated with the introduction of modern direct taxation in several countries through individual and corporate income taxes. Then, it is not before the fifties that countries that are already tax havens begin to up-



(a) First and subsequent reforms (b) Decomposition by purpose

Figure 2.1: The rise of tax havens in the 20th century

Note: This figure depicts the rise of tax havens in the 20th century according to two dimensions: (a) First and subsequent reforms, (b) Decomposition of subsequent reforms between those opening a new area of specialization and those occurring in an area in which the tax havens has already done a reform. Data on tax havens' reforms comes from own data collection detailed in section 2.1. "New area" corresponds to reforms made in a sub-category in which the country had done no reform before and "revision" corresponds to reforms made in a sub-category in which the country had already made a reform before. Sub-category classification is the following: Banking, Insurance, Exempt companies (IBC or not), MNE-specific, Holding regimes, Individual, Ships, and Other. Shaded areas indicate the world wars and the vertical line (1962), the beginning of the independence wave in the U.K.-dominated Caribbean area.

date their legal architecture through new large-scale reforms. While the increase in the first reforms appears constant over the century, we observe a clear acceleration in the subsequent reforms from the seventies. The vertical black line marks the beginning of the British decolonization in the Caribbean. It is followed by an increase in the number of reforms. I discuss below the role of decolonization and of increased competition between tax havens as drivers of this trend. At the end of the sample, the majority of reforms happen at the intensive margin (subsequent reforms) rather than at the extensive margin (new tax havens). Subsequent reforms correspond to a reinforcement of the legal architecture. Keeping in mind the market analogy, making a new reform is comparable to updating a product or proposing a new product.

To understand more precisely the intensive margin, I decompose it in panel (b) between reforms in a new area of specialization and reforms in areas where the tax haven has already made a reform (following table 2.1 classification). There are slightly more reforms happening in new areas than revisions. It illustrates that tax havens are probably competing horizontally by diversifying and vertically by deepening their specialization.

Type of reforms To better understand the development of tax havens, it is necessary to look at the type of reforms enacted. Figure 2.2 decomposes the trend by havens' specialization following the distinction described in table 2.1.

First, it must be noted that the first reforms during the interwar are diversified in many different types of activities. It suggests that competition between them might have been limited at the beginning of tax havens' history. From

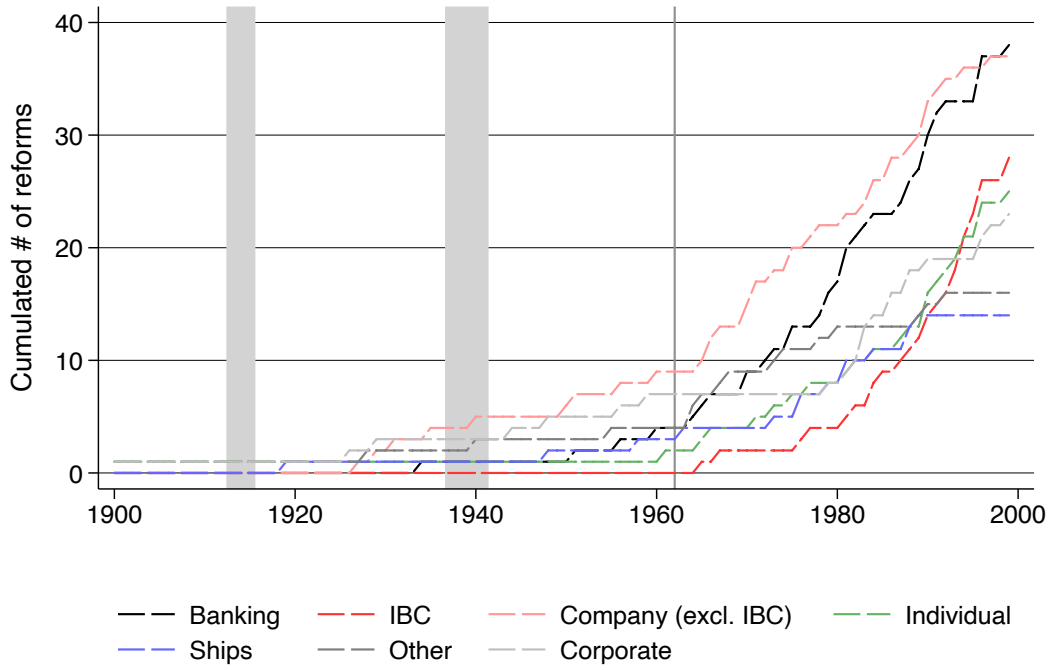


Figure 2.2: Decomposition by type

Note: This figure plots the cumulated number of reforms by type of reforms. Data on tax havens' reforms comes from own data collection detailed in section 2.1. Details on the classification used in this figure are displayed in table 2.1. Shaded areas indicate the world wars and the vertical line (1962), the beginning of the independence wave in the U.K.-dominated Caribbean area.

the fifties, "Exempted companies" emerged as the dominant type of regulation while reforms in other activities happened at a slower rate. Exempted companies are a flexible instrument as they can be used by firms or individuals, particularly to manage their business income. This flexibility also decreases administrative costs for the tax havens that implement them (as there is a limited number of legal forms for different situations), which is an attractive property. It might explain why more and more tax havens are adopting such regulations.

We also observe a rapid rise in the number of banking reforms. Banking reforms, offshore banking or bank secrecy laws are complementary to other types of use of tax havens. Contrary to onshore banks, offshore banks offer flexibility and secrecy, which are necessary for offshore users. Therefore offshore banking reforms are expected to develop simultaneously with other types of reforms. For instance, the famous bank secrecy law introduced in 1934 in Switzerland had been partly enacted to avoid any authority having access to details about the activity in Swiss banks following a scandal in the early thirties during which French authorities pressured Swiss banks to obtain information from them (Guex, 2000).

Finally, International Business Corporations appear more and more attractive at the end of the century as we notice a significant increase in the number of IBC reforms. There are a few IBC reforms in the sixties but we observe a break in the trend following the reform of 1984 in the British Virgin Islands. Since then, IBC has been the legal form that has experienced the most remarkable growth until the end of the century. It underlines the importance of legal innovations in the development of tax havens. It also indicates how quickly legal innovations can diffuse. Contrary to other markets, regulations can be easily replicated as they are publicly available and not protected from copy. It allows some countries to adopt regulations that appear successful quickly.

The geography of tax havens The last dimension to describe the rise of tax havens is the geographic dimension. Figure 2.3 reveals striking spatial differences in the development of tax havens. Some regions such as Europe, the Americas, and later Asia have a consequent number of tax havens while Oceania and Africa lag behind in havens development.

Until the fifties, almost all tax havens were located in Europe or the Americas, particularly in the Caribbean area. This is in line with the fact that taxation was first introduced in these regions. Second, for a large part of the 20th century, Europe hosted the largest number of tax havens. From the sixties, following decolonization and the global liberalization of financial flows associated with the end of the Bretton-Woods system, we observe a break in the trend of American tax havens, which number increased significantly. This is also the moment where tax havens appear in the other regions, Asia, Oceania, and to a lesser extent Africa. We can therefore divide the global history of tax havens in the twentieth century into two broad periods. During the first one, from WWI to the seventies, Europe dominated the scene of tax havens. During this period, Switzerland was the most important tax haven.[20] From the seven-

[20]The history of Switzerland, particularly its dominant role during the interwar, has led to

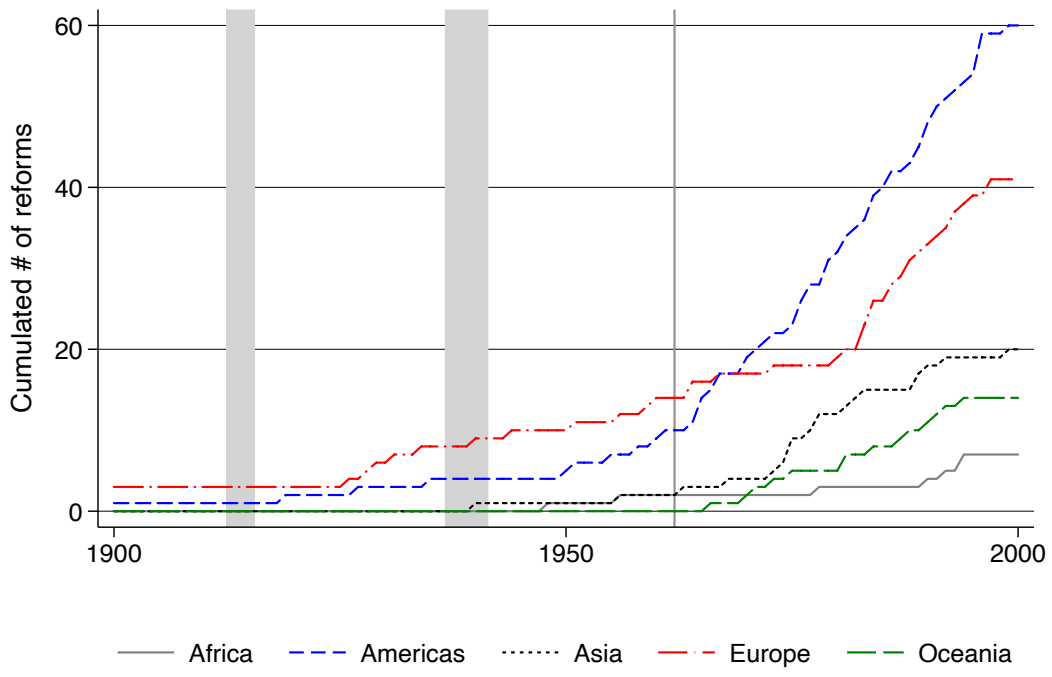


Figure 2.3: The rise of tax havens in the 20th century: Decomposition by region

Note: This figure plots the cumulated number of tax haven reforms by broad world region. Data on tax havens' reforms comes from own data collection detailed in section 2.1. Shaded areas indicate the world wars and the vertical line (1962), the beginning of the independence wave in the U.K.-dominated Caribbean area.

ties, more tax havens emerge in the developing world. A new world geographic distribution of tax havens is drawn, driven by many new tax havens and new reforms in the Caribbean, which has become the region where tax havens are the most concentrated. As the center of the world economy moved from Europe to the U.S., the offshore world followed the same path.

Some characteristics of tax havens To complete the description of tax havens from the new database created in this paper, I explore their main characteristics. Several country-level characteristics of tax havens have been discussed in the literature. The most significant one is the small size of tax havens (Dharmapala and Hines, 2009). This fact is also grounded in theoretical models (for instance Kanbur and Keen, 1993, Hansen and Kessler, 2001, Slemrod and Wilson, 2009, Bucovetsky, 2014).

A second important characteristic of tax havens is their colonial history. Different studies have highlighted the tight connection between the colonial world, especially the British one, and the making of tax havens (Palan, Murphy, and Chavagneux, 2009, Ogle, 2017; Ogle, 2020 for instance). Newly independent countries have found a convenient specialization in the tax haven industry that necessitated a resource available to all countries: their sovereignty. Ogle (2017) argues that the connection between the colonial world and the offshore world is linked to the constitution of an informal empire by the United Kingdom, with limited actual sovereignty and different legal and political institutions. This difference generates loopholes that the former colons will use for offshore purposes. She also argues that the shock was partly a demand shock, with colonizers' assets partly reallocated in tax havens after the decolonization. On the contrary, Farquet (2021) argues that even though some colonial assets have been relocated to tax havens, the bulk of offshore assets is constituted by rich countries' assets.

Some scholars have also argued that the United Kingdom has encouraged, at least indirectly, these countries to become tax havens in order to reduce their development aid (Sagar, Christensen, and Shaxson, 2013, Ogle, 2017). On the contrary, other colonial powers such as France, have been more reluctant to encourage this development choice (Rawlings, 2004).

Figure 2.C.3 in the appendix plots the share of tax havens by size and colonial history by year. Until the decolonization period, small countries followed a similar trend, whatever their colonial history. In 1960, 20% of the small countries had become tax havens while around 5% of the large countries did. We observe a break in the trend of small countries connected to the United Kingdom from the sixties. At the end of the sample, more than 80% of the small U.K.-related countries are tax havens while only 40% of the small, not-U.K.-related countries are tax havens. The trend is similar among big countries. This figure adds to the literature a dynamic dimension: the shock of decolonization played a significant role in the construction of tax havens but only specific countries, newly independent and small, reacted to this shock.

To further explore this last fact, I study the evolution of the tax haven sta-

several studies by historians. See for instance Farquet (2016) and Farquet (2018) or Guex (2000) and Guex (2021).

tus in countries following their independence. To do so, I estimate the following dynamic difference-in-difference where the treated group is composed of countries experiencing decolonization and the control group is composed of countries that have never become independent in my sample:

$$Tax\ Haven_{it} = \sum_{k=-6}^{15} \beta_k Independent_{it}^{k} + \mu_i + \mu_t + \epsilon_{it} \tag{2.1}$$

where $Tax\ Haven_{it}$ is equal to 1 when country i becomes a tax haven. $Independent_{it}^{k}$ is a dummy variable equal to one for treated countries k years before or after it becomes independent. μ_i and μ_t are country and time fixed effects, and ϵ_{it} is the error term. The equation is estimated using the estimator of Sun and Abraham (2021) to account for potential heterogeneous effects in a generalized difference-in-difference setting with different treatment dates. The model is estimated for former U.K. colonies and other colonies.

Results are displayed in Figure 2.4. I find that the probability that a former U.K. colony becomes a tax haven increases by about five percentage points 12 years after becoming independent compared to a territory that does not. This effect is large given that the initial probability of becoming a tax haven a given year is around 3%. The absence of significant pre-trends for U.K. colonies as well as the exogeneity of decolonization suggest that this is a causal effect. The coefficients estimated for other colonies display a different pattern. The estimated coefficients are positive at all dates, in particular before treatment. They are therefore difficult to interpret and do not suggest a causal relationship for this group of countries.

To sum up, the shock of decolonization has been a sizable exogenous shock, particularly for U.K. colonies. This fact helps explaining the significant increase in the number of tax havens and reforms from the sixties in the different descriptive figures above. I will use this shock later to analyze the effects of increasing competitive pressure on tax havens' choices.

2.2.2 . Demand

In this paper, tax havens are seen as suppliers in a specific market, the market for tax avoidance and tax evasion services. The previous subsection has highlighted suppliers' spatial and temporal development in this market. In this subsection, I describe the rise in demand for tax haven operations.

A striking fact about state-building in the 20th century is the rapid spread of modern taxation (Seelkopf et al., 2021). A consequence of this global rise in taxation is that some individuals and firms are now willing to avoid it. It creates a demand for tax avoidance and tax evasion services. On the personal taxation side, this is reinforced by the fact that personal income taxes were characterized by their high degree of progressiveness, with the top marginal tax rate often larger than 60% in the twenties.[21] In this subsection, I correlate the rise of modern taxation to the rise of tax havens.

[21] A recent literature have shown that individuals located at the top of the distribution were more likely to evade taxes (Alstadsæter, Johannesen, and Zucman, 2019, Leenders, Lejour, Rabaté, and Riet, 2020).

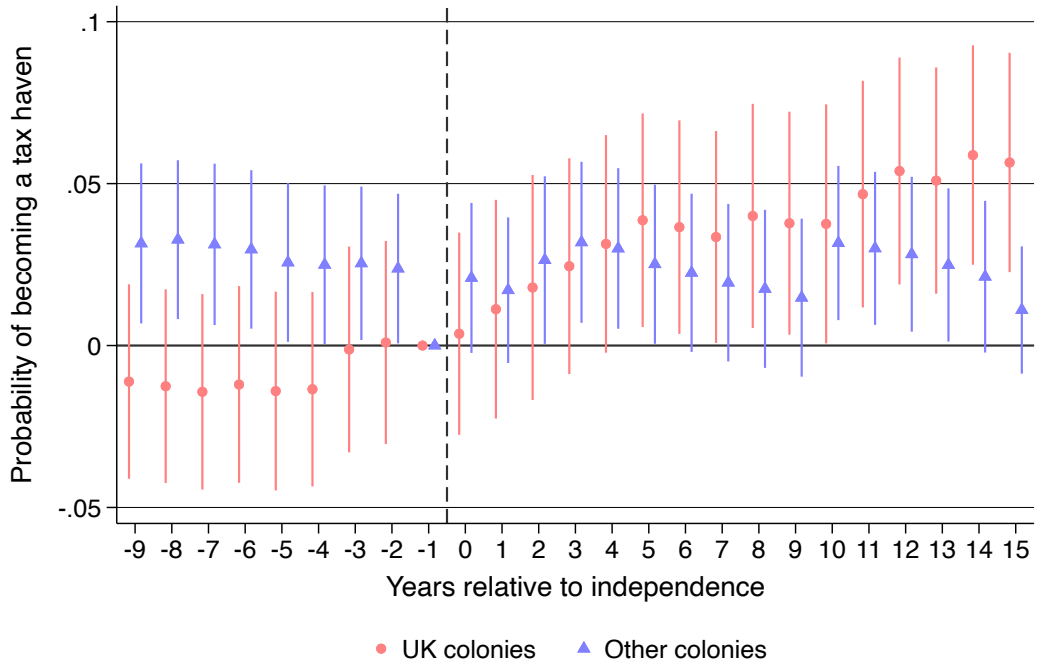


Figure 2.4: Tax havens and decolonization: Event study

Note: This figure plots coefficients from an event-study regression following equation 2.1. I use the Sun and Abraham (2021) estimator. It studies how the probability of becoming a tax haven changes with a country's independence. Red markers correspond to an estimation using only treated countries that are United Kingdom colonies. Blue markers correspond to an estimation using only treated countries that are not United Kingdom colonies. The control group corresponds to territories that have never been independent over the period. Europe is excluded from the regression. The mean of the dependent variable one year before treatment is 0.03. 90% confidence intervals from robust standard errors clustered at the country level.

The rise of taxation and the rise of tax havens Following the hypothesis that the rise in taxes creates demand for tax havens services, figure 2.5 puts in relation the rise in the introduction of modern direct taxation through personal income tax (PIT) and corporate income tax (CIT) and the building of tax havens' architecture. It plots for Europe and Americas the cumulated number of modern direct taxes income taxes introduced in the region and the cumulated number of tax havens reforms in these regions.

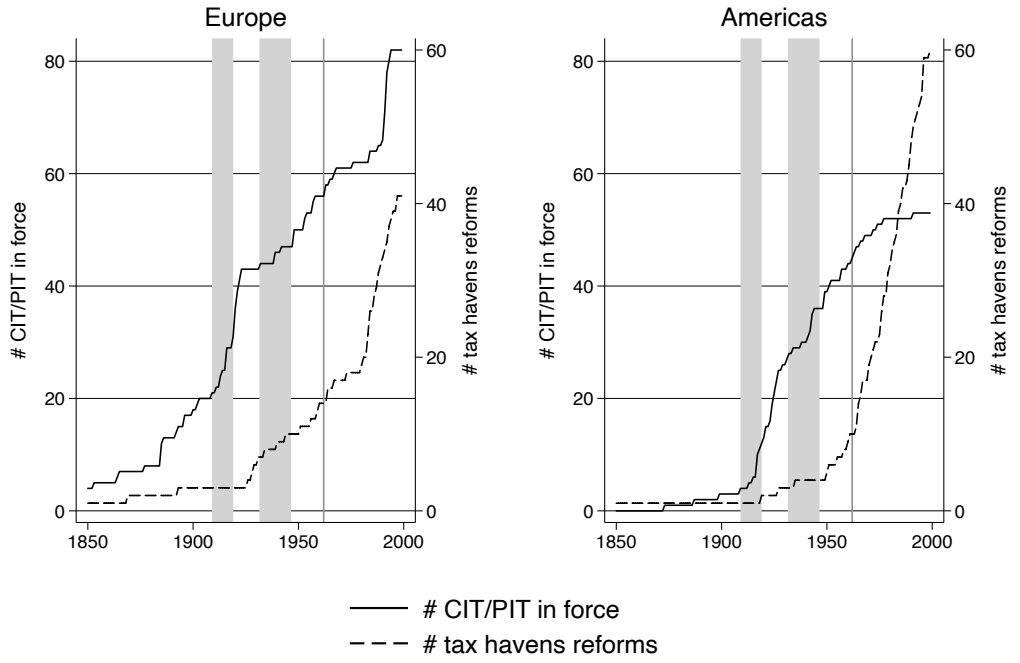


Figure 2.5: The building of tax havens' legal architecture and the rise of direct taxation.

Note: This figure plots the number of direct taxes (Corporate income taxes and Personal income taxes) introduced and the number of tax haven reforms for Europe and the Americas. Data on the introduction of taxes comes from Seelkopf et al. (2021). Data on tax havens' reforms comes from own data collection detailed in section 2.1. Shaded areas indicate the world wars and the vertical line (1962), the beginning of the independence wave in the U.K.-dominated Caribbean area.

The first observation from this figure is that the increase in tax haven reforms always comes after the increase in tax introductions. It suggests that tax introductions impact positively tax haven reforms. For instance, in Europe, the steep rise in direct tax introductions began at the end of the 19th century, while the rapid increase in tax havens reforms began around 1925. On the contrary, the rapid increase in reforms in Europe at the end of the 20th century cannot be easily explained by rising taxation in the same region. A competing explanation, that will be explored later, is that the increasing competition between tax havens pushed them to update their legal architecture.

The figure for Americas reinforces this interpretation. The quick introduction of direct taxation at the beginning of the 20th century is followed by a rise in reforms in tax havens. The break in the trend from the fifties can be

attributed to the decolonization period as described above. However, decolonization or the rise in taxation cannot explain why the number of reforms keeps rising until the end of the century. As for Europe, an interpretation of this trend is that competition between tax havens pushed them to update their legal architecture.

Figure 2.C.2 in the appendix plots the same figure for Asia, Africa, and Oceania. We observe a similar trend in Asia, where there is a lag between tax introductions and the rise in tax havens reforms. The evolution is different for Oceania and Africa, where a steep rise does not directly follow the rise in modern direct taxation in tax reforms.

Gravitational forces and tax haven use These figures correlate the rise of taxation with the rise of tax havens reforms both temporally and geographically. The implicit assumption is that there is a regional component of demand: when taxes are introduced in a country, it increases the demand for tax havens' services in nearby countries. It boils down to the assumption that the costs of tax evasion increase with distance. Bilateral evasion costs are diverse. For instance, they include the extent of compatibility between the regulations in the high-tax country and those in the offshore country. They also include communication and travel costs. Locating its assets in a tax haven means traveling there occasionally, communicating with intermediaries located in the tax haven, etc. These costs are most likely distance-dependent.

This assumption can be backed empirically. There is some evidence for geographically-dependent costs in the literature. Studying the behavior of multinational firms, Ferrari, Laffitte, Parenti, and Toubal (2022) shows that a gravity-like relationship exists for profit shifting between production places and tax havens. This link is also found in the bilateral profit shifting data of Torslov, Wier, and Zucman (2022). Studying individuals' tax evasion in the Netherlands, Leenders, Lejour, Rabaté, and Riet (2020) find that individuals close to a border tend to locate their hidden wealth in the country with which they share the border.

To complement this evidence, I use micro-level data from Offshore leaks (ICIJ, 2022b). The International Consortium of Investigative Journalists (ICIJ) has received data from different leaks in tax-advising firms between 2013 and 2021 (ICIJ, 2022a). This data includes micro-level information on entities opened in several tax havens. When available, the entity is linked with its ultimate owner and the location of this ultimate owner is identified. I use this data to gather information on the country of location of tax-haven entities and of their users. I create a variable that measures the number of links between each (non-haven; haven) pair of countries. A link corresponds to an ownership link between an offshore entity in a tax haven j and an entity in a non-haven country i. I detail the treatment of the data and the main assumptions made to count links between two countries in Appendix 2.D. I estimate the following gravity equation to explain the number of links between two pairs:

$$\#Links_{ijk} = exp\left(\beta_1 ln(Dist._{ij}) + \beta_2 Ever\ Colony_{ij} + \beta_3 Legal\ origins_{ij} + \nu_{ik} + \nu_{jk}\right)\epsilon_{ijk} \quad (2.2)$$

where $\#Links_{ijk}$ is the number of links between non-haven country i and tax haven j released in the leak source k (see the list of sources in appendix 2.D). $Dist._{ij}$ is the geographic distance between i and j, $Ever\ Colony_{ij}$ is an indicator variable that is equal to 1 when both countries have ever been in a colonial relationship and $Common\ Legal\ origins_{ij}$ is an indicator variable that is equal to 1 if both countries share legal origins. ν_{ik} and ν_{jk} are country $\times$ source fixed effects that account for any country-level characteristic and any country $\times$ source-level characteristics such as preferences from the offshore providers exposed in a given leak for some tax havens or some origin countries. ϵ_{ijk} is the error term. Given the count nature of the data, the equation is estimated using a Poisson pseudo-maximum likelihood (PPML) estimator.[22] This equation is estimated on a restricted sample where origin countries are necessarily non-haven countries and destination countries are tax havens to avoid haven-haven links that are less likely to reflect ultimate ownership links. Results are qualitatively similar on the full sample and with data aggregated at the country-pair level.

Results are displayed in Table 2.2. I find that distance plays an important role as increasing distance by 1% decreases the number of links between two countries by approximately 1%. This result supports the hypothesis that bilateral evasion costs increase with distance. It is also important to note that these costs also depend negatively on the legal similarities between the origin country and the tax haven: sharing a common legal origin increases the number of tax evasion links. It can be explained by the fact that two legal systems having the same origin might be more complementary when one wants to evade or avoid taxation. This variable also probably absorbs some colonial links as legal transplantation has followed colonial domination in history.[23]

Table 2.2: Gravity in Offshore leaks data: PPML estimation

	(1) Nb. links	(2) Nb. links
ln(Dist.)	-0.987***	-1.072***
	(0.104)	(0.113)
Colonial link		-0.146
		(0.241)
Common legal origin		1.435***
		(0.227)
Observations	2,291	2,291
Estimator	PPML	PPML
Origin-source and Destination-source FE	Yes	Yes

Robust standard errors clustered at the country-pair level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

[22] The gravity structure of the data also holds using OLS.

[23] Klerman, Mahoney, Spamann, and Weinstein (2011) show that it is difficult to separate the effect of colonial links from the effects of common legal origins in the context of the study of economic development.

These results suggest that distance plays a key role in the relative demand received by tax havens. We can draw a parallel with the notion of market access from the economic geography literature (Redding and Venables, 2004). In this literature, countries that are distant from markets suffer from cost penalties, which impact the wages they can pay for a given level of technology. On the contrary, countries close to markets benefit from smaller costs and can pay higher wages. In the case of tax havens, being close to countries that introduce taxes allows them to serve more demand. Consequently, countries close to large markets with large tax rates will be more likely to become tax havens. Here, it does not matter to be a large country. What matters is to be located close to large countries.

2.2.3 . The market for tax havens' services

Until now, this section has shown that the rise of tax havens in the 20th century is correlated, in time and space, with the rise of modern taxation. Tax havens have been seen as the suppliers of services for tax evasion and tax avoidance but the market itself has not been described. In particular, two questions are in order. First, is becoming a tax haven followed by an increase in the provision of tax haven services? Second, do new tax havens lead to an increase in the market size, or do they substitute for older tax havens?

In this subsection, I use two different settings to answer both questions positively. It allows me to draw a direct link between suppliers - the tax havens - and the market equilibrium.

From reforms to service provision To investigate whether the provision of tax havens services follows new reforms, I use the micro-level data from the Offshore Leaks database described earlier. I now use a different feature of this database that allows me to observe offshore entities, identified by their country of registration and year of creation. I can therefore track the number of entities registered in a tax haven, before and after reform. Entities are seen as a proxy for the provision of offshore services. For this exercise, I concentrate only on reforms that aim at allowing the registration of offshore companies. This is the type of reform that corresponds best to the entities registered in the database. This corresponds to "Exempted Companies" reforms and "International Business Corporations" reforms. I estimate the following event-study regression:

$$arcsinh(Entities)_{it} = \sum_{k=-7}^{20} \zeta_k Haven_{it}^k + u_i + u_t + v_{it} \tag{2.3}$$

where $arcsinh(Entities)_{it}$ is the inverse hyperbolic sine transform of the (cumulated) number of offshore entities registered in tax haven i at date t. This transform is used to smooth the data while keeping zeros in the estimation (Bellemare and Wichman, 2020). $Haven_{it}^k$ is a dummy variable equal to one for treated countries k years before or after it becomes a tax haven. Note that for clarity, I group year dummies into 3-year bins. u_i and u_t are country and time fixed effects and v_{it} is the error term. The control group corre-

sponds to tax havens that have never enacted any exempt company (including IBC) reforms. The equation is estimated using the estimator of Sun and Abraham (2021) to account for potential heterogeneous effects in a generalized difference-in-difference setting with different treatment dates. The model is estimated differently for "Exempted Companies" reforms and "International Business Corporations" reforms.

Figure 2.6 shows different results for both types of reforms. First, IBC reforms appear efficient in terms of entity incorporation. Following the reform adoption, the number of offshore entities recorded in the Offshore leaks data increases by 460% after.[24] The effects appear from the first three years of implementation and increase during the next nine years. Estimates before the treatment are very close to zero and not statistically significant.

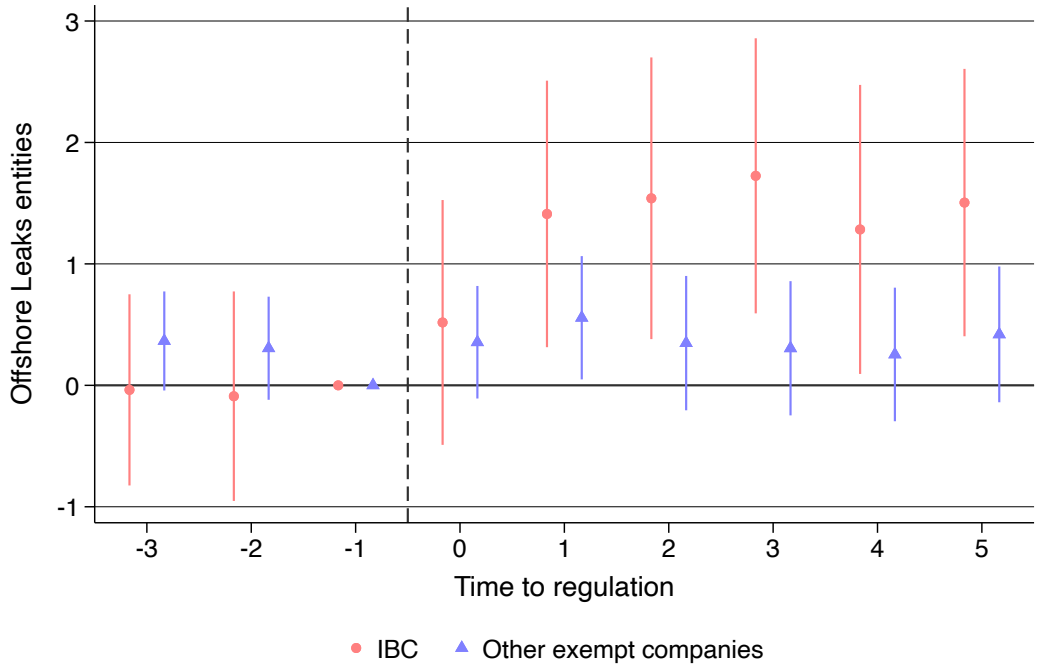


Figure 2.6: Tax havens reforms and tax havens services: Event study

Note: This figure plots coefficients from an event-study regression following equation 2.3. Independent variables correspond to 3-year dummies. It studies how the number of offshore entities registered in a tax haven changes when the country enacts a new reform. The dependent variable has been transformed using the inverse hyperbolic sine transformation to keep zeros in the estimation. Red markers correspond to International Business Corporation reforms. Blue markers correspond to other exempt company reforms. The control group corresponds to tax havens that have never enacted any exempt company (including IBC) reforms. The mean of the dependent variable one year before treatment is 0.53. 90% confidence intervals from robust standard errors clustered at the country level.

Exempt companies follow a different path. On average, there is no appar-

[24] $exp(1.72)-1 = 4.6$. To compute this effect, I follow Bellemare and Wichman (2020) that provide elasticity formulas for inverse hyperbolic sine transformations. This computation holds in particular for large values of the dependent variable which is likely to be verified in this case. The average value of the number of entities in the estimation sample is 1080.

ent effect of these reforms on incorporation. If any, there is a slightly positive effect, but its interpretation is made uncertain due to the existence of a pre-trend. In any case, the effect is lower than that of IBC reforms. It highlights the importance of IBC reforms and their effectiveness.

This figure shows that tax-haven reforms, in the context of company incorporation at least, materialize into an increase in the provision of tax haven services. The effect of reforms is however heterogeneous according to the type of reform.

The Swiss market for tax evasion The previous exercise draws a link between reform and service provision. This increase in the provision of services can be at the expense of tax havens already supplying the market or could expand the size of the market. This latter effect could materialize in the case of reforms implementing legal innovations that likely cut the costs of tax havens services.

The first challenge to answering this question is finding historical data about tax havens services' market size. To do so, I use data from Zucman (2013) that collects fiduciary deposits in Switzerland by country of origin between 1976 and 2014 from the Swiss National Bank (SNB). Fiduciary deposits are deposits collected by Swiss banks and invested on behalf of their clients. As described by Zucman (2013), fiduciary deposits are used to avoid paying the 35% Swiss advance tax.[25] An interesting feature of this data is that the SNB records the origin of the last owner and does not see through conduit entities in tax havens. Consequently, it records investments made through tax havens from other places. Zucman (2013) argues that the majority of these investments are actually coming from European ultimate owners and are going to Switzerland through conduits in tax havens. Going through tax havens adds layers of secrecy between Swiss accounts and their actual owners. Assuming that the bulk of fiduciary deposits of tax havens corresponds to the use of sham corporations (such as IBCs for instance), an increase in the share of fiduciary deposits from tax havens corresponds to an increase in tax havens' market size for the Swiss market. The Swiss market is one of the largest ones for individuals' tax avoidance: according to Zucman (2013) it represented 34% of all offshore financial wealth in 2008 and it was probably even larger before this date (Alstadsæter, Johannesen, and Zucman, 2018). An increase in the share of fiduciary deposits from a given tax haven corresponds to an increase in market share from this tax haven in the Swiss offshore market.

Figure 2.7 plots the market size of tax havens and decomposes it between countries that become tax havens before 1960 and countries that become tax havens after this date. This year represents the moment of the entry of new tax havens following decolonization (see figure 2.C.3 in appendix). These tax havens will develop their activity gradually during the end of the 20th century. We observe that the global size of the tax haven market in the Swiss place has been increasing over the period, especially since the beginning of the nineties.

[25] More precisely, any interest received on fiduciary deposits are considered as paid by foreigners. The bank acts as "fiduciary". This feature allows a tax exemption.Fiduciary deposits represent one quarter of all foreign holdings in Switzerland in 2008.

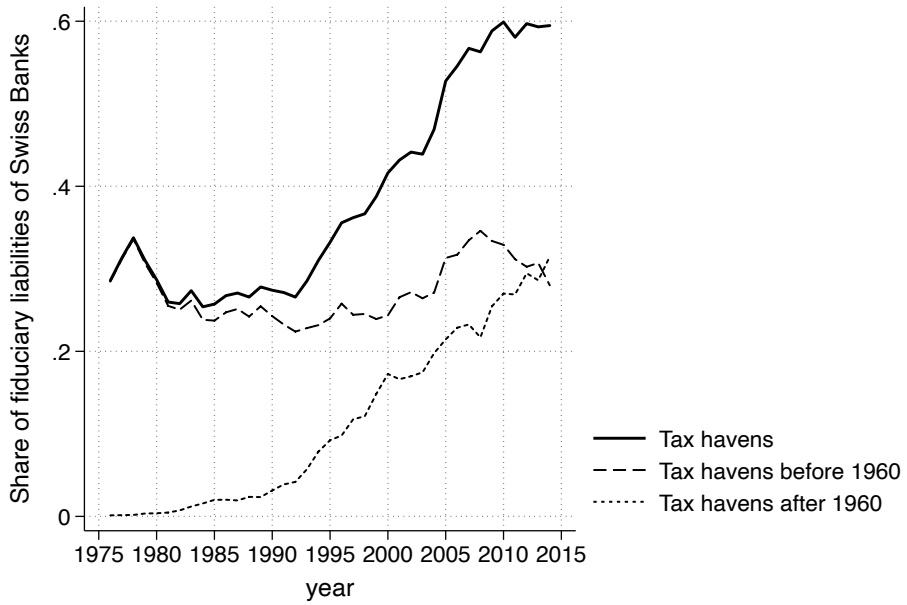


Figure 2.7: The Swiss Market for tax havens' services

Note: This figure plots the share of fiduciary liabilities of Swiss banks by the origin country of the direct owner. Fiduciary deposit data is from Zucman (2013) which collects fiduciary deposits in Swiss by origin from the Swiss National Bank (SNB). Fiduciary deposits are deposits collected by Swiss banks and invested on behalf of their clients. They are used to avoid paying some Swiss taxes. The SNB records the last owner's origin and does not see through conduit entities in tax havens. Data on tax havens' reforms comes from own data collection detailed in section 2.1. The category "Tax havens" includes all tax havens covered in the SNB dataset. This represents the market share of tax havens in Swiss fiduciary deposits. "Tax havens before 1960" includes entities that become tax havens before 1960: Andorra, Netherlands Antilles, Bahamas, Bermuda, Cayman Islands, Honk-Kong, Isle of Man, Ireland, Jersey, Lebanon, Liberia, Liechtenstein, Luxembourg, Monaco, Netherlands, and Panama. "Tax havens before 1960" includes entities that become tax havens after 1960: Aruba, Antigua and Barbuda, Bahrain, Belize, Barbados, Cyprus, Dominica, Guernsey, Gibraltar, Grenada, Jordan, Saint Kitts-and-Nevis, Saint Lucia, Macao, Marshall Islands, Malta, Mauritius, Malaysia, Nauru, Singapore, Seychelles, Turks and Caicos Islands, Tonga, Saint Vincent-and-the-Grenadines, Virgin British Islands, Vanuatu, and Western Samoa.

The share of the older tax havens has been oscillating around 30% of all deposits with a little upward trend since the nineties.

Importantly, the market share of new tax havens has constantly been increasing, reaching the level of old tax havens after 2010. This increase in the share of new tax havens is not associated with a sharp decrease in the share of old tax havens, indicating that substitution between new and old tax havens should have been limited. On the contrary, the total market share of tax havens in Switzerland, proxied by the thick black line, has constantly increased. We can conclude from this graph that there is a positive correlation between the entry of new tax havens since the sixties and the increase in the market size of tax havens. In other words, the entry of new tax havens has contributed to the increase in the market size of tax havens. It must also be noted that the increase in the share of fiduciary deposits held in Switzerland is positively correlated with the increase in offshore entities recorded in the Offshore Leaks (see table 2.B.2 in appendix).

2.3 . A Theoretical Framework

This section presents a conceptual framework that describes the fundamental forces underlying the choice of a government to become a tax haven and update its legal architecture.

To build it, I use the legal capacity building framework of Besley and Persson (2011). This choice is motivated by the fact that this type of model allows for a rich characterization of a country's institutions. Beyond the tax rate, I need to model the tax havens' legal architecture and its change. Models à la Besley and Persson (2011) are particularly centered on institutions and their evolution and therefore correspond well to the objectives of this section.

In this 2-periods framework, a utility-maximizing government chooses its tax rate and the level of productive infrastructures. Between the two periods, it can decide to invest in its level of productive infrastructure in order to increase revenues in period 2. To attract more tax revenues, he can also decide to set up an offshore legal architecture. This legal architecture can be upgraded through investment between period 1 and period 2. Comparing its utility over the two periods, the government chooses before period 1 if it chooses to become a tax haven.

This framework is centered on the tax haven decision and not on the reaction of non-haven countries. In this respect it is different from the tax competition models with endogenous tax havens (Slemrod and Wilson, 2009, Bucovetsky, 2014). These models generally assume countries that only differ by their size. In my framework, countries must not be symmetric to allow for geography and market access of tax havens. This framework is particularly designed to explain the trajectory of tax havens in the first half of the twentieth century, where competition between tax havens was likely limited (see above in section 2.2).

A simple economy Consider a simple economy where a government makes its choices taking the state of the economy in foreign countries as granted

(mimicking the small open economy framework). There are two time periods $s = 1, 2$ and the population corresponds to N homogeneous individuals. The utility of a given individual is $u_s = (1 - t_s)y(\pi_s) + \alpha_s g_s$ with y its revenues, t_s the income tax rate, and g_s its consumption of a public good. Revenues are a positive function of the level of infrastructure in the country π_s. π_s encompasses the legal support such as the administrative support or property rights protection but also more generally the level of public infrastructures in the economy such as education or health infrastructures. [26] It can be seen as the productivity of the real sector of the economy. $\alpha_s \geq 1$ is the value of the public good.

The tax rate t_s and the level of infrastructure π_s are constrained by the fiscal capacity τ_s and the infrastructure capacity Π_s. As seen later, in this simple model a non-haven government sets the highest possible tax rate and infrastructure level. The fact that they are constrained will push governments to invest in their respective capacities in order to increase the future revenues. Here, because we are interested in tax havens that generally set taxes under the level of fiscal capacity, we consider the fiscal capacity as fixed: $\tau_s = \tau$. The government can invest in infrastructure by paying a cost defined as follows: $\mathcal{L}(\pi_2 - \pi_1)$. The cost is a positive and convex function of the difference between the levels of infrastructure in period 2 and in period 1 with $\mathcal{L}(0) = 0$.

Before considering the model where a country can choose to become a tax haven, I describe the optimum solution in the standard case.

The government budget is :

$$\underbrace{t_s y(\pi_s) N}_{\text{Revenues}} = \underbrace{g_s N + m_s N}_{\text{Expenses}}$$
$$\text{s.t. } t_s < \tau,$$
$$\pi_s < \Pi_s$$

with m_s the cost of investment per capita (which is 0 when $s = 2$). The tax revenues on the left-hand side should equal the government expenditures on the right-hand side: public goods provision and investment in infrastructures. As described in detail later, becoming a tax haven will precisely affect the government budget by bringing tax revenues from the taxation of offshore activity. Note that in the non-haven case, the size of the population will not matter. It will become important when introducing tax havens.

The timing is the following: τ_1, Π_1, α_1 and α_2 are given in stage 0.[27] The government chooses whether or not to become a tax haven by writing a law. At the beginning of period 1, the government chooses a set of period-1 policies: $\{t_1, \pi_1, g_1\}$ and invest to determine Π_2. At the beginning of period 2 the government chooses a set of period-2 policies: $\{t_2, \pi_2, g_2\}$. The model is solved by backward induction.

[26] This enlarges the definition of the fiscal capacity from Besley and Persson (2011). However, it is in line with their interpretation that investment in productive infrastructures and legal capacity share many similarities, see section 3.2 of their book.

[27] As it would not bring key results in this framework, the value of the public goods in period 2 is assumed to be known to the government in period 1.

A non-haven government maximizes:

$$\begin{aligned} u_s^I &= (1-t_s)y(\pi_s) + \alpha_s g_s \\ \text{s.t } t_s y(\pi_s) &= g_s + m_s, \\ t &\leq \tau, \\ \pi_s &\leq \Pi_s. \end{aligned}$$

The level of public goods can be written as a residual from the government constraint: $g_s = t_s y(\pi_s) - m_s$. Therefore, taking into account the level of the public goods, the government now maximizes:

$$u_s^I = (1-t_s)y(\pi_s) + \alpha_s \left(t_s y(\pi_s) - m_s\right)$$

What is the level of infrastructures and taxes? A first result of the model is that they are both set at their maximum possible level, those of their respective capacities.

Proof: the first order conditions are

$$\begin{aligned} \frac{\partial u_s^I}{\partial \pi_s} &= (1-t_s)\, y_\pi + \lambda_s t_s y_\pi \geq 0 \text{ (infrastructures)} \\ \frac{\partial u_s^I}{\partial \pi_s} &= -y_\pi + \lambda_s y_\pi \geq 0 \text{ (taxes)} \end{aligned}$$

with $y_\pi = \frac{\partial y(\pi_s)}{\partial \pi_s}$. This notation, where derivation is noted with subscripts is applied for other variables in the rest of the paper.

Increasing the level of infrastructures or the level of taxation always increases utility. At the optimum, $t_s = \tau$ and $\pi_s = \Pi_s$. To increase utility in period 2, the government can invest in the infrastructure capacity, which will increase the general level of infrastructures in period 2, therefore increasing revenues.

I now describe how the level of investment is set. The investment in infrastructure capacity is an intertemporal problem. The government sets the optimal level of infrastructures in period 2 by maximizing its utility over the two period.

$$W = (1-t_1)y(\pi_1) + \alpha_1 \left(t_1 y(\pi_1) - m_1 \left(\pi_2 - \pi_1\right)\right) + (1-t_2)y(\pi_2) + \alpha_2 \left(t_2 y(\pi_2)\right)$$

By maximizing W, I find that the level of investment in the public infrastructures is defined by:

$$\underbrace{\alpha_1 \mathcal{L}_\pi (\pi_2 - \pi_1)}_{\text{Marginal cost of investment}} \quad \geq \quad \underbrace{y_\pi \left[1 + (\alpha_2 - 1)t_2\right]}_{\text{Marginal benefits from investment}} \tag{2.4}$$

The government invests in the infrastructure capacity until the marginal cost of investment (lower public goods provision in period 1) is equal to or larger than the marginal benefits (higher revenues and higher public goods provision in period 2). The left-hand side is equal to 0 when there is no investment. The right-hand side is always positive because $\alpha_2 \geq 1$. Therefore, investment in the public infrastructure capacity will be positive. I use this condition as a benchmark to compare it with the situation where the country is a tax haven.

The tax haven option I now introduce the possibility for a country to become a tax haven. The government can choose to write a law before period 1 to make its country a tax haven for periods 1 and 2. I assume that the government of a tax haven has the ability to tax foreign offshore revenues, ω_s^F. This modeling of tax evasion aims at being very simple to be as broad as possible and cover different uses of tax havens. It is possible to interpret it as individual tax evasion when an individual uses a trust structure or opens an international business company to channel its revenues in the tax haven in exchange of a small tax or a fee. It can also be interpreted as a firm shifting its revenues to the tax haven. Benefits of becoming a tax haven only come from higher tax revenues. As argued before, both types of specialization (firms or individuals) bring revenues to tax havens. Tax havens benefit from tax evaders only through additional taxes. As noted by Slemrod and Wilson (2009), this could extend to any indirect source of revenues such as revenues from tourism.

This new source of revenues comes with a constraint: the tax rates on the domestic economy and on the offshore revenues cannot be independent. I assume that the tax rate on the domestic economy is proportional to the tax rate on the offshore revenues: $t_s^D = \delta t_s$ with t_s^D the tax rate on the domestic economy, t_s the tax rate on the offshore economy and $\delta \geq 1$. In absence of this constraint, becoming a tax haven is always utility-maximizing.

This constraint creates a trade-off: decreasing its tax rate to attract more offshore revenues is done at the expense of the domestic economy. This is a similar mechanism as in Slemrod and Wilson (2009). From an empirical point of view, tax rates on the domestic economy in tax havens tend to be lower than those of comparable countries. [28] More broadly, this assumption boils down to assuming that developing the offshore economy absorbs resources from the domestic economy.

The demand for tax haven services Before describing how becoming a tax haven affects the choices of the country, I put more structure on ω_s^F, the demand for tax haven services addressed to the country of interest. To do so, we look at the behavior of taxpayers in other countries indexed by i. The utility of individual n when she pays taxes in i (no evasion) is: $V_i = (1 - t_i)\omega_i + \varkappa_h$ with ω_i its revenues and $\varkappa_h$ the preference of individual n for paying its taxes in i, distributed Gumbel. [29] We can interpret it as tax morale for instance. The individual can also choose to evade its taxes by locating all of its revenues in a tax haven $h \in \{TH\}$.

[28] Table 2.E.1 in appendix 2.E compares the corporate and individual tax rates on the domestic economy in tax havens and non havens. It shows that tax rates in tax havens tend to be smaller than those in non havens by 5 percentage points for personal taxation and 7 points for corporate taxation. As this gap might be driven by some characteristics independent from the tax haven status, I control for different country characteristics in figures 2.E.1 and 2.E.2. The figures reveal that tax havens have lower tax rates than similar countries, confirming the empirical foundations of this hypothesis. One can also imagine that a disconnection between both tax rates will push taxpayers to try to appear as foreigners in order to benefit from the lower tax rates. This is for instance what happens with round-tripping when firms invest in their domestic countries through foreign entities to benefit from advantageous conditions. See for instance Hanlon, Maydew, and Thornock (2015).

[29] This assumption allows to have a functional form for ω_s^F.

The service of tax evasion is sold competitively in each tax haven. I assume its marginal cost to be $\frac{1}{p_h}$ with p_h the quality of tax haven h. The quality of the tax haven represents how effective is the process of tax evasion in a country. It can be mediated through better offshore laws, better communication and travel infrastructure, better administrative and legal efficiency in the offshore sector, incentives for foreign banks and law firms to establish, etc. It works as a cost shifter parameter that decreases the cost of using the country as a tax haven when it increases. On top of this cost, an individual from i has to pay an iceberg bilateral cost τ_{ih} that corresponds to communication costs, transport costs, and any other bilateral cost (the compatibility between the law systems of i and h for instance). This assumption is empirically relevant as demonstrated in section 2.2. I also assume that one has to use an intermediary in h to use it a tax haven. The taxes paid by the intermediary firms in tax havens are fully passed-through to consumers.[30]

The total cost of evading taxes in country h is therefore: $\frac{\tau_{ih}\omega_i}{p_h(1-t_h)}$ The utility of the individual that evades taxation is h is $V_h = (1-t_h)\omega_i - \frac{\tau_{ih}\omega_i}{p_h(1-t_h)} + \varkappa_h$. In both cases, U_k is the deterministic part of the utility. Using the properties of the Gumbel distribution, the probability that an individual in i pays its taxes in country h, noted $\mathbb{P}_{ih}$, is

$$\begin{aligned}\mathbb{P}_{ih} &= \mathbb{P}(V_h > V_k, \forall k \in \{TH\} \cup \{i\}) = \mathbb{P}(\varkappa_k < \varkappa_h + U_h - U_k) \\ &= \frac{exp\left((1-t_h) - \frac{\tau_{ih}}{p_h(1-t_h)}\right)}{\sum_{k\in\{TH\}} exp\left((1-t_k) - \frac{\tau_{ik}}{p_k(1-t_k)}\right) + exp(1-t_i)}\end{aligned}$$

This represents the share of people evading taxation in country i to tax haven h. As an individual that evades taxes shelters all his revenues in the tax haven, we can deduct the total amount of revenues sent from country i to tax haven h, which represents the demand from i to h and the total demand addressed to h

$$\omega_s^F = \sum_i D_{ih} = \sum_i N_i \omega_i \mathbb{P}_{ih} \tag{2.5}$$

Demand has the desired properties as it decreases with the tax haven tax rate and the bilateral costs. It increases with the quality of the tax haven. Importantly it also decreases with the number of competitors and their bilateral costs relative to non-haven countries. In a parallel with economic geography literature (Redding and Venables, 2004), ω_s^F can be seen as the market access of tax havens for exchanging tax haven services. In particular, variations in market access are partially driven by geography, which is an arguably exogenous factor. This suggest that this property can be used for the empirical identification of the effect of demand on the supply of tax haven services.

Tax rate, legal support, and tax haven quality The optimal public good level is set similarly as in the non-haven case. The new government objective

[30] This assumption allows the demand to be zero when taxes in the tax haven are equal to one.

function writes:

$$u_s^I = (1-\delta t_s)y(\pi_s) + \frac{\alpha_s}{N}\left[\delta t_s y(\pi_s)N + \underbrace{t_s\omega_s^F\left(p_s,t_s\right)}_{\text{Haven-specific revenues}} - m_s N\right]$$

Once a country is a tax haven it has to choose its quality p_s. By increasing its quality, the tax haven becomes more attractive, which increases ω_s^F. The quality of the tax haven is constrained by the "tax-haven-quality" capacity noted P_s. Between periods 1 and 2, the government can invest in P in order to be able to raise its quality capacity in period 2. The cost of investment is noted $\mathcal{P}(p_2 - p_1)$ and has the same properties as $\mathcal{L}$.

Intuitively, as we can see π_s as the productivity of the real sector, p_s can be interpreted as the productivity of the offshore sector. Their relative strength can therefore be indicative of the advantage a country has in a sector.

We can now solve for the optimal tax rate, legal support and tax haven quality. To set its tax rate, the government maximizes its utility. Contrary to the non-haven case, where the tax rate is set at the level of the fiscal capacity, in this case, the tax rate might be set at a rate lower than the fiscal capacity. Therefore the tax rate is determined following the first-order condition:

$$\frac{\partial U_s}{\partial t_s} = \delta y(\pi_s)(\alpha_s - 1) + \frac{\alpha_s}{N}\left(\omega^F + t_s\omega_t^F\right) = 0 \tag{2.6}$$

with ω_t^F, the partial derivative of ω_s^F by t. The tax rate is set at the point where the marginal revenues from a higher tax rate equal the marginal losses on the offshore economy. There is no explicit solution to this equation. I note t_s^* the solution of this equation. The tax rate on domestic activity is set to $t_s^D = min\{\delta t_s^*, \tau_s\}$. In the rest of the exposition, I will consider that $t_s^D = \delta t_s^*$, *i.e.* that δt_s^* is small enough to be lower than the fiscal capacity. The optimal infrastructure level and tax haven quality are set the same way as in the non haven case. They are set at their maximum possible level, *i.e.* est their respective capacities (see proof in appendix 2.F).

Investment in legal support and tax haven's quality In order to enhance its expected utility of the two periods, the government can now invest in its infrastructure capacity and its tax haven quality. It does so by maximizing its expected utility over the two periods.

Implication 1 : Tax havens always invest in their quality. The more so if the costs of investment are low. In particular this is the case when the tax haven quality is small (as the cost function is convex) and when new legal technologies reduce the marginal cost of investment, $\mathcal{P}_p$, for all p. The introduction of a new legal technology that decreases costs therefore increases investment in quality.

Proof: the two following conditions describe investment in infrastructure capacity and tax-haven quality:

$$\alpha_1 \mathcal{L}_\pi(\pi_2 - \pi_1) \geq y_\pi \left[1 + (\alpha_2 - 1)\delta t_2\right] \quad (2.7)$$

$$\alpha_1 \mathcal{P}_p(p_2 - p_1) \geq t_2 \frac{\alpha_2}{N} \omega_p \quad (2.8)$$

The government invests in the infrastructure and tax haven quality until the left-hand side of equations 2.7 and 2.8 are larger than the right-hand side. The left-hand side corresponds to the marginal cost of investment weighted by α_1, the marginal value of foregone tax revenue in period one. The right-hand side corresponds to the marginal gains of investment. As $\mathcal{L}(0) = 0$ and $\mathcal{P}(0) = 0$, it means that investment in infrastructure and tax haven quality will be positive as long as the right-hand side is positive. This is the case because $\alpha_1 - 1 > 0$.

Note that investment in the general public infrastructure is lower in tax havens than in non-haven countries. This result comes from the comparison of the investment condition in infrastructure when the country is a tax haven and when it is not. Both are very similar since the only difference is that it is scaled by a different tax rate. Because the equilibrium tax rate on the domestic economy is lower in tax havens than in other countries, this makes the investment in productive infrastructure less valuable. This result is important as it implies that tax havens, despite maximizing welfare, will invest less in the general public infrastructure than if they were not tax havens.

Which countries become tax havens? We now have all the elements to compare the utility when a government chooses to make its country a tax haven or not. The government does so by comparing utilities in both cases. The country becomes a tax haven if $U^H > U^{NH}$ over the two periods: $\mathbf{1}\{Haven\} = \mathbf{1}\left\{U^H > U^{NH}\right\}$. I define $\Delta_U = U_1^{TH} - U_1^{NTH} + U_2^{TH} - U_2^{NTH}$, the difference between the utility when the country is a tax haven and when it is not.

$$\begin{aligned} U^H - U^{NH} = & \underbrace{y(\pi_1^*)\left(\delta t_1^{H*} - t_1^{NH*}\right)}_{\text{More domestic revenues in non-haven countries}} \underbrace{(\alpha_1 - 1)}_{\text{Net value of publics funds}} \\ & + \frac{\alpha_1}{N}\left(\underbrace{t_1^{H*}\omega_1^F}_{\text{Offshore sector revenues}}\right) + \underbrace{m_1^{NH*} - m_1^{H*}}_{\text{Differences in investment}} \\ & + \left(1 + (\alpha_2 - 1)\,\delta t_2^{H*}\right) y(\pi_2^{H*}) - \left(1 + (\alpha_2 - 1)\,t_2^{NH*}\right) y(\pi_2^{NH*}) \\ & + \frac{\alpha_2}{N} t_2^{H*}\omega_2^F \end{aligned}$$

The first line shows the losses from becoming a tax haven due to lower tax revenues on the domestic economy. These lower tax revenues only impact the difference in utility if the net value of public funds is strictly positive. The level of infrastructures, by increasing revenues, increases the value of these losses. The second line shows the gains from becoming a tax haven due to higher tax revenues on the offshore economy. It also shows the role of the differences in investment in legal capacity and tax haven quality. The third and fourth line are the equivalent of the two first lines for the second period. The only difference

is that $y(\pi_2^{H*}) < y(\pi_2^{NH*})$ because the investment in infrastructures has been lower in the tax haven. As a consequence, the higher the cost of investment in infrastructure, the higher the probability of becoming a tax haven all other things being equal.

I now describe how ΔU is impacted by country size (N), changes in foreign tax rates (t_i), and initial levels of infrastructure and haven quality (π_1 and p_1) .

Implication 2: The probability that a country becomes a tax haven decreases with its size.

Proof in appendix 2.F where I show that $\frac{\partial \Delta_U}{\partial N} \leq 0$. This result is due to the fact that a large population size provides more domestic tax receipts while not affecting offshore tax receipts. This result is in line with observations that tax havens are generally small countries. A similar result, with a different theoretical setting, is obtained by Slemrod and Wilson (2009).

Implication 3: The introduction of taxes in foreign countries increases the probability that a country becomes a tax haven. This probability decreases when distance with these countries increases and decreases with country size.

Proof in appendix 2.F. Intuitively, the introduction of taxes in foreign countries increases demand all other things being equal. Therefore it increases the potential revenues from becoming a tax haven. This benefits more tax havens that are closer to the country that introduces taxes because costs rise with distance, and tax havens that are smaller because the benefits of becoming a tax haven decrease with size. This result shows the key role of the market access of tax havens.

This result explains well the patterns uncovered in the previous section that links the rise of taxation in a continent and the subsequent rise in the number of tax haven reforms.

Implication 4: The higher the level of initial tax haven quality, the higher the probability of becoming a tax haven. On the contrary the higher the initial level of infrastructure, the lower the probability of becoming a tax haven. This implication exhibits the role of absolute advantage. Countries with large p compared to π will have more incentives to become tax havens.

Proof in appendix 2.F. This result is due to the fact that higher initial quality will increase the utility to become a tax haven compared to staying a non-haven country. As a consequence, if we make the hypothesis that the common law provides key legal instruments for offshore activity, common law countries are more likely to become tax havens, all other things being equal. The hypothesis of a greater offshore potential of the common law lies in the fact that trust laws are a key instrument of offshore practices and that they find their origins in the English common law (see Palan, Murphy, and Chavagneux, 2009, Pistor, 2019 or Harrington, 2016 for discussions). Besides, if we assume the newly decolonized countries have a low level of infrastructure, we find that U.K. newly decolonized countries are more likely to become tax havens. This can explain the pattern found in figure 2.4 that there is a causal impact of decolonization on the probability of becoming a tax haven. It also confirm that the reaction of countries to this shock directly depends on their characteristics.[31]

[31]On a side note, combined with Implication 1, these results can shed light on the empirical results of Dharmapala and Hines (2009). The authors argue that, on average, tax havens are

Discussion This model does not include competition between tax havens. Such extension is left for future work. A few remarks are in order. Competitors enters directly in the specification of the demand, ω_s^F, which decreases with the number of tax havens. Consequently, an exogenous increase in the number of competitors will negatively affect the demand, all other thing being equal. to maintain constant demand, tax havens have to either decrease their tax rates or to reinforce their legal architecture. While tax rates are constrained, this is not the case of the legal architecture that has much more flexibility.

We can also note, that the level of competition from other tax havens will also depend on their access to demand. Other tax havens that are further away from demand (high τ_{ih} with many i countries for instance) have a lower impact on competitive pressure than closer tax havens. A consequence of this is that tax havens that are close by compete for the same demand and therefore exert a higher competitive pressure on others. as with demand, competition has a geographical component. This will be used in the empirical analysis to identify the effect of increased competition on tax havens' policies.

2.4 . Demand shocks in tax havens

The theoretical framework shows that the market access of tax havens is a driver of their development (Implication 3). A first exploration of the data in section 2.2 motivates the analysis by providing descriptive evidence about the correlation between increasing taxation in close countries and new reforms. To test this proposition, I use the temporal and spatial variation of the demand shocks triggered by the increase in taxation in the 20th century.

Demand shocks The conceptual framework indicates that this demand has a geographical component (Implication 3). The geographical variation in demand comes from i) the assumption of bilateral evasion costs and ii) the assumption that bilateral costs increase with distance. The assumption that bilateral costs increase with distance is critical in the identification as it creates country-level variation in the demand faced by a country. A country further away from the shock experiences a lower increase in demand than a closer country. The empirical relevance of this assumption has been demonstrated in section 2.2 by studying the elasticity of offshore use to distance.

I construct demand shocks received by country i as an average of other countries' tax level, weighted by the size of these countries (proxied by population) and their distance with country i. This specification has the advantage of being easy to interpret and can deliver elasticities of reforms to foreign demand. The weight is constructed as follows: $W_{ijt} = \frac{ln(pop_{jt})}{ln(dist_{ij})}$. pop_{jt} is the num-

better-governed countries than other countries. They also write that they cannot establish the direction of the causality. In their empirical framework, governance is measured by voice and accountability, political stability, government effectiveness, rule of law and control of corruption. One can argue that these variables are associated with a larger tax haven quality p_s. Indeed all these variables are likely to decrease the cost of using a tax haven by providing stability and predictability to its users. Implication 3 implies that a higher initial p_1 is associated with a higher likelihood of becoming a tax haven, while Implication 1 suggests that tax havens invest in their governance. In other words, the causality likely goes in both directions.

ber of inhabitants in country j at date t and $dist_{ij}$ is the geographical distance between countries i and j. From these weights, I compute demand as:

$$D_{it} = \left(\sum_{j} W_{ijt} \right)^{-1} \times \sum_{j} \left(W_{ijt} \times \frac{Direct\ Tax\ Revenues_{jt}}{GDP_{jt}} \right) \tag{2.9}$$

The tax rate in country i is proxied by the average direct tax revenues in GDP, which is a macro-level proxy for the effective tax rate on (any) revenues. Data comes from the Government Revenues Dataset (Andersson and Brambor, 2019a; Andersson and Brambor, 2019b). I assess the robustness of this specification at the end of the section.

Identification To study the effect of demand on reforms transforming countries in tax havens, I estimate the following equation:

$$\mathbb{1}_{Reform_{it}} = \alpha_1 ln(D_{it}) + \chi Z_{it} + \mu_i + \mu_t + u_{it} \tag{2.10}$$

with $\mathbb{1}_{Reform_{it}}$ an indicator variable equal to 1 if country i makes a reform at date t, $ln(D_{it})$, the logarithm of the demand received by country i at date t. Z_{it} is a vector of control variables, and χ is the associated vector of coefficients. Control variables include an indicator variable for being independent at date t and the number of years since independence. In specifications without country fixed effects, I also include the log of the size of the country, an indicator variable for being a (current or former) U.K. colony, and indicator variables for common law and civil law. Country fixed effects and time fixed effects are introduced through μ_i and μ_t. u_{it} are the residuals. The equation is estimated using a linear probability model. [32] All countries, including countries that never become tax havens, are included in the estimation sample.

The demand corresponds to a i-specific average of the tax rate in foreign countries weighted by the size of these countries and the distance of these countries to country i. In the cross-section, the variation comes from the fact that bilateral distance is unique for all pairs of countries. Any difference in the level of taxation in a foreign country j affects all other countries in the world differently. Besides, this source of variation is exogenous as it is based on geography. In the time dimension, variation in the demand received by country i comes from changes in the tax environment in foreign countries j. Overall, different countries are affected differently by demand shocks based on geography and on the timing of tax changes in foreign countries.

Endogeneity The identification of the impact of demand shocks on tax haven formation raises empirical identification concerns. In particular, some shocks can affect both the revenues to GDP ratio observed in foreign non-haven countries and the probability of doing a reform. It can typically happen in the case of

[32] According to Timoneda (2021), a linear probability model with fixed effects if well-suited for estimating models with rare events, which is the case in our data. It also facilitates the use and interpretation of instrumental variables and interaction models.

a large regional shock such as a war, that will affect both tax rates (increasing them to finance the war) and the probability that countries become tax havens due to capital flight.

To deal with this issue, I propose an exogenous instrument. The goal of the instrumentation strategy is to construct a variable that affects the probability of doing a reform only through its effect on the tax-rate-driven demand for tax havens services. To do so, I construct a variable that predicts tax revenues based only on exogenous variables. Then, I use this variable to construct an exogenous demand variable.

In particular, Kiser and Karceski (2017) highlight three important determinants of tax revenues from a comparative perspective: war, democracy, and development. First, the occurrence or the threat of war has been extensively discussed as a determinant of tax revenues (Tilly, 1990). However, as just described, the occurrence of war might be correlated both with tax levels and tax flight and does not constitute a good candidate for the IV. Apart from their effect on tax rates, democratization and development are more likely to be independent of the formation of tax havens in close countries as they are generally country-specific, contrary to war that can affect a whole region and therefore have a much more significant impact on foreign countries. I, therefore, use these two variables to predict exogenous tax to GDP ratios.

In an initial stage, I construct the predicted share of direct taxation in GDP by estimating the following regression:

$$\begin{aligned} ShareDirect_{jt} &= \theta_1 ln(GDPpc_{jt}) + \theta_2 ln(GDPpc_{jt})^2 + \theta_3 Democracy_{jt} \\ &+ \delta_t + e_{jt} \end{aligned} \tag{2.11}$$

where $ShareDirect_{jt}$ is the share of direct taxation in GDP in country j at date t, $ln(GDPpc_{jt})$ is the logarithm of GDP per capita, $Democracy_{jt}$ is a variable that captures the extent of democracy in country j using VDEM's electoral democracy index (Coppedge et al., 2021). δ_t are year fixed effects and e_{jt} is the error term. The regression is estimated over the period 1920-2000.

Using the predicted value, $\widehat{ShareDirect_{jt}}$, I construct the instrument, D_{it}^{IV}, as the weighted average of direct taxation around a given country i following equation 2.9. As an instrumental variable, D_{it}^{IV} should fulfill two conditions: i) D_{it}^{IV} must be correlated with D_{it}, ii) it should only affect the probability of becoming a tax haven through its effect on D_{it} (exclusion restriction). The first condition will be checked by looking at the first-stage F-statistics. Anticipating the results, the F-statistics are large and above the thresholds of relative bias computed by Stock and Yogo (2005). The exclusion restriction will be fulfilled as long as no endogenous variation is introduced in our initial stage. For this to be the case, democratization and development of a country j should be exogenous to the presence of tax havens around them. This condition should be fulfilled as, contrary to wars, democratization and development are not large regional shocks but are country-specific.

Results The results from the estimation of 2.10 are displayed in table 2.3. The table gives the results for all reforms in columns (1) to (3), for only the reform

that makes a country a tax haven (the country leaves the estimation sample once it becomes a tax haven) in columns (4) to (6) and for other reforms conditional on being a tax haven in columns (7) to (9). The number of observations in the sample with only first reforms and in the sample with only other reforms sums up to the number of observations in the sample with all reforms. Results are presented for OLS estimations and IV estimations. I begin by describing OLS results.

In column (1), the regression does not include country fixed effects. The coefficient can be interpreted as the effect of demand on the probability of becoming a tax haven exploiting variation between countries. An increase in the average tax-GDP ratio by 1% increases the probability of becoming a tax haven by 13 percentage points. In columns (2) and (3), I include country fixed effects. In the specification with controls and exploiting within-country variation, I find that increasing potential demand by 1% increases the probability that a country becomes a tax haven by 19 percentage points.

Table 2.3: The impact of demand on the probability of reform

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		$\mathbb{1}_{Reform}$			$\mathbb{1}_{FirstReform}$			$\mathbb{1}_{OtherReforms}$	
OLS									
$ln(D_{it})$	0.131***	0.170**	0.187**	0.0446***	0.0839*	0.101**	0.409***	0.358	0.507
	(0.0304)	(0.0796)	(0.0809)	(0.0163)	(0.0443)	(0.0466)	(0.118)	(0.421)	(0.337)
IV									
Second-Stage									
$ln(D_{it})$	0.105***	0.151	0.197*	0.0385**	0.195***	0.241***	0.285**	-1.305	-1.438
	(0.0323)	(0.113)	(0.116)	(0.0165)	(0.0672)	(0.0744)	(0.124)	(0.818)	(1.133)
First-Stage									
$ln(D_{it}^{IV})$	0.975***	0.969***	0.969***	0.976***	0.885***	0.880***	0.866***	1.054***	0.973***
	(0.0147)	(0.0552)	(0.0534)	(0.0159)	(0.0585)	(0.0555)	(0.0671)	(0.181)	(0.205)
Av. Dep. Var.	0.00732	0.00732	0.00732	0.00261	0.00261	0.00261	0.0529	0.0529	0.0529
s.d residualized indep. var	0.0122	0.0122	0.0122	0.0115	0.0115	0.0115	0.0178	0.0178	0.0178
Scaled effect OLS	0.218	0.284	0.312	0.196	0.369	0.442	0.138	0.121	0.171
Scaled effect IV	0.176	0.253	0.329	0.169	0.859	1.062	0.0959	-0.440	-0.485
K-P F-stat	4395	308.1	329.4	3783	228.8	252	166.7	33.85	22.61
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Observations	18,574	18,574	18,574	16,836	16,836	16,836	1,738	1,738	1,738

Note: This table estimates equation 2.10. Data on the share of taxes in GDP comes from Andersson and Brambor (2019b). Data on tax havens' reforms comes from own data collection detailed in section 2.1. Columns (1), (2) and (3) include all reforms as dependent variables. In columns (4), (5) and (6), tax havens leave the sample after the first reform. Columns (7), (8), (9) only consider new reforms from countries that are already tax havens. Additional controls correspond to ln(Area), indicator variable for common law and civil law, indicator variable for being a former U.K. colony, indicator variable for being independent and the number of years since independence. When country fixed effects are added, only the two last variables are used as controls, the other being absorbed by the fixed effects. The scaled effects are computed by multiplying the coefficient by the standard deviation of the residualized independent variable and dividing it by the average of the dependent variable in the sample. It can be interpreted as the percentage change in the probability of the event represented by the dependent variable when demand increases by one standard deviation. "K-P F-stat" stands for the Kleibergen-Paap Wald rk F statistic. Robust standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

To scale these effects, they must be compared with a typical variation in the residualized dependent variable and with the average probability of enacting a reform in the sample.[33] Using the estimates in column (3), I multiply the estimated effect with a standard deviation of (residualized) $ln(D_{it})$, and divide it by the probability of enacting a reform at any point in the sample. I obtain

[33]The residualized dependent variable corresponds to the dependent variable cleared from the variation coming from the fixed effects. It follows the methodology proposed by Mummolo and Peterson (2018).

that a one standard deviation change in demand increases the probability of doing a reform by 31.2% ($\frac{0.187*0.0122}{0.00732} = 0.312$). Note that the initial probability of doing a reform is very small in the sample. If a typical change in demand significantly impacts the probability of doing a reform, it is still small in absolute value. It suggests that large demand increases are necessary to impact the decision to enact a reform.

The effects estimated for the probability of becoming a tax haven are smaller. In the version without country fixed effects, I find that the probability of becoming a tax haven increases by 4 percentage points when potential demand increases by 1%. Once scaled, this coefficient is closer to those estimated in the first three columns. It is explained by the fact that the probability of doing a reform in this sample is smaller. Adding country fixed effects, the coefficient increases to 0.08 without controls and 0.1 with controls. It corresponds to a change of 37% and 44% in the probability of becoming a tax haven for a typical change in demand.

The three last columns consider reform adoption when a country is already a tax haven. In this case, I find lower estimates than before, particularly in the specifications with country fixed effects. In the specifications with country fixed effects, the estimated coefficients are not statistically different from zero at the standard significance levels. These results show that conditional on being a tax haven, demand has a lower impact on the building of the legal architecture of tax havens.

The second part of the table shows the results from the IV estimation. A look at the first stage regressions indicates coefficients close to 1 and statistically significant, which is expected by design. The first-stage Kleinbergen-Paap Wald rk statistics are large and above the thresholds of 5% relative bias computed by Stock and Yogo (2005).[34] I concentrate here on the results that include fixed effects and controls in columns (3), (6), and (9). The IV estimates are larger than the OLS estimates and significantly different from zero in columns (3) and (6). They confirm the substantial impact of demand on reforms in tax havens. In column (9), I obtain a negative and non-statistically significant coefficient. The instrument is also weaker, as demonstrated by the lower Kleinbergen-Paap F statistic. This result is in line with the OLS regressions and suggests a limited role for demand once a country is a tax haven.

The theoretical framework predicts that small countries are more likely to become tax havens and to react to demand shocks (Implications 2 and 3). This is also the case for countries with low infrastructure capacity and high tax haven quality (Implication 4). As argued above, former U.K. colonies are good candidates for being in this group of countries. To test these predictions, I interact the demand variable with i) an indicator for being a small country (country size lower than the median) and ii) an indicator for being a (current or former) U.K. colony. I compare the effect for countries belonging to these groups to the effect for other countries by taking their ratio. I plot this ratio in

[34]Table 2.B.4 in appendix displays Montiel Olea-Pflueger Effective F statistics (Montiel Olea and Pflueger, 2013) and the associated 5% critical values for testing the null hypothesis that the asymptotic estimator bias exceeds 10%. The effective F statistics are systematically higher than the threshold except for the estimations in the last column, where it is slightly above the critical value.

figure 2.C.4. The left panel corresponds to the ratio for the size dummy and the right panel to the ratio with the U.K.-colony dummy. The ratio is positive and larger than 1 in all cases. It indicates a higher probability of becoming a tax haven after a demand shock in countries belonging to each group.

Overall, these results suggest that the level of external potential demand strongly affects the probability that a country becomes a tax haven as predicted in the theoretical framework. However, demand determinants seem less important when looking at new reforms conditional on being a tax haven. This result is somewhat at odds with the theoretical framework, where higher demand should lead to more investment in the quality of the tax haven. It also suggests that other factors, such as supply-side factors might be at play.

Robustness I run different additional regressions to assess the robustness of the results. First, I correct the IV estimates for spatial correlation using the estimator of Colella, Lalive, Sakalli, and Thoenig (2019). I specify spatial clusters such as the correlation between error terms of two observations decreases linearly with distance and is zero when their distance is larger than 1000km and when they are separated by more than 10 years. Results are displayed in the upper panel of table 2.B.5. The new standard errors are in the range of those computed in the main table, and all results hold.

In the lower panel of table 2.B.5, I assess the robustness of the specification of the demand variable. To make sure that the variation used to identify the effect of demand is coming from changes in tax rates, I compute the demand without the size weight: $W_{ijt} = \frac{1}{ln(dist_{ij})}$. The results are similar to those obtained in table 2.3 and the coefficients within one standard deviation of the original estimates.

Then, I use a different variable to measure demand. Instead of relying on the weighted average of the tax-GDP ratio in foreign countries, I rely on information about tax introduction. Using data from Seelkopf et al. (2021), I create three indicator variables that count the number of corporate income taxes and personal income taxes introduced in countries i) closer than 500km, ii) located in a range of 500km to 1000km, iii) located in a range of 1000km to 2500km, iv) located further away than 2500km. This demand variable has the interest of being straightforward to interpret. Tax introductions also constitute larger shocks than those captured in the baseline exercise. The coverage is also slightly better as it allows to include years between 1900 and 1920 in the estimation sample. The scaled effects are generally of a larger magnitude in general than in the baseline results. It illustrates that tax introductions capture larger shocks than changes in tax rates.

I also construct D_{it} following its definition in the theoretical framework. A key difference is that this measure of demand is weighted by the presence of competitors. Again, this specification is very close to the idea of market access as analyzed in the economic geography literature. All variables of the model cannot be identified empirically, though. This is why this specification is used as a robustness test. The form of demand is the following: $D_{it} = \sum_j GDP_j \frac{exp(1-ln(dist_{ij}))}{\sum_k exp(1-ln(dist_{jk}))+exp(1-t_j)}$. To obtain it, I use equation 2.5 and I assume that the tax rate in tax havens is 0, that the ratio $\frac{\tau_{ih}}{p_h}$ can be approximated by

the log of the distance between i and h, and that the tax rate in country i can be proxied by the average direct tax revenues in GDP. Note that this regression is endogenous for the same reason as in table 2.3 but also because it depends on other tax havens policies. I use the same IV strategy as in table 2.3 exploiting only exogenous variations in tax-GDP ratios in foreign countries to identify the effect of demand. I find results similar to those in table 2.3, especially for the first reforms in OLS and IV. The scaled effects are comparable. The OLS results are somewhat different from the main ones for other estimations. The estimates are small and not significantly different from zero in the specifications with fixed effects. These results are reversed in the IV regressions, where only exogenous variation in foreign countries' tax rates is used to identify the impact of demand. IV estimates are overall close to those in the main table, with comparable scaled effects. The main result, that demand is important for the first reform and less so for other reforms, holds in both OLS and IV regressions.

In the last robustness test, I proceed to a placebo test through permutations. I randomly permute the tax haven history of countries in my sample. Countries (tax havens and non-tax-havens countries) are randomly assigned with the tax haven history of another country. Then I run the specification in column (3) of table 2.3 1000 times with the OLS and IV estimators. Positive and statistically significant coefficients are found in 2.6% of the cases in OLS and in 2.1% of the cases in IV regressions. The probability of obtaining a coefficient as large as the coefficient in the baseline estimation is 0.1% in OLS and 0.3% in IV regressions.

2.5 . Supply shocks

The previous section has studied how supply changes when demand changes exogenously. It has been established that an increase in the demand received by a country increases its probability of becoming a tax haven. This effect is amplified if the country is small or if it has a colonial link with the United Kingdom. The results also suggest that demand does not explain why countries update their legal architecture well.

In this section, I use a large quasi-natural experiment, the decolonization of British colonies in the Caribbean and the Pacific. Decolonization can be seen as a large supply shock in the market for tax haven services. Figure 2.4 has demonstrated that this shock causally increases the probability of becoming a tax haven for former U.K. colonies.

Following the wave of decolonization, many newly decolonized countries became tax havens. This shock can mainly be described as a supply shock that pushed many newly independent countries to seek revenues. As shown in the theoretical framework, former U.K. colonies have characteristics that incentivize them to become tax havens. It must be added that on top of these characteristics, the policy of the U.K. concerning its colonies and former colonies has participated in the choices of these countries to become tax havens (Palan, Murphy, and Chavagneux, 2009, Sagar, Christensen, and Shaxson, 2013, Ogle, 2017).

For standard products, the economic literature studies how competition affects the firms participating in the market, particularly how they innovate. I take a similar approach and look at the effect of competition on the decisions taken by countries to enact havens' reforms. Updating its legal architecture is akin to diversifying, either vertically, by increasing the quality of its current regulations or horizontally, by creating regulations in new offshore areas. This exercise is important because it participates in understanding how tax havens adapt when they face negative shocks. This is what is expected when governments introduce anti-avoidance policies.

Identification To study the role of competition on tax havens' policies, I estimate the following equation:

$$\begin{aligned} \mathbb{1}_{Reform_{it}} &= \beta_1 ln(D_{it}) + \beta_2 \left(\sum_j Reforms_{jt} \times \mathbb{1}_{Dist_{ij}<1000km} \right) \\ &\quad + CZ_{it} + \gamma_i + \gamma_t + \upsilon_{it} \end{aligned} \tag{2.12}$$

where $\mathbb{1}_{Reform_{it}}$ is an indicator variable equals to 1 when a reform is enacted in country i at date t. $\left(\sum_j Reforms_{jt} \times \mathbb{1}_{Dist_{ij}<1000km}\right)$ is a variable that counts the number of reforms enacted in foreign havens j distant by less than 1000 kilometers. Z_{it} is a vector of control variables, γ_i are country fixed effects and γ_t are time fixed effects. υ_{it} are the residuals. The equation is estimated using a linear probability model.

The effect of competition on the legal architecture of tax havens is estimated through β_2. This effect is identified by the fact that different countries are hit differently by the competition shock. The shock hits harder the countries closer to tax havens that implement reforms. In the cross-section, variation comes from geographical variations. I have shown above that the demand for tax havens has a geographical component. It means that tax havens located in the same area compete for the same markets and therefore are more likely to be affected by the policies of other close tax havens.

Equation 2.12 is subject to endogeneity issues through reverse causality. Indeed, reforms taken in country i depend on other tax havens policies, which in turn depends on i policies. Therefore, I use the natural experiment of decolonization to obtain exogenous variation in reforms. The exclusion restriction imposes that the independence of countries in an area of 1000km around country i affects country i tax havens' policies only because it pushes newly independent countries to enact tax haven reforms. The geography and timing of decolonization have the advantage of being independent of the level of demand. Therefore it excludes a violation of the exclusion restriction through this channel.

I concentrate on the American and Pacific areas since these are the areas affected by the decolonization shock. I instrument the number of tax reforms in the 1000km around a given country by the number of newly independent British colonies in the 1000km around this country. Because of the country and time fixed effects, this instrument only captures the variation coming from

newly independent countries. The variation exploited in these regressions comes from a different exposure of different tax havens to the shock. This is due to differences in geography and differences in the timing of decolonization.

Results Results are displayed in table 2.4. The three first columns display OLS regressions, columns (3) to (6) display IV regressions with the number of independent countries in 1000km around as an instrument, columns (7) to (9) restrict the sample of the IV regressions to countries that do not become independent during the period studied. This sample restriction limits the extent of bias introduced by the fact that some countries might experience the decolonization shock at the same time as the competition shock. This is an additional robustness exercise as this channel is accounted for by controlling for independence and time since independence. The coefficient on the number of reforms around has been multiplied by 100. It should be interpreted as the percentage point increase in the probability of becoming a tax haven when there is one new reform around. The average change in the number of reforms from 1945 to 2000 in the sample is on average 10 and can then be used as a benchmark.

Looking at all reforms in column (1), we observe that 1 additional tax haven reform around a given country increases its probability of becoming a tax haven by 1.2 percentage points. The effect is similar if we concentrate only on the first reforms. When looking at subsequent reforms made in countries that are already tax havens, 1 additional reform increases the probability of making a new reform by 3.4 percentage points. The effect is imprecisely estimated though and not significantly different from 0 at the 10% level.

The IV regressions confirm the above results: 1 new reform around a country increases the probability of doing a reform by 1.5 percentage points, of becoming a tax haven by 1.3 percentage points and of adopting a subsequent reform once a country is already a tax haven by 6.1 percentage points. When the sample is restricted to countries that never become independent in the sample, I find a large effect on subsequent reforms. A new reform in a circle of 1000km increases the probability of adopting a subsequent reform by 11.8 percentage points. However, despite being positive, the effect on first reforms is now lower than in the previous columns and not significantly different from zero. This suggests that for these countries, the level of competition played little in entry into the tax haven status.

Overall, these results show a large effect of competition on tax havens' policies. I now discuss a potential channel of this effect: the role of legal technologies and their diffusion.

Mecanism: legal technologies At least two channels can be at play. On the one hand, more competition in the market for tax havens services reduces the rent of tax havens. This is directly seen from equation 2.5 where new competitors decrease the demand addressed to a given tax haven. This should have a negative impact on the probability of reforms. On the other hand, tax havens might want to adjust to this shock by updating their legal architecture to in-

Table 2.4: The impact of increased competition on the probability of reform

	(1) $\mathbb{1}_{Reform}$	(2) $\mathbb{1}_{FirstRef.}$	(3) $\mathbb{1}_{OtherRef.}$	(4) $\mathbb{1}_{Ref.}$	(5) $\mathbb{1}_{FirstRef.}$	(6) $\mathbb{1}_{OtherRef.}$	(7) $\mathbb{1}_{Ref.}$	(8) $\mathbb{1}_{FirstRef.}$	(9) $\mathbb{1}_{OtherRef.}$
# Reforms $<$ 1000 km	1.217**	1.150*	3.406	1.538**	1.328*	6.097	2.205**	0.971	11.83***
	(0.607)	(0.604)	(3.090)	(0.771)	(0.699)	(3.664)	(0.933)	(0.984)	(1.704)
ln(Av. Direct Tax/GdP)	0.0798	0.0236	-0.705	0.0892	0.0230	-0.104	0.733	0.174	8.395**
	(0.231)	(0.134)	(1.550)	(0.241)	(0.134)	(1.910)	(0.812)	(0.540)	(3.499)
K-P F-stat				542	577.8	65.07	476.7	254.6	426.8
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Post-1945	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Non independent only	No	No	No	No	No	No	Yes	Yes	Yes
Observations	4,139	3,488	651	4,139	3,488	651	1,389	1,119	254

Note: This table estimates equation 2.12. Coefficients on *# Reforms $<$ 1000 km* have been multiplied by 100 for readability. Data on the share of taxes in GDP comes from Andersson and Brambor (2019b). Data on tax havens' reforms comes from own data collection detailed in section 2.1. Columns (1), (2) and (3) estimate OLS. Columns (4), (5) and (6), estimate an IV regression. Columns (7), (8), (9) estimate an IV regression restricted to the sample of never-independent territories. Additional controls are included in columns (1) to (6) and correspond to an indicator variable for being independent and the number of years since independence. All regressions include country and year fixed effects. "K-P F-stat" stands for the Kleibergen-Paap Wald rk F statistic. Robust standard errors clustered at the country level in parentheses. *** p$<$0.01, ** p$<$0.05, * p$<$0.1

crease their rents.[35] This latter effect can benefit from the diffusion of new legal technologies.

We know, for instance, that the International Business Company law of the British Virgin Islands enacted in 1984 has been copied almost word for word by other offshore jurisdictions such as Anguilla or the Bahamas. It suggests that the diffusion of new legal technologies can reduce the costs of updating the legal architecture and increase the probability of reform (see Implication 1 of the theoretical framework).

The competition effect is therefore intertwined with a learning effect where actual and potential competitors can observe the type of laws used by other countries and can design their laws according to their perception of the effectiveness of these laws. This effect can be even more important given that the laws are generally written with the help of a small pool of lawyers advising several countries simultaneously.

This second effect dominates the first as we observe an increase in the number of reforms in tax havens hit by the competition shock. In other words, tax havens react on the intensive margin. This intensive margin can be decomposed between reforms in an area of specialization in which the tax haven has already made a reform or reforms in a new area. This is what I explore in table 2.5. This table replicates columns (6) and (9) of table 2.4 with indicator variables for "reforms in a new area" or "revisions" as dependent variables. The table shows that the competition shock has a larger impact on investment in new areas than in areas in which the tax haven is already specialized. This is true both for all countries and for only non-independent countries.

Innovation in a new area can be facilitated if investment in the architecture is not expensive. This is the case when new types of reforms (or legal technologies in a more general vocabulary) emerge. For instance, International Business Companies constitute such a technology. I have discussed above the

[35] Another alternative would be to compete on tax rates. The absence of historical information on the tax rate applied by tax havens prevents me from exploring this channel.

Table 2.5: Competition and type of reform

	(1) $\mathbb{1}_{Reform\ in\ new\ area}$	(2) $\mathbb{1}_{Revision}$	(3) $\mathbb{1}_{Reform\ in\ new\ area}$	(4) $\mathbb{1}_{Revision}$
# Reforms $<$ 1000 km	4.503***	0.689***	3.102***	0.772***
	(1.075)	(0.189)	(0.867)	(0.193)
F-Test	65.07	65.07	426.8	426.8
Controls	Yes	Yes	Yes	Yes
Reforms	Next	Next	Next	Next
Post-1945	Yes	Yes	Yes	Yes
Non independent only	No	No	Yes	Yes
Observations	651	651	254	254

Note: The sample from columns (1) and (2) correspond to the sample of column (6) in table 2.4.The sample from columns (3) and (4) correspond to the sample of column (9) of table 2.4. Robust standard errors clustered at the country level in parentheses. "New area" corresponds to reforms made in a sub-category in which the country had done no reform before and "revision" corresponds to reforms made in a sub-category in which the country had already made a reform before. Sub-category classification is the following: Banking, Insurance, Exempt companies (IBC or not), MNE-specific, Holding regimes, Individual, Ships, and Other. Additional controls are included: in columns (1) and (2) they include $ln(D_{it})$, an indicator variable for being independent and the number of years since independence. In columns (3) and (4) they include $ln(D_{it})$. The other control variables cannot be included as the sample is restricted to non-independent territories. *** p$<$0.01, ** p$<$0.05, * p$<$0.1

importance of IBCs in the development of the Virgin British Islands. I have also shown that IBCs diffused quickly between countries despite being a relatively late innovation in the 20th century. The emergence of new legal technologies can favor learning of tax havens which helps to mitigate the negative effects of decreased rents. Learning is particularly facilitated by the fact that laws are public and not protected from reproduction.

In table 2.6, I explore the extent of diffusion of types of reforms. To do so, I follow the structure of equation 2.12 and look at the impact of new reforms of a given type c in a circle of 1000km on the probability of introducing this type of reform in its legal architecture:

$$\begin{aligned}\mathbb{1}_{FirstReform^c_{it}} = \quad & \zeta_1 ln(D_{it}) + \zeta_2 \left(\sum_j Reforms^c_{jt} \times \mathbb{1}_{Dist_{ij}<1000km} \right) \\ + \quad & CZ_{it} + \gamma_i + \gamma_t + u_{it}\end{aligned} \tag{2.13}$$

where $\mathbb{1}_{FirstReform^c_{it}}$ is an indicator variable equals to 1 when a reform of type c is enacted in country i at date t for the first time. The country leaves the sample once it has enacted the reform for the first time. $\left(\sum_j Reforms^c_{jt} \times \mathbb{1}_{Dist_{ij}<1000km}\right)$, is a variable that counts the number of reforms of the type c enacted in foreign havens distant by less than 1000 kilometers. Z_{it} is a vector of control variables, ν_i are country fixed effects and ν_t are time fixed effects. u_{it} are the residuals. The equation is estimated using a linear probability model.

The coefficient ζ_2 is interpreted as the effect of one additional reform in a circle of 1000km in a category c on the probability of doing a reform in this category. A larger coefficient for a category c means that reforms of the category

c are more likely to diffuse geographically. This model is estimated for reforms in the four more important categories at the end of the sample: Banking, Exempt Companies (no IBC), IBCs, and Individual. The first column estimates equation 2.13 on the whole sample to assess the global diffusion patterns of these reforms. In the four next columns, the sample is restricted to the sample used in table 2.4. These columns look at the diffusion patterns at play during the "decolonization" shock.

The results in the first column of table 2.6 reveal that IBC reforms are those that diffuse the more in the whole sample. One additional reform around a tax haven not yet specialized in IBCs increases its probability of implementing such reform by 4.8 percentage points. This effect is statistically significant at the 5% level. The coefficient for the other types of regulations is not significantly different from zero and low, even negative for Exempt Company laws and Finance laws. These results suggest that the cost of implementation and diffusion differs by technology.

In the four next columns, I concentrate on the IV sample of table 2.4 (post-1945 in Americas and Pacific areas) to identify the role of legal technology in the effect of competition. Column (2) considers all reforms and includes independent and non-independent countries. The coefficients estimated are not significantly different from zero but the point estimates are close to those estimated in column (1). It means that the diffusion patterns are relatively similar in this sample than in the whole sample. The Kleinbergen-Paap F statistic is above conventional levels. It is higher for IBCs, suggesting a stronger correlation between independence from the U.K. and the implementation of IBC reforms. Column (3) restricts the sample to subsequent reforms once a country is already a tax haven. There are large and positive coefficients for Exempt company laws (excluding IBCs) and Finance laws. The coefficients are not estimated with a lot of precision.

Column (4) limits the sample to non-independent countries. Again, the coefficients are close to those estimated in columns (1) and (2). Finally, column (5) looks at subsequent reforms. I find a large positive coefficient for IBCs, revealing an important diffusion pattern among non-independent countries following the decolonization shock. A large and negative coefficient is also found for Individuals regulations.

The results of this section suggest one mechanism to explain the observed effect of competition. Facing a shock, tax havens tend to explore new areas of specialization. New legal technologies, especially if implementation costs are low such as in the case of IBCs, facilitate the upgrading of tax havens following the competition shock. Legal innovations are therefore crucial to understanding tax haven dynamics.

2.6 . Extension: The consequences of becoming a tax haven

The previous sections have explored the causes of the development of tax havens. The argument developed in these sections has assumed that becoming a tax haven had positive economic consequences. It was explicitly assumed in the theoretical framework as countries that become tax havens maximize

Table 2.6: Competition and legal technology diffusion

	(1) Whole Sample	(2)	(3)	(4) IV Sample	(5)
IBC					
Number of laws $<$ 1000km	4.533**	4.094	2.323	3.647	22.60***
	(1.863)	(2.721)	(4.857)	(5.396)	(4.004)
K-P F-stat		841.2	217.3	479.9	139.5
Observations	5,214	1,444	651	564	254
Exempt (no IBC)					
Number of laws $<$ 1000km	-2.858	-3.373	8.079	-2.099	-0.151
	(2.674)	(6.142)	(9.162)	(7.545)	(0.185)
K-P F-stat		105.4	34.11	199.8	273.8
Observations	5,214	1,444	651	564	254
Finance					
Number of laws $<$ 1000km	-2.459	-2.056	12.49*	0.808	-2.171
	(2.079)	(3.780)	(7.121)	(6.365)	(4.541)
K-P F-stat		188.3	42.17	116.1	108.6
Observations	5,214	1,444	651	564	254
Individuals					
Number of laws $<$ 1000km	0.449	-4.940	-8.638	-6.600	-23.39**
	(2.308)	(5.101)	(7.321)	(8.689)	(9.280)
K-P F-stat		452.7	92.37	282.4	95.53
Observations	5,214	1,444	651	564	254
Controls	Yes	Yes	Yes	Yes	Yes
Country and year FE	Yes	Yes	Yes	Yes	Yes
Reform	All	All	Others	All	Others
Non-independent only	No	No	No	Yes	Yes

Note: This table estimates equation 2.13. Column (1) estimate it on the whole sample. Columns (2) to (5) estimate it on the "IV sample" of table 2.4 i.e for countries in Americas and Oceania, after 1945. "Number of laws $<$ 1000km" corresponds to the number of laws of the type indicated in the panel header that have been implemented in countries that are located in less than 1000km of the country of interest. The dependent variable is an indicator variable equal to 1 if a law of the type indicated in the panel header have been implemented. Country are dropped from the sample once they implement a law the category studied. Additional controls are included: in columns (1) to (3) they include $ln(D_{it})$, an indicator variable for being independent and the number of years since independence. In columns (4) and (5) they include $ln(D_{it})$. The other control variables cannot be included as the sample is restricted to non-independent territories. Data on tax havens' reforms comes from own data collection detailed in section 2.1. Details on the classification of reforms are displayed in table 2.1. Robust standard errors clustered at the country level in parentheses *** p$<$0.01, ** p$<$0.05, * p$<$0.1

their utility. In other words, we have assumed that if countries become tax havens, it is because they have economic incentives to do so, if there is enough demand.

This section investigates the effects of becoming a tax haven on GDP per capita. To do so, I run an event study regression. I regress the log of GDP per capita on leads and lags of the event of becoming a tax haven. Data on GDP per capita is taken from the World Bank and begin in 1962. It is not available for all countries. This limits the number of tax havens that can be included in the estimation sample. Nine tax havens, mainly from the Caribbean and Pacific, are included in the sample of treated countries. The control group is composed of countries in the same regions as treated countries but that never become tax havens.[36] I estimate the following equation:

$$GDPpc_{it} = \sum_{k=-6}^{15} \theta_k Haven_{it}^k + \eta_i + \eta_t + \iota_{it} \tag{2.14}$$

where $GDPpc_{it}$ is the GDP per capita of country i at date t. $Haven_{it}$ is equal to 1 when country i becomes a tax haven. $Independent_{it}^k$ is a dummy variable equal to one for treated countries k years before or after they become independent. η_i and η_t are country and time fixed effects, and ι_{it} is the error term. The control group corresponds to countries that have never become tax havens and that are located in the same regional areas. The equation is estimated using the estimator of Sun and Abraham (2021) to account for potential heterogeneous effects in a generalized difference-in-difference setting with different treatment dates.

Results are displayed in figure 2.8. The figure reveals an interesting pattern: becoming a tax haven increases GDP per capita by large amounts. The average growth rate estimated is around 40% after 7 years. This number corresponds to an annual additional growth rate of the GDP per capita of 4.9%. This result is in line with the anecdotal observation that the countries in our sample experienced large growth rates at the end of the 20th century. For instance, one year after becoming a tax haven in 1986, Grenada experienced a 9.3% increase in its GDP per capita.[37] The gains from becoming a tax haven virtually stagnate after 7 years on average and potentially decrease over time. The premium in GDP per capita from becoming a tax haven is mainly short-term but creates long-term differences in GDP of about 40%. The pre-trends are small, stable, and not significantly different from zero. This reinforces the causal interpretation of the results.

It must be noted that the GDP data should be taken with caution. It might not be very precise or be partly imputed, given the level of development in the countries that enter the estimation. This is a drawback that is hard to correct. Measurement error appears here to be a confounding factor. However,

[36] The tax havens included in the sample are Dominica, Grenada, Jordania, Saint Kitts-and-Nevis, Saint Lucia, Marshall Islands, Tonga, Saint Vincent-and-the-Grenadines, and Western Samoa.

[37] Using different empirical settings, Hines (2005) and Butkiewicz and Gordon (2013) also find a positive impact of being a tax haven on GDP.

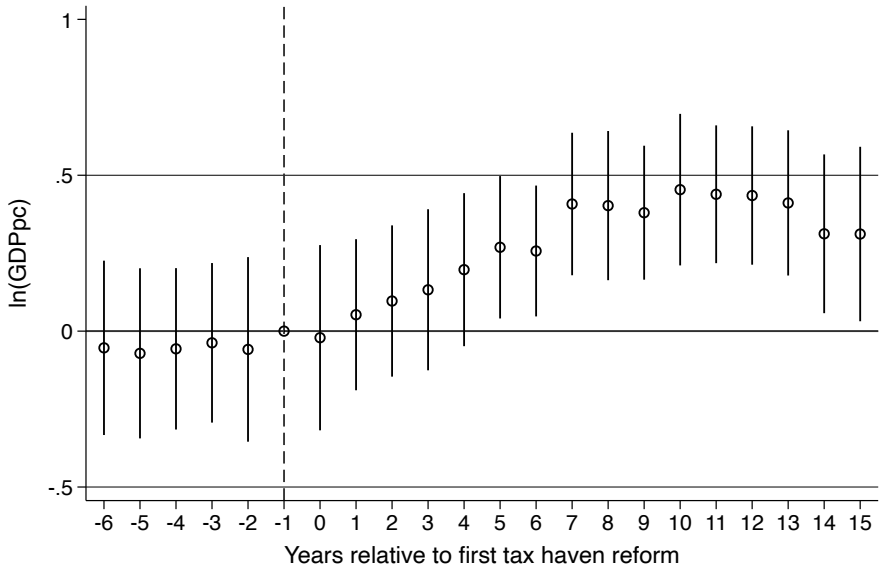


Figure 2.8: Effect of becoming a tax haven on GDP per Capita

Note: This figure plots coefficients from an event-study regression following equation 2.14. I use the Sun and Abraham (2021) estimator. It studies how the GDP per capita changes when a country becomes a tax haven. The control group corresponds to territories that have never been tax havens and that are located in similar regions as treated countries: Caribbean, Melanesia, Polynesia, Western Asia, and Micronesia. 90% confidence intervals from robust standard errors clustered at the country level.

this confounding factor would have to follow a very specific path to be consistent with the observed trend in figure 2.8. Increases in GDP in tax havens are also known not to necessarily participate in the populations' revenues precisely because an increase in offshore revenues might be accounted for while being owned by foreigners.

In the tax competition theory, countries become tax havens as long as there is a positive rent. The marginal tax haven should be indifferent between becoming a tax haven or not (Slemrod and Wilson, 2009, Johannesen, 2010). The results here are at odds with this theoretical reasoning. There could be different reasons. First, I study here a specific group of tax havens. The large positive effects on GDP per capita would suggest that they are still rents to acquire by becoming a tax haven. In absence of structural changes in the international taxation environment, more countries would be expected to enter. Second, it might be possible that rents exist for some country characteristics but that no existing country has the required characteristics and then no country is willing to enter. Third, as discussed before, GDP per capita, overestimates welfare in tax havens. Using the right metric might decrease the potential gains from becoming a tax haven.

2.7 . Conclusion

In this paper, I have created a new database that tracks the building of the legal architecture of tax havens. Using this database, I show the key role of market forces in the creation and development of tax havens. Demand matters through the market access of tax havens, while competition between tax havens has been one of the main drivers of their development. I also show that legal innovations can play an important role in the way tax havens react to shocks. Finally, I show that becoming a tax haven has positive and lasting effects on GDP per capita.

How can we analyze the recent developments in tax havens regulation using the framework discussed in this paper? In the last years, two major reforms have been led by the OECD. The first one concerns the tax evasion of individuals. The Common Reporting Standard (CRS) put in place a multilateral automatic exchange of information between the signatories, which includes major tax havens. The United States is not part of the CRS because it has its own exchange of information mechanism (FATCA). The second one aims to reduce the use of tax havens by multinational firms by introducing destination taxation on residual profits (Pillar 1) and enacting a minimum tax rate (Pillar 2).[38]

These regulations constitute large negative shocks on tax havens' rents.[39] Insights from this paper suggest that it may induce tax havens, especially those that are more dependent on the offshore sector, to update their legal architecture. This can be facilitated by using new legal technologies not regulated by high-tax countries.

Indeed, these recent reforms have likely led some tax havens to deepen their offshore legal architecture. For instance, some Caribbean tax havens have enacted new "high-risk" Citizenship-by-investment schemes to bypass the CRS (Langenmayr and Zyska, 2021, OECD, 2022). It allows these countries to raise a substantial amount of revenue. According to the Eastern Caribbean Central Bank data, in 2021, Citizenship by investment schemes represent 9% of government's revenues in Antigua and Barbuda (0% in 2014), 54% of government's revenues in Dominica (12% in 2014), 4% of government's revenues in Grenada (0% in 2014), 51% of government's revenues in Saint-Kitts and Nevis (37% in 2014).

An unintended effect of regulations can be increased competition between tax havens and increased aggressiveness in tax havens' regulations. Consequently, this paper suggests that international regulations of tax havens should be designed to be as robust as possible against tax havens' legal innovations and their diffusion. This could be achieved by reducing the legal complexities involved in the reforms, for instance, through increased transparency (third-party reporting or asset registries, for instance) or minimum taxation (that makes the place of location of assets and revenues less relevant). Both these directions align with the current policy directions followed by the OECD.

[38] See for instance the Automatic Exchange Portal of the OECD for more information on the CRS and OECD (2020) about the reform for multinational firms.

[39] For instance, Gomez Cram and Olbert (2022) show that the announcements of new regulations on multinational firms have increased the perception by markets of the default risk of tax havens.

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Appendix

2.A . Data sources

GDP and GDP per capita and population: Long-term GDP and population data from GapMinder that aggregates GDP from World Bank (World Development indicators), the Maddison Project, and the Penn World Tables. Details on the documentation: https://www.gapminder.org/data/documentation/gd001/. The event study on tax havens and GDP per capita uses GDP and population data from the World Bank's World Development Indicators.

Colonial History: I first associate each territory with a status relative to its sovereign history. Each country or territory can be either independent, non-independent and a colony, or non-independent and not a colony. This last status is created to deal with specific cases treated differently by different databases about colonial history. For instance, the islands of Jersey and Guernsey, despite being under the actual control of the United Kingdom, are generally not considered as colonies. However, for the purpose of this paper, it is important to highlight their link with the United Kingdom. To this purpose I use information from the Colonial Dates Dataset (Becker, 2020), the Cepii Gravity Dataset (Head and Mayer, 2014) and the ICOW colonial dataset (Hensel, 2018). The data is then manually completed when information is missing for a given territory using worldstatesmen.org, rulers.org, and wikipedia.org. The main colonial variable used in this paper record the last ruler of a territory (including its current ruler if applicable). It includes countries not generally considered as colonies, such as the Channel Islands.

Tax introductions: Data from Seelkopf et al. (2021).

Tax revenues: Data from Andersson and Brambor (2019a) and Andersson and Brambor (2019b).

Gravity data: Data from the U.S. International Trade Commission Gravity Portal (release 2.1), Gurevich and Herman (n.d.).

Swiss Market for haven's services: Data from Zucman (2013)

Fee revenues in Cayman Islands: Data from Cayman Islands Economics and Statistics Office (2021)

Citizenship by investment revenues: Data from the statistics portal of the Eastern Caribbean Central Bank (https://www.eccb-centralbank.org/statistics/fiscals/comparative-report/3).

2.B . Supplementary tables

Table 2.B.1: Comparing different lists of tax havens.

Country	Lists	Country	Lists	Country	Lists	Country	Lists	Country	Lists	Country	Lists	Country	Lists
Bahamas	11	**Vanuatu**	10	**Monaco**	8	**Samoa**	6	Latvia	2	Campione	1	Nigeria	1
Bermuda	11	**Gibraltar**	9	**Nauru**	8	**Seychelles**	6	Madeira	2	Egypt	1	Northern Cyprus	1
Cayman	11	**Hong Kong**	9	**St Kitts & Nevis**	8	**Lebanon**	5	**Netherlands**	2	France	1	Palau	1
Guernsey	11	**Singapore**	9	**Andorra**	7	**Niue**	5	Philippines	2	Germany	1	Puerto Rico	1
Jersey	11	**St Vincent & the Grenadines**	9	**Anguilla**	7	**Macau**	4	South Africa	2	Guatemala	1	Russia	1
Malta	11	**Switzerland**	9	**Bahrain**	7	**Malaysia**	4	**Tonga**	2	Honduras	1	San Marino	1
Panama	11	**Turks & Caicos Islands**	9	Costa Rica	7	**Montserrat**	4	Uruguay	2	Iceland	1	Sao Tome e Principe	1
Barbados	10	**Antigua & Barbuda**	8	**Marshall Islands**	7	Maldives	3	**US Virgin Islands**	2	Indonesia	1	Sark	1
British Virgin Islands	10	**Belize**	8	**Mauritius**	7	United Kingdom	3	USA	2	Ingushetia	1	Somalia	1
Cyprus	10	**Cook Islands**	8	**St. Lucia**	7	Brunei	2	Alderney	1	**Jordan**	1	Sri Lanka	1
Isle of Man	10	**Grenada**	8	**Aruba**	6	Dubai	2	Anjouan	1	Marianas	1	Taipei	1
Liechtenstein	10	**Ireland**	8	**Dominica**	6	Hungary	2	Belgium	1	Melilla	1	Trieste	1
Netherlands Antilles	10	**Luxembourg**	8	**Liberia**	6	Israel	2	Botswana	1	Myanmar	1	Ukraine	1

Note: This table counts the number of tax havens lists in which each country is reported. Countries used in the sample of this paper are highlighted in **bold** font. The list of countries comes from table 1.4 of Chavagneux, Palan, and Murphy (2010). The eleven lists are the following: International Bureau of Fiscal Documentation (1977), Charles Irish (1982), Hines and Rice (1994), OECD (2000), IMF (2000), FSF (2000), FATF (2000,2002), TJN (2005), IMF (2007), STHAA (2007), Low-Tax.net (2008).

Table 2.B.2: Offshore entities and fiduciary deposits.

	(1)	(2)	(3)
	arcsinh(Fiduciary deposits)		
arcsinh(Number entities)	0.394***	0.415***	0.370***
	(0.0682)	(0.0770)	(0.0962)
Observations	934	404	524
R-squared	0.910	0.901	0.930
Sample		IBC reform	Other exempt reform
Country and year FE		Yes	Yes

Note: "IBC reforms" stands for countries that have implemented IBC reforms. "Other exempt reform" stands for countries that have implemented other exempted company reforms. Robust standard errors clustered at the country level in parentheses.*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.B.3: Permutation tests

	OLS	IV
Share α_1 positive and significant at 10%	5.2%	5.4%
Share α_1 as large as the baseline coefficient	0.1%	0.3%

Note: This table shows the result of a permutation test. I run the OLS and IV specifications of column (3), table 2.3 on a dataset where observations of the dependent variable have been permuted between countries. In particular, it comes down to assigning the offshore history of country i' to another country i. I replicate this exercise with 1000 different permutations of the data.

Table 2.B.4: Montiel Olea-Pflueger robust weak instrument test (Montiel Olea and Pflueger, 2013)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$\mathbb{1}_{Reform}$			$\mathbb{1}_{FirstReform}$			$\mathbb{1}_{OtherReforms}$		
Effective F stat.	4395	304.2	325.3	3783	225.7	248.6	166.7	32.87	21.96
10% Critical value	23.11	23.11	23.11	23.11	23.11	23.11	23.11	23.11	23.11
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes

Note: This table shows the Montiel Olea-Pflueger effective F-stat and the critical value at the 10% confidence level for a worst bias of 5% for the estimations in table 2.3. Each column in this table reports the results corresponding to the estimation that has the same column number in table 2.3.

Table 2.B.5: The impact of demand on the probability of reform: robustness for spatial auto-correlation and independent variable definition

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	$\mathbb{1}_{Reform}$			$\mathbb{1}_{FirstReform}$			$\mathbb{1}_{OtherReforms}$		
Spatial correlation									
ln(Av. Direct Tax/GDP)	0.105***	0.151	0.197*	0.0385**	0.195***	0.241***	0.285	-1.305**	-1.438*
	(0.0277)	(0.107)	(0.107)	(0.0168)	(0.0641)	(0.0714)	(0.179)	(0.637)	(0.805)
K-P F-stat	12312	507.1	502.3	10237	384.9	379.2	613.4	59.84	41.50
Distance weights only									
ln(Av. Direct Tax/GDP)	0.123***	0.180**	0.197**	0.0430**	0.0878*	0.105**	0.365***	0.399	0.543
	(0.0305)	(0.0824)	(0.0839)	(0.0166)	(0.0458)	(0.0482)	(0.117)	(0.433)	(0.353)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Observations	18,574	18,574	18,574	16,836	16,836	16,836	1,738	1,738	1,738

Note:This table estimates equation 2.10. Data on the share of taxes in GDP comes from Andersson and Brambor (2019b). Data on tax havens' reforms comes from own data collection detailed in section 2.1. Columns (1), (2) and (3) include all reforms as dependent variables. In columns (4), (5) and (6), tax havens leave the sample after the first reform. Columns (7), (8), (9) only consider new reforms from countries that are already tax havens. "Distance weights only" uses an independent variable computed as the weighted average of direct taxation over GDP in foreign countries, each country being weighted by the inverse of the log(distance) with the country of interest. Additional controls correspond to ln(Area), indicator variables for common law and civil law, an indicator variable for being a former UK colony, an indicator variable for being independent, and the number of years since independence. When country fixed effects are added, only the two last variables are used as controls, the other being absorbed by the fixed effects. "K-P F-stat" stands for the Kleibergen-Paap Wald rk F statistic. Robust standard errors clustered at the country level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 2.B.6: The impact of demand on the probability of reform: robustness on the definition of demand

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		$\mathbb{1}_{Reform}$			$\mathbb{1}_{FirstReform}$			$\mathbb{1}_{OtherReforms}$	
OLS									
$ln(D_{it})$	0.00802***	-0.00627	-0.00145	0.00207**	0.0115	0.0162*	0.0226***	-0.0900	-0.0675
	(0.00193)	(0.0191)	(0.0189)	(0.000875)	(0.00915)	(0.00966)	(0.00742)	(0.101)	(0.104)
IV									
Second-Stage									
$ln(D_{it})$	0.00793***	0.0288	0.0379*	0.00297**	0.0353***	0.0439***	0.0209**	-0.234*	-0.239
	(0.00246)	(0.0214)	(0.0220)	(0.00130)	(0.0117)	(0.0129)	(0.00982)	(0.122)	(0.162)
First-Stage									
$ln(D_{it}^{IV})$	12.93***	5.100***	5.038***	12.65***	4.892***	4.843***	11.82***	5.886***	5.846***
	(0.0147)	(0.0552)	(0.0534)	(0.0159)	(0.0585)	(0.0555)	(0.0671)	(0.181)	(0.205)
Av. Dep. Var.	0.00732	0.00732	0.00732	0.00261	0.00261	0.00261	0.0529	0.0529	0.0529
s.d residualized indep. var	0.0798	0.0798	0.0798	0.0743	0.0743	0.0743	0.121	0.121	0.121
Scaled effect OLS	0.0874	-0.0684	-0.0158	0.0589	0.327	0.461	0.0516	-0.206	-0.154
Scaled effect IV	0.0865	0.314	0.413	0.0845	1.005	1.248	0.0476	-0.534	-0.547
F-Test	609.1	603.9	591.8	577.5	484.4	454.7	68.71	123.3	88.98
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Observations	18,574	18,574	18,574	16,836	16,836	16,836	1,738	1,738	1,738

Note: This table estimates equation 2.10. Demand variable $ln(D_{it})$ is constructed following the theoretical formula of equation 2.5. Data on the share of taxes in GDP comes from Andersson and Brambor (2019b). Data on tax havens' reforms comes from own data collection detailed in section 2.1. Columns (1), (2) and (3) include all reforms as dependent variables. In columns (4), (5) and (6), tax havens leave the sample after the first reform. Columns (7), (8), (9) only consider new reforms from countries that are already tax havens. Additional controls correspond to ln(Area), indicator variables for common law and civil law, an indicator variable for being a former UK colony, an indicator variable for being independent, and the number of years since independence. When country fixed effects are added, only the two last variables are used as controls, the other being absorbed by the fixed effects. The scaled effects are computed by multiplying the coefficient by the standard deviation of the residualized independent variable and dividing it by the average of the dependent variable in the sample. It can be interpreted as the percentage change in the probability of the event represented by the dependent variable when demand increases by one standard deviation. "K-P F-stat" stands for the Kleibergen-Paap Wald rk F statistic. Robust standard errors clustered at the country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 2.B.7: The impact of demand on the probability of reform: number of tax introductions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		$\mathbb{1}_{Reform}$			$\mathbb{1}_{FirstReform}$			$\mathbb{1}_{OtherReforms}$	
Extensive margin									
# Direct $<$ 500km	0.332*	0.566**	0.575**	0.112	0.253*	0.269*	1.172	6.434***	5.684***
	(0.182)	(0.250)	(0.232)	(0.0858)	(0.145)	(0.143)	(1.709)	(1.738)	(1.338)
# Direct in [500;1000]	0.205	0.326	0.318	0.0534	0.0518	0.0534	0.822	5.876***	5.247***
	(0.187)	(0.242)	(0.221)	(0.0873)	(0.139)	(0.132)	(1.569)	(1.465)	(1.191)
# Direct in [1000;2500]	0.276	0.319	0.332	0.0783	0.0449	0.0546	0.810	6.453***	5.899***
	(0.191)	(0.250)	(0.224)	(0.0848)	(0.132)	(0.128)	(1.502)	(1.533)	(1.205)
# Direct $>$ 2500km	0.242	0.334	0.354*	0.0729	0.0635	0.0794	0.765	5.939***	5.345***
	(0.184)	(0.234)	(0.211)	(0.0839)	(0.130)	(0.125)	(1.527)	(1.545)	(1.243)
Av. Dep. Var.	0.00590	0.00590	0.00590	0.00210	0.00210	0.00210	0.0506	0.0506	0.0506
s.d residualized indep. var	0.00630	0.00630	0.00630	0.00626	0.00626	0.00626	0.00667	0.00667	0.00667
Scaled effect # Direct $<$ 500km	0.354	0.604	0.614	0.334	0.754	0.800	0.155	0.848	0.749
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Controls	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes
Observations	23,214	23,214	23,214	21,396	21,396	21,396	1,818	1,818	1,818

Note: This table estimates equation 2.10. # Direct refers to the number of Corporate income taxes or Personal income taxes introduced within a distance range. The coefficient has been multiplied by 10 to facilitate interpretation. Data on the introduction of taxes comes from Seelkopf et al. (2021). Data on tax havens' reforms comes from own data collection detailed in section 2.1. Columns (1), (2) and (3) include all reforms as dependent variables. In columns (4), (5) and (6), tax havens leave the sample after the first reform. Columns (7), (8), (9) only consider new reforms from countries that are already tax havens. Additional controls correspond to ln(Area), indicator variables for common law and civil law, an indicator variable for being a former UK colony, an indicator variable for being independent, and the number of years since independence. When country fixed effects are added, only the two last variables are used as controls, the other being absorbed by the fixed effects. The scaled effects are computed by multiplying the coefficient by the standard deviation of the residualized number of direct taxes introduced in less than 500km and dividing it by the average of the dependent variable in the sample. It can be interpreted as the percentage change in the probability of the event represented by the dependent variable when demand increases by one standard deviation. *** p$<$0.01, ** p$<$0.05, * p$<$0.1

2.C . Supplementary figures

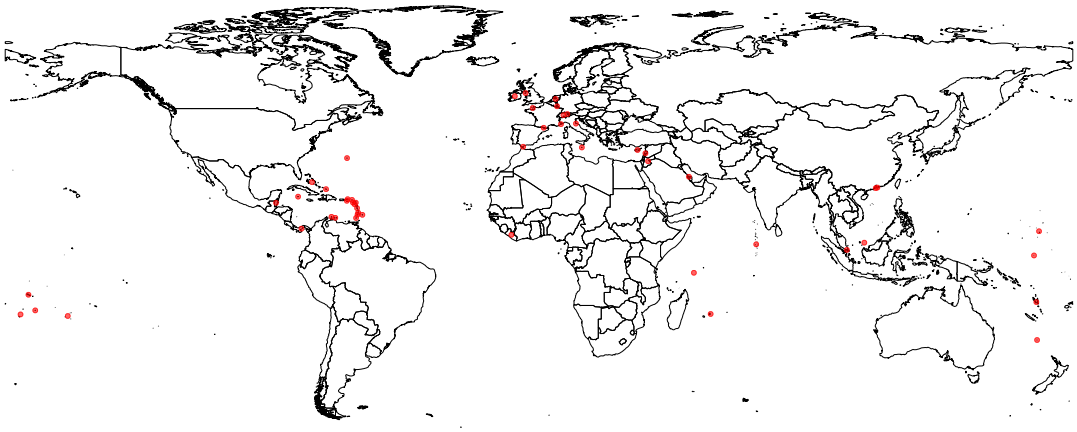


Figure 2.C.1: The location of contemporary tax havens.

Note: This map depicts tax havens nowadays. This list of tax havens is discussed in section 2.1 and presented in appendix table 2.B.1.

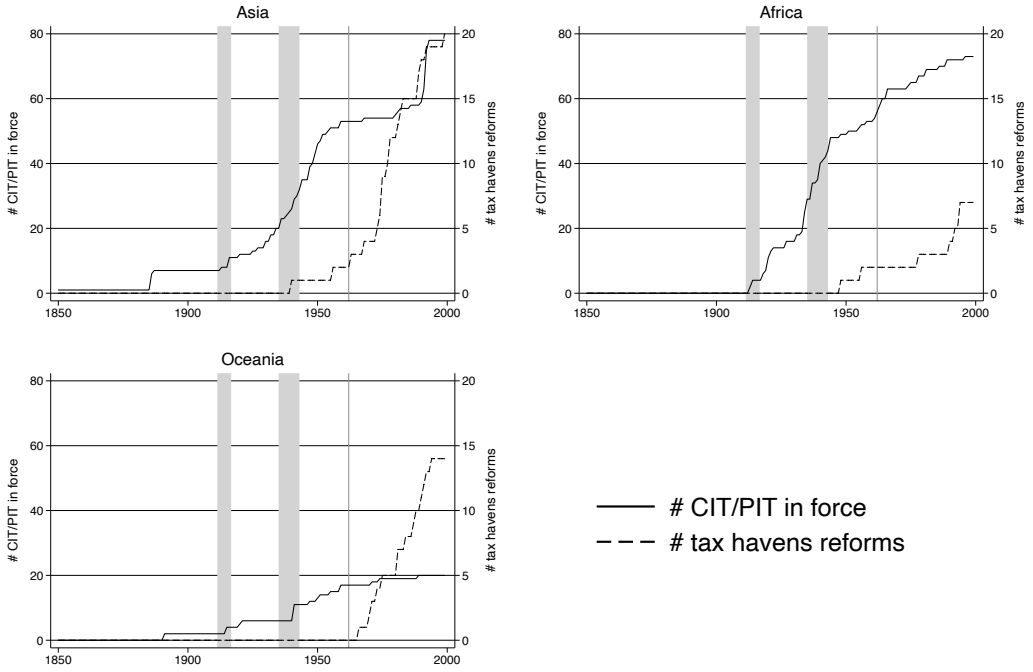


Figure 2.C.2: The building of tax havens' legal architecture and the rise of direct taxation (other regions)

Note: This figure plots the number of direct taxes (Corporate income taxes and Personal income taxes) introduced and the number of tax havens reforms for Africa, Asia, and Oceania. Data on the introduction of taxes comes from Seelkopf et al. (2021). Data on tax havens' reforms comes from own data collection detailed in section 2.1. Shaded areas indicate the world wars and the vertical line (1962), the beginning of the independence wave in the UK-dominated Caribbean area.

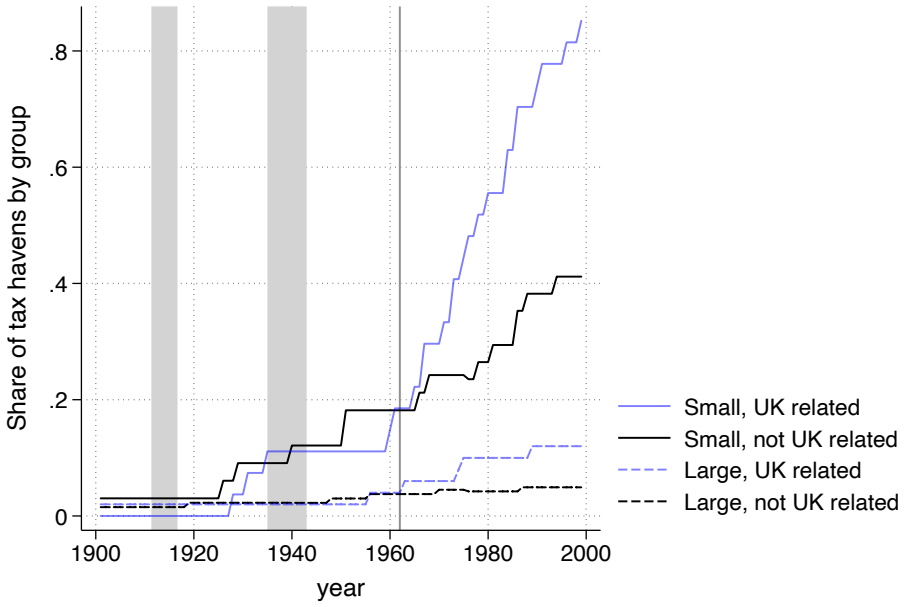
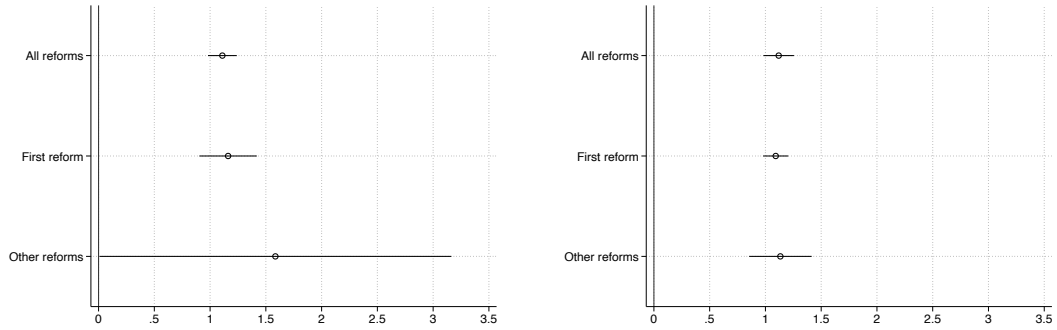


Figure 2.C.3: Tax havens characteristics: size and colonial history

Note: This figure plots the share of tax havens in two size groups (small and large countries) crossed with groups constructed according to colonial history (UK related or not). The group of small countries corresponds to countries in the first quartile of country size. Other countries are classified as large. UK-related colonies correspond to colonies for which the last ruler is the United Kingdom. The construction of colonial history is detailed in section 2.1. Data on tax havens' reforms comes from own data collection detailed in section 2.1. Shaded areas indicate the world wars and the vertical line (1962), the beginning of the independence wave in the UK-dominated Caribbean area.



(a) Size premium

(b) UK colony premium

Figure 2.C.4: Premia in the probability of becoming a tax haven for size and colonial history

Note: This figure plots the ratio of the demand coefficients for small countries (panel a) and (former and current) UK colonies (panel b) to demand coefficient for other countries. The confidence interval corresponds to a 5% confidence interval. It can be interpreted as a premium for small countries and UK colonies. A coefficient of 1.5 in the left panel means that the elasticity of the probability of becoming a tax haven to demand is 1.5 times higher in small countries. Small countries are defined as countries smaller than the median country size in the sample. Each coefficient is computed for three different dependent variables: $\mathbb{1}_{Reform}$, $\mathbb{1}_{FirstReform}$ and $\mathbb{1}_{OtherReforms}$. Each model includes control variables and country and year fixed effects following the specifications in columns (3), (6) and (9) of table 2.3.

2.D . Offshore Leaks

To provide evidence that the use of tax havens follows a gravity structure, I use data from Offshore Leaks released by the International Consortium of Investigative Journalists (ICIJ, 2022a; ICIJ, 2022b). This data result from different leaks:

- Panama Papers (2016): entities registered by the law firm Mossack Fonseca.
- the Paradise Papers (2017): clients of the law firm Appleby and seven tax havens' corporate registries.
- the Pandora Papers (2021): data leaked from 12 offshore service providers.
- the Bahamas leaks (2016): Bahamas corporate registry containing information on Bahamian Companies, trusts and foundations.
- the Offshore Leaks (2013): entities incorporated through two service providers.

The data allows linking entities registered in tax havens to their owners (beneficial owners when available) and to the intermediaries participating in the offshore structure. The ICIJ has linked the owners (individuals or companies, named officers in the database) to specific countries using their registered addresses. In 8.6% some cases, a given officer might be linked to more than one country. I drop cases where a given officer is linked to more than three countries (0.87% of the cases). Otherwise, I assign to the officer all the countries listed. I drop entities without any officer listed.

I then count any observed entity linked to a given officer as a "link" between the tax haven in which the entity is registered and the country to which the officer has been assigned (if there are multiple countries, I count one different link for each different country). I obtain a dataset where I observe the number of offshore links for each pair of countries available in the data and for each different leak source. Keeping the heterogeneity coming from the source provider allows me to control for additional non-observed factors (such as the differential propensities for some law firms to work with tax havens or origin countries) through fixed effects.

I drop same-country pairs. The rest of this exercise assumes that the links available in the Offshore Leaks are a good proxy for the actual (unobserved) links. It should be the case as long as the entities revealed by the leaks are not correlated with the origin countries of officers. In all likelihood, this is not a strong assumption given the number of independent sources and the fact that the ICIJ has released data indistinctly from these considerations. This data is then merged with the USITC gravity dataset (Gurevich and Herman, n.d.) to perform gravity estimations.

2.E . Tax rates in tax havens

One assumption of the theoretical framework is that the tax rate on the domestic and offshore economies are correlated in tax havens. Consequently, tax rates in tax havens should be lower than in comparable countries. This section explores this hypothesis. I explore this hypothesis by collecting corporate and individual tax rates from KPMG tax rates tables (KPMG, n.d.).[40] Data are provided for 151 countries between 2011 and 2021. For corporate tax rate it lists the statutory tax rate for a large firm, including local taxes when substantial. For individual tax rates, it generally lists the top marginal income tax rate and does not include deductions or special rules.

Table 2.E.1, describes the average tax rate applicable in tax havens for corporate income tax and individual income tax. It reveals substantial differences in tax rates between tax havens and non-havens. The corporate tax rate in tax havens is, on average, about 7 percentage points lower. It is, on average, 5 percentage points lower for the personal income tax rate. However, it is uncertain if this difference is driven by the fact that tax havens have specific characteristics such as being small countries or because they are tax havens, all other things being equal. The tax competition literature has shown that small countries have lower tax rates in equilibrium than larger countries, even in models that do not include tax havens (Bucovetsky, 1991). Consequently, tax havens tax rates should be compared to those of similar countries.

Table 2.E.1: Comparison of tax rates between havens and non-havens

	Corporate Income Tax	**Personal Income Tax**
Tax havens	17.3	24.0
Non-havens	24.2	29.1

Note: Average tax rates for tax havens and non-havens in 2021. Data on statutory income tax rates is taken from KPMG Tax Rates Tables. Corporate income tax corresponds to the statutory tax rate including local tax rates when applicable. Personal income tax corresponds to the top marginal tax rate and does not include deductions or special rules. The list of tax havens used is described in section 2.1 of the paper and available in table 2.B.1 of the appendix.

To do so, I estimate the following equation by OLS:

$$Rate_{it} = \beta_1 Tax\ Haven_i + CZ_i + \mu_t + \epsilon_{it}$$

with $Rate_{it}$ being the statutory tax rate (either corporate or personal), $Tax\ Haven_i$ an indicator variable equal to 1 if country i is a tax haven, Z_i a vector of country-level characteristics such as its size, its GDP or its legal origins, C is the vector of coefficients associated. μ_t is a year fixed effect and ϵ_{it} is the error term.

[40] See https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/corporate-tax-rates-table.html and https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/individual-income-tax-rates-table.html

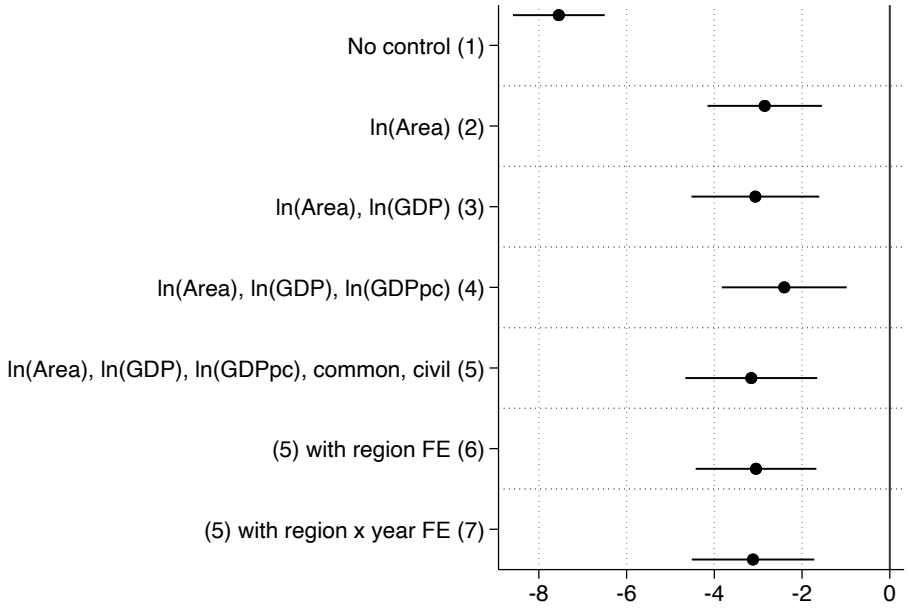


Figure 2.E.1: Estimation of β_1 for corporate income taxes

Note: This figure plots the estimation of β_1 along with its 95% confidence interval (robust standard errors) for different models. The dependent variable is the statutory corapote income tax rate including local taxes if applicable. Data on statutory income tax rates is taken from KPMG Tax Rates Tables.

In figures 2.E.1 and 2.E.2, I plot the estimation of β_1 along with its 95% confidence interval for different models. Figure 2.E.1 reveals that for all models, corporate income tax rates are lower in tax havens than in comparable countries by 3 percentage points on average. This effect is significantly different from zero at the 5% level. It is also true when we control for size, GDP, GDP per capita, legal origin and include region $\times$ year fixed effects. Interestingly, adding controls to the regression decreases by approximately 2.5 the estimated coefficient of tax havens. It confirms that a part of the lower tax rates in tax havens can be explained by their characteristics, particularly their size. However, controlling for these characteristics cannot fully explain why tax havens have lower tax rates than comparable countries.

Figure 2.E.2 repeats the exercise for the individual tax rate. In models (1) to (5), including a diverse set of controls and year fixed effects, we observe a lower tax rate in tax havens than in comparable countries by about 2 percentage points. We add region fixed effects and region $\times$ year fixed effects in models (6) and (7). These models compare countries to similar countries in the same broad world region. The coefficient estimated appears negative but lower than in other models. This coefficient is also imprecisely estimated and not significantly different from zero at the 5% level.

Overall, these results do not contradict the assumption made in the theoretical framework that the domestic tax rate is not independent of the tax rate on the offshore economy. Indeed, tax rates on the domestic economy tend to be lower in tax havens than in comparable countries.

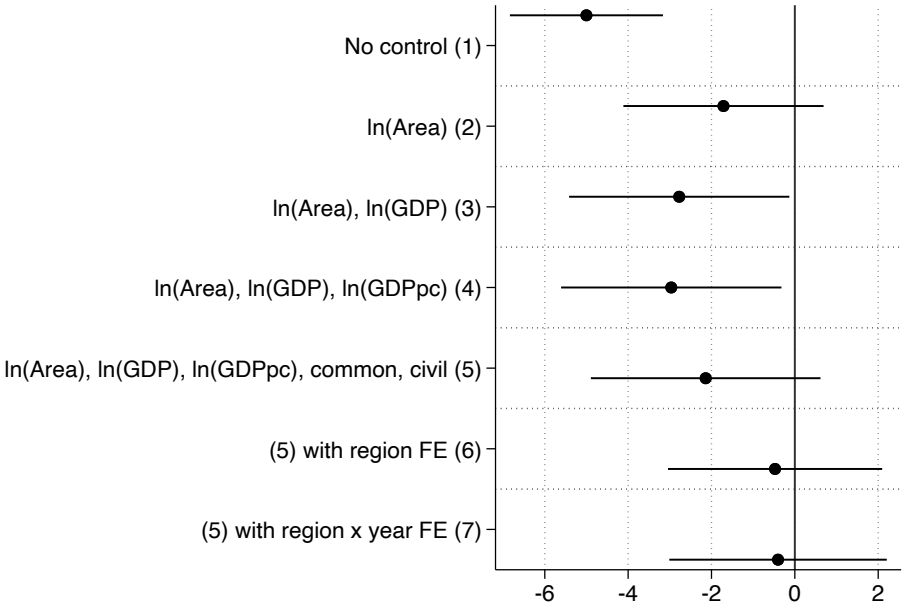


Figure 2.E.2: Estimation of β_1 for individual income taxes

Note: This figure plots the estimation of β_1 along with its 95% confidence interval (robust standard errors) for different models. The dependent variable is the statutory personal income tax rate base on the top marginal tax rate. Data on statutory income tax rates is taken from KPMG Tax Rates Tables.

2.F . Theoretical proofs

Infrastructure level and tax haven quality. Proof that the level of infrastructure and the quality of the tax haven are set at their maximum in the non-haven case:

The firs-order condition for infrastructure maximization is:

$$\frac{\partial u_s^I}{\partial \pi_s} = \underbrace{y_\pi \left(\delta t_s(\alpha_s - 1)\right)}_{\geq 0} + t_\pi \underbrace{\left(\delta y(\pi_s)(\lambda_s - 1) + \frac{\alpha_s}{N}\left(\omega^F + t_s \omega_t^F\right)\right)}_{=0 \text{ using } 2.6} \geq 0$$

Therefore $\frac{\partial u_s^I}{\partial \pi_s}$ is always positive. The level of infrastructure is set at his maximum, constrained by the infrastructure capacity.

The first-order condition for tax haven quality maximization is:

$$\frac{\partial u_s^I}{\partial p_s} = t_p \underbrace{\left(\delta y(\pi_s)\left(\alpha_s - 1\right) + \frac{\alpha_s}{N}\left(\omega_s^F + \omega_t t_s\right)\right)}_{=0 \text{ using } 2.6} + \frac{\alpha_s}{N} t_s \frac{\partial \omega}{\partial p} \geq 0$$

Therefore $\frac{\partial u_s^I}{\partial p_s}$ is always positive. The tax haven quality is set at his maximum, defined by the tax haven capacity.

Implication 2 I compute $\frac{\partial \Delta U}{\partial N}$:

$$\frac{\partial \Delta U}{\partial N} = \sum_s t_{sN}\left(y\left(\pi_s\right)\left(\alpha_s - 1\right)\delta + \frac{\alpha_s}{N}\left(\omega_s^F + t_s^H \omega_{st}^F\right)\right) - \frac{\alpha_1}{N^2} t_s^H \omega_s^F$$

Because of the first-order condition on tax rate, $y\left(\pi_s\right)\left(\alpha_s - 1\right)\delta + \frac{\alpha_s}{N}\left(\omega_s^F + t_s^H \omega_{st}^F\right) = 0$ (this is the envelope condition). It follows that

$$\frac{\partial \Delta U}{\partial N} = -\sum_s \frac{\alpha_1}{N^2} t_s^H \omega_s^F \leq 0$$

Implication 3 To show that an increase in taxes in other countries increases the probability that a country become a tax haven, I compute $\frac{\partial \Delta U}{\partial t_i}$. I can make use of the envelope theorem to derive only the direct effect of t_i on ΔU, not considering effects of change in t_i in the endogenous variables.

$$\frac{\partial \Delta U}{\partial t_i} = \sum_s \frac{\alpha_s}{N}\left(t_s^H \omega_{t_i}^F\right)$$

with$\omega_{t_i}^F = \sum_i \omega_i N_i \mathbb{P}_{ih} \frac{exp(1-t_i)}{\left(\sum_{k\in\{TH\}} exp(A_k) + exp(1-t_i)\right)} \geq 0$

Additionally we can show that $\frac{\partial \Delta U}{\partial t_i \partial N} \leq 0$ and $\frac{\partial \Delta U}{\partial t_i \partial \tau_{ih}} \leq 0$:

$$\frac{\partial \Delta U}{\partial t_i \partial N} = -\sum_s \frac{\alpha_s}{N^2}\left(t_s^H \omega_{t_i}^F\right) \leq 0$$

$$\frac{\partial \Delta U}{\partial t_i \partial \tau_{ih}} = \sum_s \frac{\alpha_s}{N}\left(t_s^H \sum_i \omega_i N_i \frac{exp(1-t_i)}{\left(\sum_{k\in\{TH\}} exp(A_k) + exp(1-t_i)\right)} \mathbb{P}_{ih}\left(\frac{-1}{p_h(1-t_h)}\right)\right) \leq 0$$

Implication 4 To show that, the higher the level of initial tax haven quality, the higher the probability to become a tax haven, I compute $\frac{\partial \Delta U}{\partial p_1}$. To show that the higher the initial level of infrastructure, the lower the probability to become a tax haven, I compute $\frac{\partial \Delta U}{\partial \pi_1}$. Again, I make use of the envelope theorem.

$\frac{\partial \Delta U}{\partial p_1}$ gives:

$$\frac{\partial \Delta U}{\partial p_1} = \frac{\alpha_1}{N}\left(t_1^H \omega_p^F\right)$$

with

$$\omega_p^F = \sum_i N_i \omega_i \frac{\tau_{ih}}{p^2\left(1-t_h\right)}\left(\mathbb{P}_{ih} - \mathbb{P}_{ih}^2\right) \geq 0$$

$\frac{\partial \Delta U}{\partial \pi_1}$ gives:

$$\frac{\partial \Delta U}{\partial \pi_1} = y_\pi(\pi_1)\left(\delta t_1^H - t_1^{NH}\right)\left(\alpha_1 - 1\right) \leq 0$$

This result is obtained because $\alpha_1 \geq 1$ and $\delta t_1^H - t_1^{NH} \leq 0$.

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3 - Multinational's Sales and Profit Shifting in Tax Havens[1]

The current international tax system, based on transfer pricing rules and separate accounting, is designed to ensure "*that profits are taxed where economic activities take place and value is created*" (OECD, 2015). This fundamental rule does not apply in practice. The basic strategy used by multinational corporations to shift profit is twofold: they shift sales from high-tax to low-tax jurisdictions, while moving expenses in the opposite direction. This paper focuses on *sales shifting*. In Figure 3.0.1, we show that U.S. MNEs record their worldwide sales and therefore the associated profit in low-tax jurisdictions (left side of Figure 3.0.1) and produce elsewhere (right side of Figure 3.0.1). This illustrates the discrepancy between the place where the "value" is created (proxied by the location of employment) and the place where the sales are registered *for fiscal purposes* – and profits are taxed.

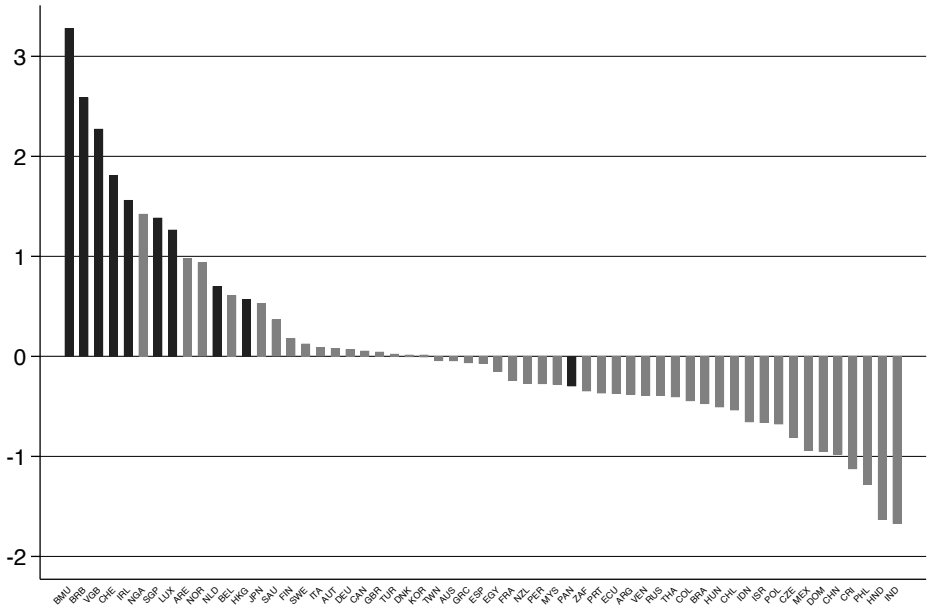

Figure 3.0.1: Distribution of U.S. multinational firms' sales and employment

Note: Figure 3.0.1 represents the worldwide distribution of U.S. multinational firms' sales and employment. Each bar is a country's sales-to-employment gap, defined as the average log ratio of the share of total sales to the share of total employees of U.S. affiliates over the period 1999–2013. Large discrepancies remain after accounting for country-level productivity differences. This suggests that U.S. multinationals register their worldwide sales in low-tax jurisdictions (the black bars correspond to tax havens) but produce in other countries (on the right-hand side of the figure)

We study the extent of sales shifting and proposes a quantification of its contribution to the overall profit that is shifted through the foreign activities

[1]This chapter has been jointly written with Farid Toubal.

of U.S. multinational firms. Our results suggest that they use complex strategies that involves many countries and record in low-tax jurisdictions most of their sales originating from high-tax jurisdictions. Our results indicate that an important source of excess profits in tax havens stems from sales shifting.

Quantifying the role of sales shifting has implications for the design and efficacy of tax policy. Sales are an important tool for both firms' tax planning strategies and states' tax policies. Yet, they have received little academic attention. The recent discussions around the reform of international corporate taxation partly focus on revenues generated from the sales of goods or services directly to consumers. These sales are one of the important factors that are discussed to allocate the taxing rights under the Pillar One of the current OECD/G20 negotiations (OECD, 2020). The key element is to identify sales according to their final destination. This is however challenging because sales are most commonly identified on an origin basis, at the location of the seller, and not where the final consumers are located (see for instance Neubig, 2019 and Delpeuch, Laffitte, Parenti, Paris, Souillard, and Toubal, 2019 on Country-by-Country reporting). The revenue is from the location of the entity selling the product or the service, not where the final consumers are located. Destination-based policies would therefore be less effective in providing a better environment for a robust corporate tax if the rules and policy design are unable to identify the true destination of sales. Our analysis questions the relevance of databases reporting sales on an origin basis to study this question. The OECD's country-by-country reporting (CbC-R) dataset does not precisely identify the location of consumers. More generally, other databases on multinational production such as OECD's AMNE or Eurostat's FATS, do not inform on the destination of sales.

There exists several cases across different sectors and countries showing that multinational enterprises use various techniques and corporate tax loopholes to relocate their sales (Murphy, 2013). Until recently, Apple had for instance set up its sales operations in Europe in such a way that customers were contractually buying products from Apple Sales International, one of the Irish incorporated companies, rather than from the Apple stores that *physically* sold the products to the customers (Levin, 2013). In this way, Apple recorded all sales, and the profit stemming from these sales, directly in Ireland (The European Commission, 2016). A number of detailed and interesting papers examines corporate tax avoidance by using bilateral transactions datasets.[2] Recording sales in low-tax jurisdictions may however require the use of strategies that are more complex and perhaps less documented, such as contract manufacturing or cost-sharing agreements, and are difficult to capture in bilateral datasets.[3] Multinational firms create complex structures across coun-

[2]See for instance Clausing, 2003, Cristea and Nguyen, 2016 and Davies, Martin, Parenti, and Toubal, 2018 for transfer mispricing of goods, Hebous and Johannesen, 2015 for transfer mispricing of services. Buettner and Wamser, 2013 use micro-data for the analysis of debt shifting.

[3]See Jenniges, Mataloni Jr., Stutzman, and Xin, 2018 on cost-sharing agreements. Gravelle, 2013 describes the techniques associated with contract manufacturing. The cases of Apple and many other companies which use contract manufacturing and cost-sharing agreements across many different countries are described in details in Appendix A.

tries that increase the cost of enforcing anti-tax avoidance regulations (see e.g. Hopland, Lisowsky, Mohammed, and Schindler, 2019 which discuss triangular structures). The use of complex strategies involving many countries may be the underlying reason why estimates of profit shifting vary from large when using macro-level datasets at the country level to small when using mostly bilateral micro-level information.[4]

We make several contributions. We examine sales shifting for the first time. The literature shows that multinational firms set up foreign affiliates, also called export platforms, close to large markets to benefit from the proximity to foreign demand.[5] Hanson, Mataloni, and Slaughter, 2001 notice however that the effect of market access on the location of export platforms depends on how the estimation sample is defined, whether it includes tax havens or not. We define the concept of *foreign sales platforms* as these affiliates do not only export but also record the worldwide sales of goods and services. These transactions may not even require physical trade. We identify the countries where U.S. MNEs record *excessive* ratios of foreign to total sales, which indicates sales shifting. We show that the share of foreign sales recorded in tax havens is disproportionately larger than in non-tax havens. The access to large markets does not explain excessive foreign sales ratio in tax havens.

To guide our empirical analysis, we propose an illustrative framework that helps to predict how the ratios of foreign to total sales are affected by sales shifting. Our framework builds on Head and Mayer (2004) which shows that market access and production costs are important factors determining the location of sales and *normal* profits of foreign affiliates. Within this framework, we incorporate elements of the tax avoidance literature borrowed from Hines and Rice (1994) and Gumpert, Hines, and Schnitzer (2016) that explain the shifting behavior of firms. The model predicts that, all other things equal, the ratio of foreign sales to total sales recorded in tax havens is larger than those registered in non-tax havens. It also predicts a weaker impact of market access on this ratio in tax havens compared to other countries. The market access motive is not prevalent in explaining the activity of U.S. multinationals in tax havens.

Our empirical analysis uses aggregate and sector-level information on sales and profits before income tax of foreign affiliates of U.S. multinationals from the Bureau of Economic Analysis for the period 1999–2013 (Bureau of Economic Analysis, n.d.). The study of Clausing, 2020 describes the strengths of

[4]Clausing, 2020 discusses in details alternative explanations for the reason why macro-level data sources find larger estimates of profit shifting than micro-level data sources. The lack of firm-level information from tax havens is one of major issue (Torslov, Wier, and Zucman, 2022). This concern is reinforced by the extreme distribution of aggressive tax planning in a handful of tax havens. As pointed by Reynolds and Wier, 2016 a few large corporations are responsible for the vast majority of profit shifting. Bilicka, 2019 and Davies, Martin, Parenti, and Toubal, 2018 provide an explanation of this pattern based on the existence of fixed costs associated with profit shifting. As shown by Dowd, Landefeld, and Moore, 2017, the bulk of tax avoidance comes from a few large firms operating in a relatively limited number of tax havens. There is relatively less tax responsiveness in the data when tax haven destinations are disregarded. Thus, studies based on typical firms will understate the problem.

[5]Theoretical contributions on this topic include Head and Mayer (2004), Ekholm, Forslid, and Markusen (2007), Mrázová and Neary (2011), Ito (2013), and Tintelnot (2017).

this dataset to examine our economic question. According to the BEA data, 22% of the total sales of U.S. majority-owned foreign affiliates take place in tax havens. This figure goes up to 33% when restricting the data to intra-firm sales. This shows the importance of tax haven locations for U.S. multinational firms. Important papers based on macro-level data estimate the amount of profit shifted to tax havens for the U.S. or at the global level (Zucman, 2014, Clausing, 2016; Clausing, 2020, Torslov, Wier, and Zucman, 2022, Wright and Zucman, 2018, or Jansky and Palansky, 2019). In the spirit of Zucman (2014), we show that several important patterns and channels of sales and profit shifting can be documented using simple variables (sales, profits, and employment) found in publicly available and aggregated datasets. The dataset provides information on local and foreign sales which is crucial for our empirical design and has not been used in previous studies. It allows to identify sales shifting which is particularly difficult to observe in bilateral or micro-level datasets. Firms use complex operations that involve many countries in order to record sales in a single tax haven. The use of aggregate data is therefore particularly relevant as we can quantify the overall amounts of excessive sales that are recorded in each jurisdictions. We show that sales shifting is pervasive in services industries across small and large tax havens and in manufacturing industries in large havens located in Europe and Asia. The revenues stemming from sales of services may be easier to shift to tax havens as they do not involve reporting to customs. We show that sales shifting to tax havens is also prominent when examining transactions of goods.

Based on our theoretical framework, we develop a quantification methodology which is partly inspired by Clausing (2016) and Torslov, Wier, and Zucman (2022) to estimate the contribution of sales shifting to the overall foreign profit shifting of U.S. multinational firms. The estimation of excessive profits requires defining a benchmark level of (normal) profits. Our model can be informative about this benchmark level. Our quantification of excessive profits takes into account corporate tax rates, the tax haven status of the country, and its level of transparency with respect to U.S. tax authorities. We evaluate the contribution of sales shifting to overall profits by including negative and zero values of profit and show that sales shifting accounts for at least one fourth of U.S. foreign profits.

Our paper is organized as follows. In Section 3.1, we present our data sources and some facts about the geographical distribution of sales and profits of U.S. multinational corporations. The illustrative framework is described in Section 3.2 and we present our econometric strategy in Section 3.3. In Section 3.4, we provide the results on the distribution of the foreign sales ratio and the estimation of the profit shifted through sales shifting. We conclude and discuss related issues, especially current policy debates, in Section 3.5.

3.1 . Data and facts

The data on the activity of U.S. owned foreign affiliates come from the annual and benchmark surveys of the Bureau of Economic Analysis (BEA). The BEA dataset tracks affiliate sales not only in manufacturing but also in service

Table 3.1.1: Foreign sales ratio by country type and sector.

	Non-Tax Havens	Tax Havens
Mining	0.24	0.33
Food	0.19	0.29
Chemicals	0.22	0.57
Primary and Fabricated Metals	0.31	0.34
Machinery	0.37	0.41
Computers and electronic products	0.43	0.48
Electrical equipment, appliances, and components	0.31	0.32
Transportation equipment	0.34	0.29
Wholesale trade	0.16	0.70
Information	0.12	0.48
Professional, scientific, and technical services	0.15	0.37
Average	0.24	0.46

sectors, which have received less attention in the literature. It includes many different variables such as total assets, property, plant and equipment assets, employment, local and foreign sales of goods and services, and net income or profit-type return. Importantly, the profit-type return variable measures profit before income taxes and excludes non-operating items (such as special charges and capital gains and losses) and income from equity investments (Bureau of Economic Analysis, 2004).[6] This measure of profit is particularly interesting for our study. It excludes financial revenue that is by definition not generated by the export activities of firms. Importantly, it is also immune from double counting as noted for instance by Wright and Zucman (2018) and Clausing (2020).[7]

Our empirical analysis focuses on the activities of majority-owned foreign affiliates in 56 countries and 11 industries from 1999 to 2013. We provide the list of countries, the definition of the different industries and details on the sample's construction in Appendix B. Appendix C provides the descriptive statistics of our sample.

3.1.1 . Foreign sales plateforms

The share of foreign sales of U.S. multinationals' foreign affiliates reported for each industry k in country i at year t is computed as the ratio of foreign to total sales:

$$FS_{ikt} = \frac{Foreign\ sales_{ikt}}{Total\ sales_{ikt}}.$$

This ratio is the basis for our empirical analysis. A higher ratio of foreign to total sales indicates that U.S. foreign affiliates record a large amount of foreign sales in the host country. While the average foreign sales ratio remains rather low at 28% in our sample, Table 3.1.1 reports great differences across industries between tax haven and non-tax havens.

[6]The profit-type return data may miss some foreign-to-foreign shifting, hybrid dividends, and income that goes entirely untaxed (see the details in Appendix A of Clausing, 2020). See also Dyreng, Hills, and Markle (2019) about the importance of untaxed foreign profits.

[7]Blouin and Robinson (2019) discuss issues related to the double counting of profits in U.S. datasets.

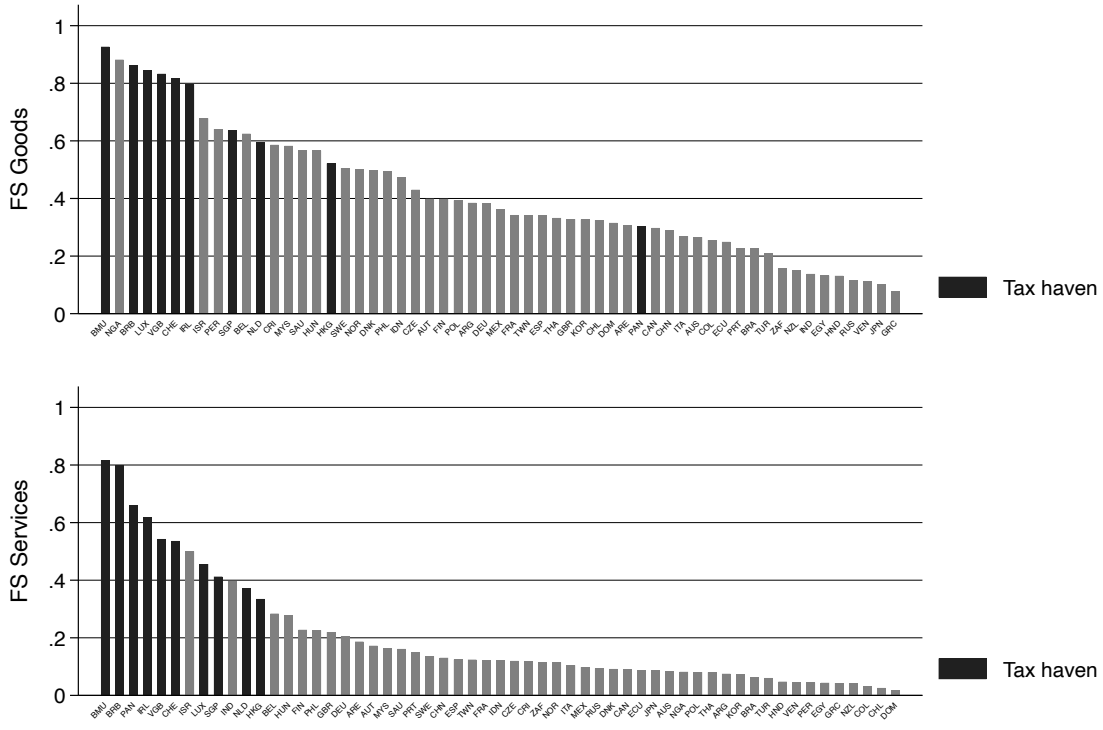

Figure 3.1.1: Average foreign sales ratio of U.S. MNEs.

Note: This figure shows the average foreign sales ratios of each country in our sample, in the upper panel for the trade of goods and in the lower panel, for the trade of services. Sectors are pooled. Tax havens are in black.

The foreign sales ratio is below average in non-tax havens (24%), while it is 1.5 times greater in tax havens (46%). In the wholesale sector, the ratio is 16% in non-tax havens and 70% in tax havens. In the sector of chemical products, the foreign sales ratio is more than twice as great in tax havens as in non-tax havens (57% against 22%). The empirical analysis shows that both sectors play an important role in the sales shifting strategy of U.S. MNEs. The vast majority of transactions in these sectors involves trade in goods rather than trade in services. Figure 3.1.1 visualizes the average foreign sales ratios for each country in our sample. We find large ratios of foreign sales to total sales in tax havens for both types of transactions. This finding suggests that sales shifting is not only used to record intangible assets in tax havens.

The foreign sales ratio has been used in the literature studying the role of the foreign export platforms of U.S. multinational companies (see for instance Tintelnot, 2017). We use a different terminology and name these affiliates *foreign sales platforms* as their foreign activities may involve transactions that do not require physical trade to cross the border. The BEA datasets are particularly helpful to understand this new concept. U.S. trade in goods must be reported on a "shipped" basis (meaning on the basis of the *physical* transaction), whereas U.S. sales and purchases are reported on a "charged" basis (meaning on the basis of the *financial* transaction). According to the BEA (Bureau of

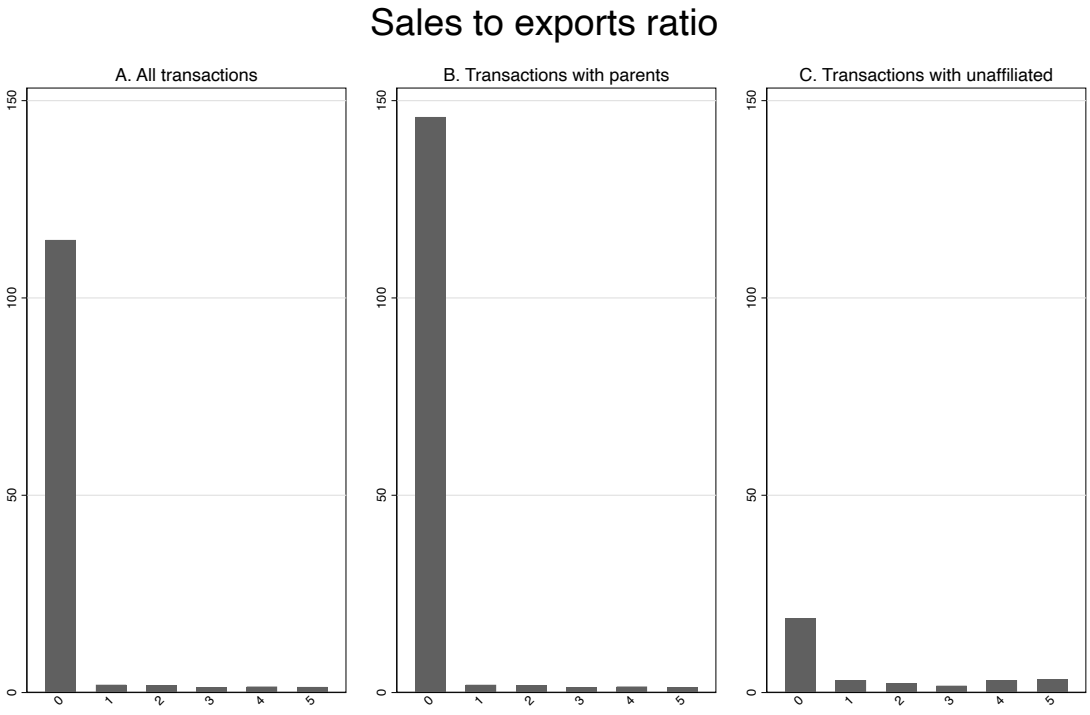

Figure 3.1.2: Evidence of contract manufacturing.

Note: This figure displays the foreign sales to export ratio for transactions with the U.S. On the x-axis, the first bar corresponds to tax havens and the other bars correspond to tax rate quintiles, excluding tax havens. The left panel considers all transactions, the middle panel, relations with the parent company, and the right panel, transactions with unaffiliated companies. Sectors are pooled.

Economic Analysis, 2004, page 34): "*The two bases are usually the same, but they can differ substantially*." Foreign sales may differ from exports, particularly in transactions involving tax havens. This is the case for instance if a foreign sales platform located in a tax haven purchases goods from a third-party contractor in China to sell them in the U.S. The tax haven affiliate records in its books the sales to the U.S. However, the customs data report an export from China to the U.S. if the goods are shipped directly from China to the U.S. This example illustrates a simple case of tax-based contract manufacturing agreement and the gap that arises between foreign sales and exports. BEA declaration requirements allow us to compare foreign affiliates sales of goods to official U.S. trade data (Bureau of Economic Analysis, 2004). Since the BEA does not record exports to countries other than the U.S., Figure 3.1.2 shows the *sales-to-exports ratio* computed by excluding all destinations other than the U.S.

To make sure that the two measures are comparable, we concentrate on the sales and physical exports of goods *only*. Contrary to conventional wisdom, the sales-to-exports ratio is larger than one in many countries. On average, the sales of foreign affiliates to the U.S. are 26 times larger than their exports to the U.S. A striking feature of Figure 3.1.2 is the disproportionate role of tax havens in explaining the sales-to-exports ratio. Panel A shows that the deviation is larger for tax havens than for non-tax havens. U.S. foreign affiliates sales in tax

havens are 171 times larger than exports. The corresponding *sales-to-exports ratio* from non-tax havens is 1.6. Panels B and C show that this imbalance is mainly due to transactions within U.S. multinational companies.

These findings suggest that U.S. parent companies shift sales from affiliates located in non-tax havens to affiliates located in tax havens. It is worth stressing that a large part of these shifts take place within multinational firms (Murphy, 2013). As argued by Gravelle (2015), low-tax countries may not be good locations to actually manufacture and sell products. Instead, affiliates in tax havens can contract with a firm in a different country as a *contract manufacturer* to produce the good with a fixed mark-up that may involve transfer mispricing (as suggested by Levin, 2013; Levin, 2014 in the cases of Apple and Caterpillar). Subpart F regulations should impede this type of contract, but these arrangements can involve hybrid entities that allow firms to defer their U.S. tax bill through the check-the-box loophole. Indeed from 1997 to 2004, 25% of U.S. MNEs' foreign income was located in affiliates that used the check-the-box exception (see Grubert, 2012).

3.1.2 . The host country's tax environment

Our main corporate tax rate variable, which is widely used in the profit-shifting literature is the statutory tax rate (Grubert and Mutti, 1991; Schwarz, 2009; Clausing, 2016; or Dowd, Landefeld, and Moore, 2017). It has the advantage to be exogenous and widely available. However, one could argue that the relevant costs associated with the profit-shifting process are based on the average effective tax rate which, due to special tax rules or negotiated tax rates, more accurately reflects the true tax cost of reporting income in a jurisdiction. The average tax rate is the percentage of a firm's overall taxable income that is paid in taxes. It may be more accurate in reflecting the true tax cost but has several drawbacks. First, the average tax rate is endogenous to the profit-type measure which is our dependent variable in the quantification exercise. Second, our empirical analysis could also suffer from a selection bias (in case of losses as the ratio of foreign income taxes over profit-type returns cannot be computed for negative profit values) and an aggregation bias (because we may aggregate profit-making and loss-making firms). Third, the average tax rate is also volatile and may be affected by losses made during the crisis period. For these reasons, we present the baseline results using the statutory tax rate and the results using the average tax rate variable in the Appendix E. We collect information on corporate taxes for each of the 56 countries in the sample from the OECD tax database (OECD, n.d.(b)), KPMG's *Corporate Tax Rates Table and Corporate Tax Rate Surveys* (KPMG, n.d.), Deloitte's *International Tax Source* (Deloitte, n.d.), EY's *Corporate Tax Guide* (Ernst and Young, n.d.) and Center for Business Taxation Tax Database (Center for Business Taxation, 2017).

To characterize tax havens, we use the definition proposed by Hines and Rice (1994) and later used by Dharmapala and Hines (2009). We add the Netherlands to this list as it is considered as a major tax haven destination given the low amount of taxes paid by U.S. firms in this country (see for instance Dowd, Landefeld, and Moore, 2017, Torslov, Wier, and Zucman, 2022, Clausing, 2020). We provide a full characterization of these countries in Appendix B. In

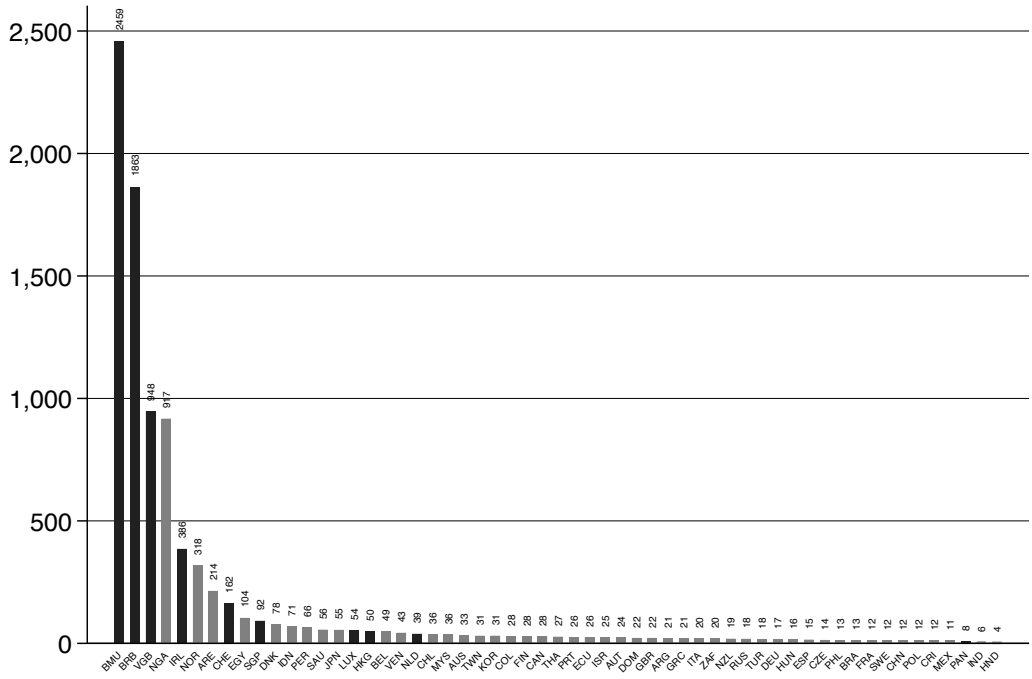

Figure 3.1.3: Profits of U.S. foreign affiliates across countries.

Note: This figure displays the average profits per employee in each country. Tax havens are in black.

our estimation sample, Barbados, Bermuda, the British Virgin Islands, the Cayman Islands, Hong Kong, Ireland, Luxembourg, Montserrat, the Netherlands, Panama, Singapore, Switzerland, and the Turks and Caicos Islands are classified as tax havens. The available data on foreign affiliates' activities for the British Virgin Islands, the Cayman Islands, Montserrat, and Turks and Caicos are gathered into a single country which we call "British Virgin Islands". Our empirical analysis therefore includes ten tax havens which are listed among the top countries that have done the most to proliferate corporate tax avoidance and break down the global corporate tax system according to the Tax Justice Network, 2019.

In Figure 3.1.3, we display the distribution of average profits per employee across countries in our sample. We observe extremely large profits per employee in British Virgin Islands, Bermuda, and Barbados and to some extent in Ireland and Switzerland compared to the profits per employee in non tax haven countries.

We include information on Double Taxation Conventions (DTCs) and Tax Information Exchange Agreements (TIEAs) between the host country and the U.S. DTCs are mainly used to avoid taxing firms twice. They often include an article implementing the sharing of tax information between the two signatories (see Article 26 of the OECD Tax Convention Model). TIEAs guarantee the exchange of information to prevent tax fraud or tax avoidance. However, the majority of TIEAs did not involve the *automatic* exchange of information. A request by one of the two signatories must be supported by well-documented suspicion of

tax avoidance, which is often difficult to gather (see, Johannesen and Zucman, 2014 or Chavagneux, Palan, and Murphy, 2010). The information on worldwide tax treaties is obtained from the Exchange of Information database provided by the OECD (OECD, n.d.(a)). The coverage of the dataset is particularly good for the U.S. which had signed agreements with 88 jurisdictions in 2017. Both DTC and TIEA conventions have special clauses on the exchange of information between the host countries and the U.S. The exchange of information is particularly relevant when characterizing the degree of compliance of each partner country with the U.S. tax authorities. We therefore construct a measure of exchange of information from both DTC and TIEA conventions. In our empirical exercises, we include information on the exchange of information as well as on double taxation conventions.

Multinational firms use indirect investment routes through countries with favorable tax treaties (see Hong, 2018 and 't Riet and Lejour, 2018). They can therefore return profits to their home countries through tax-minimizing indirect routes. The OECD, 2015 highlights that this so-called *treaty shopping* is one of the most important sources of concern regarding the Base Erosion and Profit Shifting (BEPS) project. We proxy the centrality of a country's tax treaty network through the number of Double Tax conventions (DTCs) the country has signed. This is not a direct measure of actual treaty shopping, but it may accurately describe the opportunities of treaty shopping when controlling for GDP and foreign market access, as we do in all regressions.

3.1.3 . Other variables

The activities of U.S. foreign affiliates do not only depend on the tax environment of their host country. They also reflect local and foreign demand (Redding and Venables, 2004; Head and Mayer, 2004; and Head and Mayer, 2011). In the framework of Head and Mayer, 2004, foreign affiliates sell to domestic and foreign countries, with foreign sales discounted by bilateral trade costs. We compute the foreign market access of each country in our sample following methodology described by Head and Mayer, 2011. The computation details are described in Appendix B. Finally, the series on real GDP were obtained from the Penn World tables (Feenstra, Inklaar, and Timmer, 2015).

3.2 . Illustrative Framework

In this section, we present a framework that illustrates sales shifting. We follow the approach pioneered by Hines and Rice, 1994 and extended more recently by Clausing (2016) and Torslov, Wier, and Zucman (2022) which rely on the direct observation of pre-tax profit. The premise of their methodology is that the observed pretax profits of a firm represents the sum of *normal* profits and *shifted* profits. In our framework, we assume that firms shift sales made in high-tax countries and the profits stemming from these sales to a tax haven. The model helps to predict how the ratios of foreign to total sales are affected by sales shifting. The model is informative on the level of reported profit that would have been declared by the firm without corporate tax avoidance.

3.2.1 . The tax environment of multinational firms.

Multinationals can invest in a range of countries $i = 1, \cdots, n$ including a tax haven, indicated by the superscript th. We decompose the observed pre-tax profits of a firm as the sum of *normal* and *shifted* profits. We denote ρ_i the normal level of pre-tax profits earned in country i by the U.S. foreign affiliate. We denote F_i the fixed cost of operating foreign affiliates. The reported profits are taxed at rate T_i in country i. The tax haven is assumed to have a corporate tax rate of zero, $T_0 = 0$.

As in Hines and Rice (1994) and Gumpert, Hines, and Schnitzer (2016), firms can reallocate an amount Ψ_i of their actual income stemming from their sales made in country i to the tax haven. By shifting profit, the firm incurs a reallocation cost that becomes increasingly expensive as the amount shifted increases relative to the amount earned in country i (Huizinga and Laeven, 2008 also use a similar approach). These costs are incurred in the country from which the income is shifted and are assumed to be $\left(a^{1/\gamma_i}/2\right)(\Psi_i^2/\rho_i)$.[8] The parameter $a \in (0, \infty)$ captures how much the cost of income reallocation increases with the amount reallocated. In contrast to Hines and Rice (1994) and Gumpert, Hines, and Schnitzer (2016), we assume that this cost depends on a parameter $\gamma_i \in (1, \infty)$ which decreases with the degree of transparency of a country i's tax environment. Empirically, this degree depends on exchange of information between the U.S. and each host country (OECD, 2001). The reported profit in country i, π_i can be written as:

$$\pi_i = \rho_i - \Psi_i - \frac{a^{1/\gamma_i}}{2}\frac{\Psi_i^2}{\rho_i} \ . \tag{3.1}$$

As in Gumpert, Hines, and Schnitzer (2016), and assuming that the firm has a tax haven affiliate, we derive the optimal amount of income, Ψ_i^*, to be reallocated.

$$\Psi_i^* = \frac{1}{a^{1/\gamma_i}} t_i \rho_i \ , \tag{3.2}$$

with $t_i = \frac{T_i}{(1-T_i)}$. **Proof:** See Appendix D.

3.2.2 . Profits and sales of foreign affiliates

We now turn to the formal definition of the normal pre-tax profit, ρ_i. Assume that households love variety and that firms generally engage in monopolistic competition. As in Head and Mayer (2004), we derive the expected profits of a foreign affiliate in each location.[9] Each monopolistic firm faces a demand curve $q_{ij} = \frac{\sigma-1}{\sigma}\frac{(c_i\tau_{ij})^{-\sigma}}{G_j}E_j$ with constant elasticity σ where c_i is the marginal cost in country i, τ_{ij}, the iceberg trade costs between the pair of countries i and j, and G_j the price index. The level of normal profit is $\rho_i = \frac{c_i^{1-\sigma}}{\sigma}M_i$ where $M_i = \sum_j \tau_{ij}^{1-\sigma}\frac{E_j}{G_j}$ is the market access of country i. The market access can be

[8] Our illustrative framework does not consider fixed costs due to profit shifting (Bilicka, 2019, Davies, Martin, Parenti, and Toubal, 2018 and Reynolds and Wier, 2016).

[9] Since the model determines the *aggregate* foreign sales ratio and not its *distribution* across firms, our illustrative framework does account for firm-specific mark-up (for a model of corporate tax avoidance with firm specific markup, see Martin, Parenti, and Toubal, 2020).

decomposed into the country real GDP, $M_i^d = \frac{E_i}{G_i}$ (assuming $\tau_{ii} = 1$), and the foreign market access, $M_i^f = \sum_j \tau_{ij}^{1-\sigma} \frac{E_j}{G_j}$ for $i \neq j$. The expression of normal profit suggests that firms face a trade-off between low production costs and high market potential.

Given equation (3.2) and assuming a tax rate equal to zero in the tax haven, the reported profit of the tax haven affiliate (indexed th) can be written as[10]

$$\Pi_i^{th} = \rho_i + S_j - F_i \,, \tag{3.3}$$

with $S_j = \sum_j \frac{1}{a^{1/\gamma_j}} \frac{c_j^{1-\sigma} M_j}{\sigma} t_j$.

The first term on the right-hand side of equation (3.3) is the normal profit of the firm earned in the tax haven. The second term, S_j, is the amount of profit shifted to the tax haven. It depends positively on the corporate tax rates in non-tax havens, but decreases the more transparent the country is, in particular regarding the exchange of tax information with the U.S.

The reported profit of a foreign affiliate that is not located in a tax haven is given by

$$\Pi_i^{nth} = \rho_i \left(1 - \frac{t_i}{a^{1/\gamma_i}} \left(1 + \frac{t_i}{2}\right)\right) - F_i \,. \tag{3.4}$$

The reported profit is decreasing with the tax rate and the degree of transparency of the non-tax haven country. Interestingly, equation (3.4) shows that the reported profit is lower than the normal profit that the firm would have declared without corporate taxation.

Given Equations (3.3) and (3.4), and recalling that profits are given by sales discounted by the relative markup, we can compute the foreign sales ratios in tax havens and in non-tax haven countries. The difference between these ratios allows us to determine the value of sales that is shifted to tax havens.

$$FS_i^{nth} = \frac{M_i^f}{(M_i^f + M_i^d)} \,, \tag{3.5}$$

$$FS_i^{th} = \frac{c_i^{1-\sigma} M_i^f + S_j}{c_i^{1-\sigma}(M_i^f + M_i^d) + S_j} \,. \tag{3.6}$$

Proposition 1. Assuming sales shifting to tax havens, the foreign sales ratio of tax havens is larger than the foreign sales ratio of non-tax havens all else being equals.

It is straightforward to show that $FS_i^{th} > FS_i^{nth}$. This inequality holds because M_i is positive and always larger than M_i^f. We can moreover show that the market access effect on the foreign sales ratio decreases with the amount of profit shifted to tax havens.

Proposition 2. Assuming positive profit shifting through sales shifting implies that foreign market access has a weaker impact on the foreign sales ratio in tax havens than in non-tax havens.

[10] For ease of exposition, we drop the index th and ^{nth} from the market access and production cost variables.

Proof. Let $\xi_{nth} = \frac{\partial FS^{nth}}{\partial M_i^f} = \frac{M_i^d}{(M_i^f+M_i^d)^2}$ and $\xi_{th} = \frac{\partial FS^{th}}{\partial M_i^f} = \frac{c_i^{2(1-\sigma)}M_i^d}{\left[c_i^{1-\sigma}(M_i^f+M_i^d)+S_j\right]^2}$. The foreign market access has a weaker impact on the foreign sales ratio in tax havens than in non-tax havens iff $\frac{\xi^{th}}{\xi^{nth}} < 1$.

$$\begin{aligned}\frac{\xi^{th}}{\xi^{nth}} &= \frac{c_i^{2(1-\sigma)}M_i^d}{\left[c_i^{1-\sigma}(M_i^f+M_i^d)+S_j\right]^2} \times \frac{(M_i^f+M_i^d)^2}{M_i^d} \\ &= \frac{\left[c_i^{1-\sigma}(M_i^f+M_i^d)\right]^2}{\left[c_i^{1-\sigma}(M_i^f+M_i^d)+S_j\right]^2} < 1\end{aligned}$$

3.3 . Econometric Analysis

According to the theoretical predictions, the market access and the tax environment have different effects on the foreign sales ratio in tax havens and in other countries. We conduct an empirical analysis that allows us to identify the average effects of taxes and market access on the foreign sales ratio within each group of countries. We also propose a methodology to quantify the contribution of sales shifting to the amount of profits shifted by U.S. multinationals to tax haven countries.

3.3.1 . The determinants of sales shifting

We follow Papke and Wooldridge, 1996 and estimate a fractional logit model to account for the bounded nature of our fractional dependent variable as 86% of the observations of foreign sales ratio fall between zero and one (excluded).[11] This is an improved methodological approach given the fractional dependent variable. We also report in the baseline table the results of the OLS regressions for comparison. The fractional logit model assumes that the expected value of the foreign sales ratio FS_{ikt}, conditional on a vector of time-variant country specific variable X_{it}, the tax haven dummy variable, $Haven_i$ and the sector-specific shocks that vary over time, ν_{kt} is given by

$$E\left(FS_{ikt}|Haven_i, X_{it}, \nu_{kt}\right) = G\left(\alpha Haven_i + X_{it}\beta + \nu_{kt}\right). \tag{3.7}$$

where $G\left(\alpha Haven_i + X_{it}\beta + \nu_{kt}\right) = \frac{exp(\alpha Haven_i + X_{it}\beta + \nu_{kt})}{[1+exp(\alpha Haven_i + X_{it}\beta + \nu_{kt})]}$ is the cumulative distribution function of the logistic distribution. X_{it} includes the logarithms of the foreign and domestic market access, the statutory tax rate, the tax treaties between the host countries and the U.S. and the number of signed Double Tax conventions (DTCs). The use of sector-time fixed effects accounts for a broad set of unobserved attributes of the activities at the sector level that might also account for the share of foreign sales. Sectors may for instance differ in the average costs of income reallocation a, reflecting differences in

[11] As mentioned by Papke and Wooldridge, 1996; Papke and Wooldridge, 2008 the fractional logit model is well suited to examine our question for three reasons. First, it accounts for the boundedness of the dependent variables. Second, it predicts response values within the unit interval. Third, it captures the nonlinearity of the data, thereby yielding a higher fit compared to linear models.

the importance of intangible assets and other business features that facilitate sales shifting (Gumpert, Hines, and Schnitzer, 2016).

Throughout our empirical investigation, we display the marginal effects evaluated at the mean values of the explanatory variables. Standard errors are clustered at the country level.[12]

3.3.2 . Sales and profits shifting to tax havens

We quantify the contribution of sales shifting to the amount of foreign profits shifted by U.S. multinationals. To quantify the amount of excessive profits, we rely on the observation that pre-tax profits reported by a firm represent the sum of normal profits and shifted profits. The firms generate income from the sales of goods and services and by using inputs. Thus, measures of market access and of capital and labor inputs (fixed tangible assets and number of employees) are included in the empirical analysis, to predict the counterfactual normal level of profit. Shifted income is determined by the tax environment and the ability to shift sales in tax havens. Our methodology borrows features from both Clausing (2016) and Torslov, Wier, and Zucman (2022). From Torslov, Wier, and Zucman (2022), we account for tax havens and more generally for the tax environment of the host countries. From Clausing (2016), we regress the pre-tax profits on observable and unobservable characteristics to determine the profit (semi-)elasticities to the tax environment variables. Importantly, we add the possibility for firms to use sales platforms to shift profits to tax havens. To do so, we consider the interaction between the foreign sales ratio and the tax haven dummy variable, $FS_{ikt} \times Haven_i$. Contrary to many studies before, we use data disaggregated at the sectoral level. This allows us to add $sector \times year$ fixed effects. This implies that we compare similar sectors and account for any common sector-level shock. This constitutes another innovation compared with Clausing (2016) and Torslov, Wier, and Zucman (2022), as they do not consider sectoral heterogeneity. The empirical strategy involves estimating the effects of tax havens and the foreign sales ratio on profits for each sector k of country i conditional on other factors that have proved to be important determinants in the literature (see Hines and Rice, 1994; Huizinga and Laeven, 2008; Clausing, 2016; Dowd, Landefeld, and Moore, 2017; or Torslov, Wier, and Zucman, 2022). We propose estimating the following equation:

$$\begin{aligned} \Pi_{ikt} &= \alpha_0 + \alpha_1 FMA_{it} + \alpha_2 FS_{ikt} + \alpha_3 Haven_i + \alpha_4 \left(FS_{ikt} \times Haven_i\right) \\ &+ \alpha_5 Tax_{it} + Treaties_{it}\alpha + X_{ikt}\gamma + \alpha_8 DMA_{it} + \nu_{kt} + \xi_{ikt} \,, \end{aligned} \tag{3.8}$$

with Π_{ikt} the logarithm of the pre-tax profits.[13] We provide alternative estimators besides the standard OLS log-linear specification which uses positive profits only. We use a generalized linear model with gamma distribution (Gamma

[12] In unreported regressions, we also show that our results are not sensitive to the choice of the levels of clustering regarding standard errors. The results are available upon request.

[13] As seen from the illustrative framework in Equation (3.4), the reported operating pre-tax profits may not be used as a benchmark without applying a correction coefficient $C = \left(1 - \frac{t_i}{a^{1/\gamma_i}}\left(1 + \frac{t_i}{2}\right)\right)$. C can be calibrated by using different assumptions regarding the distribution of the shifting cost parameter a^{1/γ_i} or by using a proxy for this cost. In unreported regressions, we show the main results remain using different alternative calibrations for the benchmark profits.

GLM) as an alternative estimator to account for zero profits. The Gamma GLM estimator does not allow for negative values of profits. We use a modified cubic-root transformation (CubeR) of the profit series that allows us to account for zeros and negative profits (Cox, 2011). The control variables are defined as before. X_{ikt} is a vector of sector- and country-specific controls that vary over time and γ a vector of coefficients. It includes total employment and the total productive assets of foreign affiliates. These variables allow us to scale the size of the activity.[14] ν_{kt} is a set of $sector \times year$ fixed effects and ξ_{ikt} is the disturbance term.

The coefficient of interest, which will allow us to compute the counterfactual profits, is α_4. We use our data and the estimated coefficients of Equation 3.8 to predict the amount of profits that would have been observed in the absence of sales shifting to tax havens. We therefore set the interaction term to zero and allow the tax havens to have excessive profits that are not explained by the foreign sales ratio. Notice that α_4 is likely to remain unaffected by the correction of the benchmark profit. Indeed, we are interested in the differentiated impact of foreign sales on profits in tax havens and in other countries. As long as the coefficient of correction is not correlated with the foreign sales ratio in non-tax havens, our profit shifting estimates will not be affected by the correction.

One concern may be a potential selection bias that would affect the measurement of α_4. The interaction coefficient could be over-estimated if the most productive firms locate their sales platforms in tax havens to shift their profits. Our identification strategy uses within-industry variations across countries to compare the profitability of the average firm in similar industries across different countries. The estimation equation includes the interaction term and the direct tax haven effect. Contrary to standard profit equations, we use the interaction coefficient to capture the excess profits of firms that are due to larger foreign sales ratios in tax havens. The tax haven dummy variable captures the excess profitability of firms in tax havens that may be due to selection, conditional on other important factors.

Another concern relates to the endogeneity of the foreign sales ratio. The key variable is constructed by interacting the exogenous tax haven dummy variable and the endogenous foreign sales ratio, and the interacted terms are endogenous in the regression in the profit equation. Two recent papers, Bun and Harrison (2019) and Nizalova and Murtazashvili, 2016 provide analytical proofs that the interaction of an endogenous variable (foreign sales ratio) with an exogenous one (tax haven dummy) can be interpreted as being exogenous. As shown by Angrist and Krueger (1999), the interaction terms can be interpreted as exogenous, once the main effect of the endogenous variable is directly controlled for as in our case. The identifying assumption is that the endogenous variable and the outcome variable are jointly independent of the exogenous variable.

[14] The plant, property, and equipment assets of the affiliates are less likely to be distorted by the tax-planning strategies of an MNE (Schwarz, 2009).

Table 3.4.1: Foreign Sales Ratio - GLM and OLS estimates

Dep. Variable	Foreign To Total Sales Ratio							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(Foreign Market Acc.)	0.056	0.055	0.049	0.033	0.039	-0.021	0.040	-0.031
	(0.010)	(0.009)	(0.013)	(0.013)	(0.009)	(0.034)	(0.010)	(0.034)
Tax rate		-0.570	-0.490	-0.277	0.039	-1.089	0.029	-1.035
		(0.233)	(0.211)	(0.194)	(0.178)	(0.270)	(0.174)	(0.289)
Tax Haven				0.126				
				(0.047)				
Treaty of info. exchange			-0.065	-0.038	-0.044	-0.143	-0.038	-0.126
			(0.030)	(0.029)	(0.031)	(0.112)	(0.031)	(0.123)
Double tax. agreement			-0.024	-0.015	0.025	0.004	0.017	0.023
			(0.044)	(0.034)	(0.031)	(0.063)	(0.030)	(0.072)
#DTC / 100			0.110	0.143	0.117	0.421	0.125	0.468
			(0.095)	(0.079)	(0.059)	(0.200)	(0.060)	(0.233)
ln(GDP)	0.007	0.023	0.007	0.014	-0.008	0.036	-0.008	0.032
	(0.008)	(0.009)	(0.013)	(0.012)	(0.011)	(0.024)	(0.011)	(0.027)
Estimator	GLM	GLM	GLM	GLM	GLM	GLM	OLS	OLS
Sector × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Non tax haven	Tax haven	Non tax haven	Tax haven
Observations	5,905	5,905	5,905	5,905	4,955	950	4,955	950
R2	0.229	0.251	0.272	0.290	0.323	0.487	0.300	0.487
Countries	56	56	56	56	46	10	46	10
Sectors	11	11	11	11	11	11	11	11

The dependent variable, FS_{ikt}, is the foreign to total sales ratio in sector k of country i in year t. Panel data (yearly) 1999–2013. GLM estimates in columns 1 to 6, OLS estimates in columns 7 and 8. Robust standard errors adjusted for clustering by country. Marginal effects at the sample mean are displayed.

3.4 . Results

We start by reporting the results regarding the drivers of the foreign sales ratio and quantify thereafter the contribution of sales shifting to profit shifting.

3.4.1 . Baseline results

Columns (1) to (6) of Table 3.4.1 show the results of fractional logit regressions. We report the marginal effects that are evaluated at sample means. Columns (7) and (8) report the results of the linear regressions. We show that our major findings remain when using the OLS approach. The estimated coefficients are of the same order of magnitude. This is due to the fact that a large fraction of the data on foreign sales ratios lies between 0 and 1. All specifications include a full set of sector-year specific effects to control for unobserved characteristics. The effects are therefore identified within sector and year and across countries.

The results in column (1) show that the host country's foreign market access has a strong effect on the foreign sales ratio of U.S. multinationals' foreign affiliates. This result is in line with Hanson, Mataloni, and Slaughter (2001) and Tintelnot (2017), who show that U.S. multinational companies set up foreign affiliates to sell to nearby countries and beyond. The host country size as measured by GDP does not significantly affect the foreign sales ratio.

Column (2) includes the level of corporate taxes as an additional variable.

The foreign sales ratio is significantly smaller in countries with high corporate taxes. This result suggests that U.S. multinational corporations reduce the amount of sales that are registered in countries with higher corporate taxes. In particular, increasing the tax rate by 1 percent decreases the foreign to total sales ratio by about 0.57 percentage point on average. The marginal effect is significant at the 95% confidence level. The introduction of the corporate tax rate variable increases the marginal effects of the GDP variable which becomes significant at the 99% confidence level. This suggests that U.S. firms select larger host country markets to operate their foreign sales activities when corporate tax rates are higher.

In column (3), the marginal effect of the corporate tax rate variable is smaller when we include the variables that control for the information on tax agreements between the affiliate's country and the U.S. In line with the predictions of the model, we find that the exchange of information between the host country and the U.S. reduces the foreign sales ratio of U.S. foreign affiliates. As expected, the estimated effect of double taxation agreements on the foreign sales ratio is small and non significantly different from 0 at the conventional levels.[15] The number of double taxation agreements, which controls for the opportunities of treaty shopping is positive but imprecisely estimated. The negative effect of corporate taxes and of the exchange of information on the foreign sales ratio is much less important when we control for the tax haven dummy variable in column (4). The marginal effect of the tax haven dummy variable is positive and significant at the 99% confidence level. As tax havens often provide optimization mechanisms other than low tax rates, such as confidentiality with respect to the tax authorities, this suggests that the results in column (3) are biased because the tax haven status was not controlled for. The correlation between the tax haven and the double taxation treaty dummy variables is about -0.11, and the correlation between the tax haven and the treaty of information exchange dummy variables is around -0.05. As mentioned above, half of the tax havens in our estimation sample had not signed or enforced a TIEA with the U.S. at the end of our estimation period in 2013.[16] The effect of the tax treaty network is larger and becomes significant at the 95% confidence level suggesting that the opportunity of treaty shopping becomes important given the tax haven status of some countries in our sample. In line with the predictions of our model, column (4) shows that the foreign sales ratio of U.S. foreign affiliates is strongly influenced by the host country's tax environment.[17] The detailed characterization of the host country's tax environment reduces the importance of the foreign market access variable. The marginal effect of the foreign market access variable is precisely estimated but falls in magnitude.

In columns (5) and (6), we estimate the specification in both samples of non-tax havens and tax havens to test Proposition 2. As predicted by our theoretical

[15]This last finding supports the results of Blonigen and Davies, 2004 who find no robust impacts of double taxation agreements on Foreign Direct Investments.

[16]Bermuda, the Bahamas, Panama, and the British Virgin Islands are the tax havens that had already enforced the exchange of tax information with the U.S. during the period analyzed.

[17]An investigation of the type of transactions that are concerned by sales shifting reveals excess foreign sales ratios stemming from both sales of goods and services (see Appendix E).

framework, foreign market access is a strong predictor of the foreign sales ratio in non-tax havens, while it has no influence in tax havens. In line with our model, these results suggest that large amounts of profits are shifted to tax havens through sales shifting. There are several other major differences between the determinants of the foreign sales ratios in both samples. The level of corporate tax rates does not significantly affect the ratio of foreign sales in non-tax havens, while its effect is strong and negative in tax havens. One can argue that the statutory tax rates are meaningless in the sample of tax haven. In Appendix E, we show that our results remain by substituting the statutory tax rates for the average effective tax rates.[18]

We also find that the number of DTC prove to be important in both samples. The effect is yet stronger in tax havens. These findings are in line with the results of Hong, 2018 and 't Riet and Lejour, 2018 who show the use of treaty shopping by multinational firms.

Anecdotal evidence suggests that the tax avoidance strategies of U.S. multinational companies depend on the location of tax havens. Our sample includes ten tax havens that differ markedly in terms of their economic weight and populations, as noted by Hines and Rice (1994), but also in terms of their degree of transparency. We classify these tax havens into two groups, namely the small havens —Barbados, Bermuda, the British Virgin Islands, and Panama — and the large havens —Hong Kong, Ireland, Luxembourg, Netherlands, Singapore, and Switzerland. As in Hines and Rice (1994), this dichotomization is partially based on the tax havens' population levels. We also take into account their geography and technological factors. Regarding technology, in our sample, U.S. foreign affiliates in the large tax havens employ about 36 times more people than those in the small havens, and use about 9 times more productive equipment.

To ease comparisons across specifications, the results reported in column (1) of Table 3.4.2 reproduce the estimates in column (4) of Table 3.4.1 above. In columns (2) and (3), we split the sample into broadly defined industries and study the effects of foreign market access and the tax environment on the manufacturing and service industries.[19] In these columns, we do not distinguish between large and small tax havens. Compared to the aggregate analysis, considering industries separately highlights the specific effects of foreign market access and the tax environment on the foreign sales ratio of U.S. foreign affiliates in different industries. Foreign market access has a positive and significant impact on the foreign sales ratio in the manufacturing industries. The significant positive effect of the tax haven dummy in the service sample shows however that the tax environment is an important consideration in this context. Overall, this industry-specific analysis suggests that the tax haven effects described above are driven by the service sector, while foreign market access remains a strong determinant of manufacturing activities.

In columns (4) to (6), we use a finer decomposition of the tax haven dummy

[18]The average tax rate is the percentage of a firm's overall taxable income that is paid in taxes. It is therefore endogenous to the foreign sales ratio as sales shifting increases income in tax havens.

[19]Table E2 in the Appendix reports the estimated marginal effects of the tax haven dummy variable sector by sector using a finer decomposition of sectors.

Table 3.4.2: Foreign Sales Ratio in Large or Small Tax Havens - (GLM – Aggregate and Sector Results)

Dep. Variable	Foreign To Total Sales Ratio					
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Foreign Market Acc.)	0.033	0.043	0.012	0.024	0.028	0.014
	(0.013)	(0.018)	(0.014)	(0.012)	(0.016)	(0.013)
Tax rate	-0.277	-0.328	-0.128	-0.343	-0.478	-0.117
	(0.194)	(0.276)	(0.182)	(0.179)	(0.249)	(0.187)
Tax Haven	0.126	0.048	0.236			
	(0.047)	(0.067)	(0.034)			
Large havens				0.159	0.104	0.228
				(0.043)	(0.057)	(0.032)
Caribbean havens				-0.057	-0.434	0.276
				(0.056)	(0.109)	(0.077)
Treaty of info. exchange	-0.038	-0.064	0.004	-0.010	-0.015	-0.004
	(0.029)	(0.041)	(0.024)	(0.030)	(0.039)	(0.024)
Double tax. agreement	-0.015	-0.024	0.009	-0.010	-0.015	0.007
	(0.034)	(0.048)	(0.033)	(0.031)	(0.040)	(0.032)
#DTC / 100	0.143	0.177	0.069	0.159	0.203	0.066
	(0.079)	(0.116)	(0.060)	(0.065)	(0.093)	(0.059)
ln(GDP)	0.014	0.022	-0.011	0.002	0.003	-0.007
	(0.012)	(0.016)	(0.011)	(0.013)	(0.017)	(0.012)
Sector × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Full	Manuf.	Services	Full	Manuf.	Services
Countries	56	56	55	56	56	55
Sectors	11	8	3	11	8	3
Observations	5,905	4,064	1,841	5,905	4,064	1,841
R2	0.290	0.278	0.482	0.312	0.324	0.481

The dependent variable, FS_{ikt}, is the foreign to total sales ratio in sector k of country i in year t. Panel data (yearly) 1999–2013. GLM estimates with robust standard errors adjusted for clustering at the country level. Standard errors are displayed in parentheses Marginal effects at the sample mean are displayed. **Manufacturing:** (1) Mining, (2) Food, (3) Chemicals, (4) Primary and Fabricated Metals, (5) Machinery & Equipment, (6) Computer and Electronic products, (7) Electrical Equipment, Appliances, and Components, (8) Transportation Equipment. **Services:** (9) Wholesale trade, (10) Information, (11) Professional, Scientific, and Technical Services. **Large havens:** Hong Kong, Ireland, Luxembourg, Netherlands, Singapore, and Switzerland. **Small havens:** Barbados, Bermuda, Panama, and the British Virgin Islands.

variable by distinguishing between large and small tax havens. The results using the full sample in column (4) suggest that the effect of tax havens described above is mostly driven by the group of large tax havens. In columns (5) and (6), we examine whether the determinants of the foreign sales ratios differ between industries across large and small tax havens. Interestingly, the market access variable has a smaller impact on the foreign sales ratio once we account for a finer decomposition of the effects of tax havens. In the manufacturing sector, the foreign sales ratio is larger in large havens, while it is lower in the small havens. Both groups of tax havens attract U.S. foreign sales platforms in the service industries. This finding supports previous results about the heterogeneity in the use of tax havens (Desai, Foley, and Hines, 2006 and Garcia-Bernardo, Fichtner, Takes, and Heemskerk, 2017). Small tax havens, which are closer to the U.S., drive the profit-shifting strategies of U.S. firms in the service industry, while the larger and relatively more distant tax havens help to shift profits in both sectors.

3.4.2 . Quantification of sales and profit shifting

Table 3.4.3 reports the results of the profits equation which is estimated using OLS and alternative estimators that take into account zero and negative profits.

We find a positive and statistically significant impact of the interaction coefficients on profits irrespective of the estimator used. These coefficients allow us to quantify the contribution of sales shifting to the amount of foreign profits shifted by U.S. multinationals. Table 3.4.4 reports the estimated amounts of profits shifted by the means of sales shifting in 2013. The estimated profits correspond to the overall sum of profits across tax havens i and sectors k.

The profit shifted through sales shifting in 2013 is estimated to be between $66bn and $85bn. Our lowest estimate shows that it corresponds to 68% of all the profits in tax havens and to 24% of all U.S. affiliates' profits.

In Figure 3.4.1, we report the shares of profits across tax havens that are explained by sales shifting. Sales shifting is the main driver of profit in small tax havens: 88% in Bermuda, 85% in Barbados or to 74% in British Caribbean Islands. Sales shifting also explains a large share of the profits observed in large tax havens. In particular, 72% of Ireland's profits or 71% of Luxembourg's profits are explained by sales shifting.

In the Online Appendix, we propose two robustness exercises regarding the specification of the profit equation. In Table E5 we substitute the statutory tax rate by the average tax rate which is measured as the ratio of taxes paid to profits in the country of location of the U.S. foreign affiliate. In the baseline specification, we use the statutory tax rate as it is exogenous and widely used in the literature. However, it may not capture the true tax cost of reporting income in a jurisdiction as firms may benefits from special tax rules or negotiated tax rates and shift profits to low-tax jurisdictions. It is also important to note that we can only observe taxes paid and profits aggregated at the sector level. In particular it means that the average tax rate measure may suffer from a composition bias. In Table E6, we test a non-linear specification of the profit equation by adding squared tax rates to the equation. This allows to differen-

Table 3.4.3: Profit Equation

	(1) OLS	(2) Gamma	(3) CubeR
Dep. Variable	ln(Profit)	Profit $\geq$ 0	All Profits
ln(Foreign Market Acc.)	-0.024	0.046	-0.016
	(0.041)	(0.053)	(0.113)
FS $\times$ haven	1.708	2.485	4.706
	(0.501)	(0.550)	(1.523)
Tax Haven	-0.036	-0.952	0.030
	(0.256)	(0.324)	(0.561)
Foreign sales ratio	0.240	0.325	-0.348
	(0.163)	(0.231)	(0.591)
Tax rate	0.061	-1.171	-0.769
	(0.889)	(1.569)	(2.084)
Treaty of info. exchange	0.100	-0.154	0.130
	(0.115)	(0.137)	(0.291)
Double tax. agreement	0.075	0.157	0.153
	(0.097)	(0.113)	(0.293)
#DTC / 100	0.267	-0.205	-0.129
	(0.205)	(0.312)	(0.749)
ln(GDP)	-0.007	-0.024	-0.058
	(0.050)	(0.086)	(0.133)
ln(1+ Employment)	0.392	0.199	1.241
	(0.072)	(0.087)	(0.178)
ln(1 + Productive Assets)	0.574	0.638	0.545
	(0.043)	(0.055)	(0.109)
Sector $\times$ Year FE	Yes	Yes	Yes
Sample	Full	Full	Full
Countries	56	56	56
Sectors	11	11	11
Observations	4,691	5,284	5,905
R2	0.787	0.667	0.488

Robust standard errors adjusted for clustering at the country level in parentheses.

Table 3.4.4: Contribution of sales shifting to profit shifting in tax havens.

Estimation Method	OLS	Gamma	CubeR
Sample (Year 2013)	Profit $>$ 0	Profit $\geq$ 0	All Profits
Profit Shifted (in billion $)	66.2	84.9	82.2
% of haven profits ($98,081bn)	68%	87%	84%
% of total profits ($273,360bn)	24%	31%	30%

This table shows the estimated profits shifted using sales shifting with 3 different estimations methods for the year 2013.

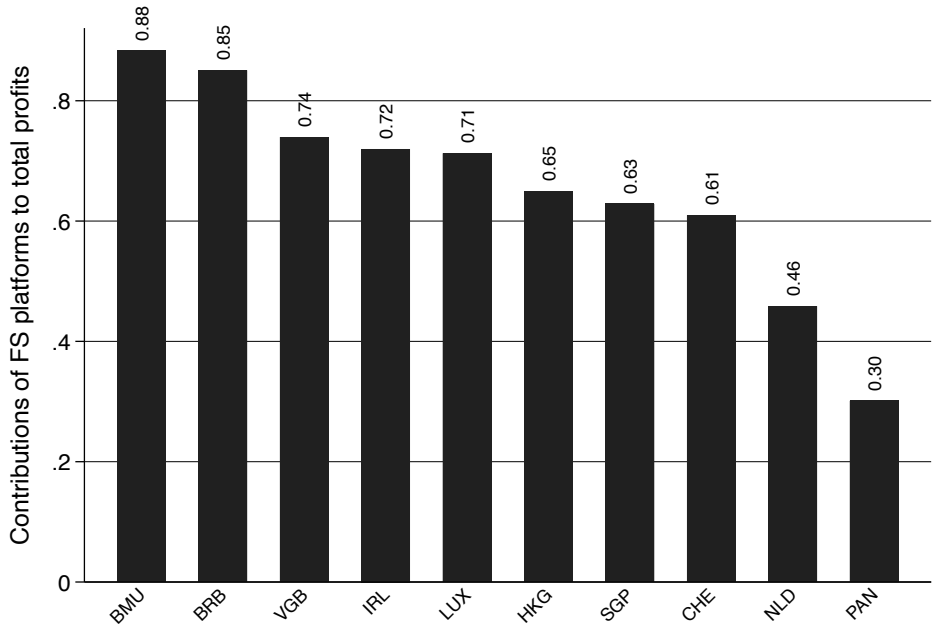

Figure 3.4.1: Share of profits explained by sales shifting.

Note: OLS estimates.

tiate the impact of taxes when taxes are high or low (see for instance Dowd, Landefeld, and Moore, 2017 or Fuest, Hugger, and Neumeier, 2021). In both exercises, we find a large contribution of sales shifting to the amount of profit shifted to tax havens.

3.5 . Conclusion and Discussion

In this paper, we document the extent of sales shifting and we propose a quantification of its contribution to the overall profits shifted to tax havens. We shed light on the concentration of U.S. foreign sales revenue from goods and services in tax havens, and highlight their relative specialization for services or manufacturing activities. Our empirical exercise is rationalized by a simple model of the location of affiliates that includes profit-shifting incentives. The econometric analysis confirms that the tax environment has a predominant impact on the distribution of U.S. foreign sales ratios. Market access, the factor conventionally considered as the most important in this context, is less important for tax havens.

We quantify the amount of profit shifted using sales shifting. Our estimate is that $66bn to $85bn of profits were shifted using sales shifting in 2013, a substantial proportion of the total amount shifted by U.S. firms. Our results support the evidence that a large share of profit shifting to tax haven countries occurs through sales shifting. This result supports the previous evidence that tax avoidance affects trade patterns and alters the design of global value chains at the firm level. In our view, the use of complex strategies to shift sales to tax haven is one of the reasons why estimates of profit shifting vary from

large when using macro-level datasets at the country level to small when using mostly bilateral micro-level information.

Our results have several policy implications. They suggest that any international tax reform that aims at giving more taxing rights to destination countries should be implemented with care for at least two reasons. Firstly, available datasets and in particular the recent country-by-country reportings promoted by the OECD record sales by jurisdiction, not final destination. As a consequence, such data do not help to assess the *final* destination of a sale; as we have shown, MNEs largely manipulate the locations where sales are registered. This calls for a redefinition and harmonization of the CbC-R guidelines to make them more effective and useful (see for instance Fuest, Parenti, and Toubal, 2019 and Delpeuch, Laffitte, Parenti, Paris, Souillard, and Toubal, 2019). Using such data without corrections would lead to a wrongful assessment of the world distribution of final consumption across countries. Secondly, by showing that the locations of sales are manipulated by U.S. MNEs, our results suggest that the sales apportionment factor in any tax system (formulary apportionment or residual profit split for instance) may be manipulated. Many recent propositions of reforms of the international tax system recommend giving taxing rights to destination countries. Under formulary apportionment for instance, the total profits of a multinational are apportioned to its different countries of activity according to a formula based on factors. These are easy to measure and supposed to be hard to manipulate. Generally, the formula contains three equally weighted factors: capital, wages, and sales.[20] The factors that enter the apportionment formula are therefore crucial to limit firms' aggressive tax planning. Avi-Yonah, Clausing, and Durst (2009) and Zucman (2014) propose using sales as a single factor to allocate profits. They argue that sales are less subject to manipulation if it excludes intra-firm transactions. The legal analysis of Fleming, Peroni, and Shay (2014) yet underlines that sales manipulation is still possible under destination-based taxation by the mean of third-party distributors. Beer, Mooij, Hebous, Keen, and Liu (2020) who studies residual profit allocation also recognizes this possibility. We do not argue that sales-based policies should be discarded for the future of international taxation, but that the law should include targeted anti-abuse dispositions to avoid sales shifting. In particular, efficient look-through rules may help to limit tax avoidance in such a system (Avi-Yonah and Clausing, 2019). However, their administrative cost may be very high (see Fleming, Peroni, and Shay, 2014).

[20] In the case of the CCCTB, the tax bill of firm f in country i would be calculated as follows: $Tax\ Bill_i^f = t_i^f \times \pi_W^f \times \left(\frac{1}{3}\frac{K_i^f}{K_W^f} + \frac{1}{3}\frac{L_i^f}{L_W^f} + \frac{1}{3}\frac{S_i^f}{S_W^f} \right)$ with t_i the tax rate in country i, K^f, the level of capital, L^f, the number of employees, and S^f, the firm's total sales. Subscript W refers to the worldwide value of the variable for firm f.

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Appendix

3.A . Sales shifting in anecdotal evidences: case studies

To illustrate the novelty of our contributions, we sum up in this section some cases that our framework captures contrary to previous studies. In addition of these less documented methods, it is worth noting that sales shifting also encompass traditional profit shifting methods based on the real (as opposed to the financial) activity of the firm: transfer mispricing of goods and services, location of intangibles in tax havens, etc.

3.A.1 . Apple

The case of Apple is a good example of how an actual foreign sales platform works. The declarations of Apple's representative to the Permanent Subcommittee on Investigations of the U.S. Senate reveal how Apple Inc. organizes its activities to register 64% of its profits in Ireland despite having only 3% of its employees there and 1% of its consumers (in 2011). According to the representative's declarations, this scheme allowed the firm to avoid $12.5bn of taxes in 2011 and 2012.

Figure 3.A.1 shows a simplified version of the structure used by Apple in Ireland. Apple Operations International (AOI) is owned (100%) by Apple Inc. and is the ultimate owner of most of the offshore affiliates of Apple. It has no employees. Despite being incorporated in Ireland, it has no tax residence. Apple uses loopholes in the Irish and U.S. tax laws that lead to both countries considering Apple resident in the other.[21] Because of the different definitions of residency, AOI is a *stateless* entity (Kleinbard, 2011). AOI owns Apple Operations Europe (AOE) that owns Apple Sales International (ASI). While the first two entities are holding companies, ASI is the affiliate that acts as a sales platform. Just like AOI, it has no tax residency. ASI and AOE have a cost-sharing agreement with Apple Inc. According to the Senate report, Apple applies two main strategies to shift its profits to Ireland. The first is the cost-sharing agreement between ASI and Apple Inc. This agreement, according to which Apple Inc. and ASI share the development of Apple products, helps to locate a large share of Apple's intangible assets in Ireland. The Senate report insists on the fact that this agreement is not economically justified and is only motivated by aggressive tax optimization. Most importantly, ASI acts as a foreign sales platform by concentrating the worldwide sales of the whole group.

The structure chosen by Apple is at the heart of its profit shifting strategy. ASI, the foreign sales platform, engages in contract manufacturing. In practice, it contracts with a manufacturing affiliate in China to outsource production. The goods are produced by the manufacturing affiliate but are always owned by ASI. In terms of trade statistics, these transactions are registered as an import of services by ASI. When a customer buys an Apple product in a store

[21] Irish tax residency is based on where management and control is performed. For ASI this is the U.S. On the contrary, residency in U.S. tax law is the place of incorporation, in this case, Ireland.

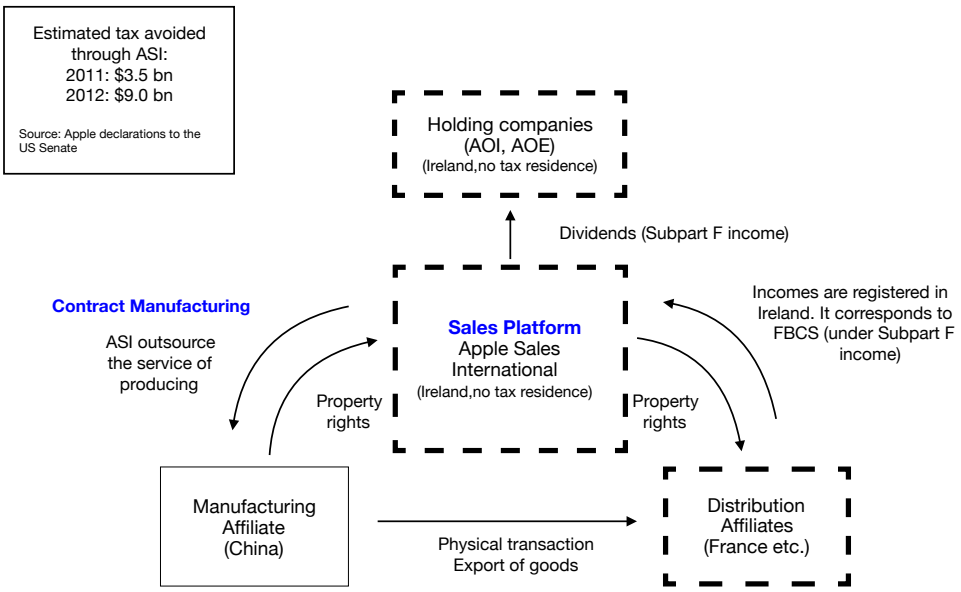


Figure 3.A.1: Simplified structure of Apple in Ireland

or over the internet, the product is directly sent from China to the customer. Thus, although the owner of these products is ASI in Ireland, the goods generally never cross the Irish border. However, the financial transaction occurs between the owner of the goods and the final customer, in this case, between the retailer and Ireland. Note the discrepancy between the physical transaction and the financial transaction. Usually, it is almost impossible to identify the two types of transactions. However the BEA data allow us to do this for certain transactions. In terms of trade statistics, customs will register an export of goods from China to the retailer's country, while the balance of payments will register an export from Ireland to the retailer's country.[22] Finally, the revenues from the sales are sent through dividends to the upper-tier subsidiaries AOE and AOI.

To avoid this transfer of revenue to tax havens, the U.S. enacted a law (the Subpart F rules) in 1962 to ensure that passive income (income that results from a passive activity e.g. dividends, interest, royalties, etc.) is always taxed. The objective of this law is to prevent income being relocated and conserved in tax havens to avoid paying taxes. Passive income is a common component of firms' tax avoidance strategies. The transactions between the retail affiliate and ASI and the transactions between ASI and the upper-tier affiliates should have been taxed under Subpart F. The first transaction is a Foreign Base Company Sale (FBCS, sales of products that have been produced by an affiliate in an other country) and in the second corresponds to Foreign Personal Holding Company income (FPHC, which includes dividends, interest, rents and royalties).

However, the check-the-box regulations enacted in 1997 can be used to circumvent the Subpart F rules. These regulations allow Apple to make the IRS

[22]The customs register trade based on the crossing of national borders while the balance of payments measures trade based on change of ownership.

disregard the lower-tier affiliates (AOE, ASI and the distribution and retail affiliates) for tax purposes. The three entities in dashed boxes in the figure are thus considered a single firm by the IRS. Because the IRS does not look at what happens within a firm, it cannot tax the transactions of passive income.

This tax avoidance scheme may be one of the most tax-saving scheme existing. It helped Apple to save around $9 billions in taxes in according to Apple's officials declarations. However, it is most likely that this scheme cannot be identified in micro studies using a bilateral identification of transfer pricing.

3.A.2 . Caterpillar

According to Levin (2014), Caterpillar's Swiss affiliate, called Caterpillar SARL (CSARL), plays a major role in the strategy of tax avoidance of the company since it reports more than 85% of non-US profits of the firm whereas no manufacturing facility is present in Switzerland and only 400 employees (among 118500) are working there. In 1999, Caterpillar negotiated a reduced corporate tax rate between 4 and 6 % with the Swiss authorities. To maximize the benefits from this advantageous tax rate, Caterpillar decided to route (following the strategy imagined by PwC) all its non-US sales through its Swiss affiliate's CSARL. CSARL is designated as the *global purchaser* of replacement parts: CSARL buy to third-party manufacturers the replacement parts. All sales of these replacement parts in the world (except in the US) are then registered in Switzerland (it does not enter in the Subpart F regulation because replacement parts are directly bought to third-party manufacturers). This paper operation does not imply that the goods physically transit through Switzerland. The goods are directly shipped from the US to the buyer. On top of this strategy, Caterpillar has also lowered its tax bill by enabling cost-sharing and tolling agreements that allow to shift more profits to the Swiss affiliate. This strategy allowed Caterpillar to avoid about $2.4 billions between 2000 and 2012 according to the report of the US Senate.

3.A.3 . Google

Google uses several loopholes in the international definition of permanent establishments to shift its taxes to tax havens. We briefly describe here the case of Google France. Google Ireland Limited is a Google affiliate located in Ireland and SARL Google France is Google's French affiliate. The sales of the Google's "Adwords" service to French firms are recorded in the Irish affiliate. These firms either establish directly a contract with Google Ireland Limited or indirectly through SARL Google France. The Paris Administrative Court recognized in 2019 that Google Ireland Limited does not own a French establishment in France (and then its profits from French customers cannot be taxed by France). This decision is based on the fact that the service of "sale assistance" provided by SARL Google France to Google Ireland Limited does not allow SARL Google France to sign contracts in the name of Google Ireland Limited. More specifically SARL Google France cannot negociate contracts or accept commands to Google Ireland Limited.[23]

[23]This service provision is linked to the "Marketing and Services Agreement signed in 2002 between Google Inc. and SARL Google France and transferred from Google Inc. to

By avoiding the stable establishment status on this activity, Google is able to register its French sales in Ireland and then to shift its tax duty from the French authorities to the Irish authorities (that negociated a preferential tax rate with Google in Ireland). As this tax avoidance scheme

3.A.4 . Kering

In the general case of contract manufacturing, an affiliate of a MNE located in a tax haven contracts with a manufacturer (either inside or outside of the boundaries of the firm) to produce some goods. This contract takes the form of an import of service from the haven affiliate. The cost of the service corresponds to the cost of inputs plus an underpriced margin (as in the Apple case). Using these types of contracts allows the tax haven entity to hold the property on the goods produced at a price lower than the arm's length price. The good is then directly sent to the distributors at a cost that limits the margin of the distributor. This way, the tax haven affiliate concentrate most of the sales (in value) of the company. The goods do not necessarily physically transit to the tax haven. They are generally exported directly from the manufacturer to the consumption market. Consequently, there is an important distinction between the foreign sale (financial transaction) and the export (physical transaction). Our dataset allows us to distinguish between both flows.

The case of Kering (Philippin, Malagutti, and Rosenberg (2018)), a French group that produces and sell luxury goods, is a variation of this scheme. Here, the goods transit physically to warehouses located in a tax haven. Some goods are produced in Italy, then transit through LGI, the sales platform located in Switzerland, and are finally exported to the rest of Europe.

3.A.5 . The tobacco Industry

In a report on the tobacco industry Vermeulen, Dillen, Branston, Nieto Solis, and el Khannoussi, 2020 discuss alleged cases of tax avoidance strategies used by some tobacco firms. In particular, they point at different strategies that aim at shifting sales from production countries to tax havens. For instance, they describe a sales shifting strategy used by British American Tobacco (BAT): "We found several examples of profit shifting via intra-firm transactions. One is the sale - on paper - of all BAT cigarettes produced by BAT Korea Manufacturing Ltd. (South Korea) to Rothmans Far East BV in the Netherlands. They are immediately re-sold to another South-Korean company, BAT Korea Ltd, at a much higher price. This way, on average each year 98 million in Korean profits are shifted to the Netherlands.". They also describe a strategy used by Phillip Morris (PM) "The Swiss branch of PMI also uses a 'cash pooling system' and a 'tolling system' with subsidiaries in other countries [...]. Under the tolling system, Dutch manufacturing company PM Holland BV buys raw materials from Philip Morris Brands sarl on paper, while revenue from sold products seems to be directed to Switzerland immediately. If the price the Dutch entity pays for these materials to their Swiss counterpart is artificially high, profits in the Netherlands are lowered, resulting in tax avoidance in the Netherlands. The

Google Ireland Limited in 2004. See the decision N.17PA03065 of the Paris Administrative Court accessible here https://www.legifrance.gouv.fr/affichJuriAdmin.do?idTexte=CETATEXT000038420177

exact importance of this route needs further investigation." These strategies, despite not being proved as tax avoidance practices, underline the role played by the shifting of the origin of sales. In particular they highlight the fact that the transaction only happen "on paper". Besides, it is important to underline that these strategies necessitate the using of contract manufacturing through a tolling system.

3.B . Data Description

The change in the sectoral definition in 1999 and the inclusion of all (rather than just non-bank) foreign affiliates from 2008 onwards led us to define a sample from 1999 to 2013 that excludes the foreign affiliates of banks from the empirical analysis. Our estimation sample covers 56 countries including 9 tax havens, and 11 industries over the period 1999-2013. The list of countries and industries is reported below.

- *Manufacturing:* (1) Mining, (2) Food, (3) Chemicals, (4) Primary and Fabricated Metals, (5) Machinery & Equipment, (6) Computer and Electronic products, (7) Electrical Equipment, Appliance and Components (8) Transportation Equipment. *Services:* (9) Wholesale trade, (10) Information, (11) Professional, Scientific and technical Services.

- Country list (tax havens in bold): Argentina, Australia, Austria, **Barbados**, Belgium, **Bermuda**, Brazil, Canada, Chile, China, Colombia, Costa Rica, the Czech Republic, Denmark, the Dominican Republic, Ecuador, Egypt, Finland, France, Germany, Greece, Honduras, **Hong Kong**, Hungary, India, Indonesia, **Ireland**, Israel, Italy, Japan, the Republic of Korea, **Luxembourg**, Malaysia, Mexico, **the Netherlands**, New Zealand, Norway, **Panama**, Peru, the Philippines, Poland, Portugal, Russia, **Singapore**, South Africa, Spain, Sweden, **Switzerland**, Taiwan, Thailand, Turkey, the United Arab Emirates, the United Kingdom, **British Islands, Caribbean**, Venezuela. **British Islands, Caribbean** includes the British Virgin Islands, the Cayman Islands, Montserrat and the Turks and Caicos Islands.

We do not use the information from the *Utilities* sector in this study. The utilities industry consists of firms operating in “electric power generation, transmission and distribution," “natural gas distribution," or “water, sewage and other systems." This industry operates locally and represents 0.03% of the total U.S. export share, accounting for 0.75% of the total number of U.S. foreign affiliates. We also exclude the *Other industries* sector since the coverage of our database in terms of foreign sales ratio is relatively low for this sector. The *Other industries* sector includes 3,558 affiliates in 1999 (corresponding to 17% of the MOFAs). It accounts for 18% of total assets, 7% of sales, 31% of net income, and 21% of employees. Inside this composite sector, the "Management of non-bank companies and enterprises" including holding companies accounts for a large share of affiliates (43%), of total assets (74%), and of net income (89%). On the other hand, this sub-sector only accounts for 3% of net property plants and equipment, 1% of sales, and 1% of employees of the *Other industries* sector. This should represent 9,240 observations. However, some of the observations in the dataset are missing either because of insufficient precision in assessing the value of the activity or because the data are subject to disclosure. In the first case, the BEA indicates that they do not have the exact value of sales and number of employees. This occurs for sales of between $-$\$500,000 and $+$\$500,000, and for a number of employees below 50. Data subject to disclosure are erased. Our sample is reduced to 5,905 observations. It however covers 72.5% of the total sales of foreign U.S. MNE affiliates in 2013.

3.B.1 . Empirical Definition(s) of Tax Havens

There is no commonly accepted definition of what constitutes a tax haven. According to Geoffrey Colin Powell (former economic adviser to Jersey cited in *The Economist*, 2002): "What identifies an area as a tax haven is the existence of a composite tax structure established deliberately to take advantage of, and exploit, a worldwide demand for opportunities to engage in tax avoidance." Chavagneux and Palan (2012) propose a list of criteria that encompass many definitions of tax havens: low or zero taxes, reinforced bank secrecy, extended professional secrecy, easy and fast registration procedure for firms, total free movement of capital, political and economic stability, and a network of bilateral agreements with other countries. We add to this definition the central idea that a tax haven is used as a fictive location for the individuals and firms that use it. An important point is that tax havens are not just low-tax and/or opaque countries.

The OECD (OECD, 2000) also outlines some of the features that characterize a tax haven. It is a country with no or only nominal taxes, no effective exchange of information[24] and no substantial activities (meaning that investment and transactions are mainly driven by tax incentives). Ireland, Luxembourg, Hong-Kong and Singapore do not appear in the OECD's list of tax havens.

In the academic literature, the definition of Hines and Rice, 1994, based the U.S Internal Revenue Service's (IRS), is close to the OECD's definition: low tax rate, business and banking secrecy, a good communication network and self-promotion as a tax haven. In this paper we use the list compiled by Dharmapala and Hines, 2009, which fills in the gaps in the OECD's by including countries considered tax havens by Hines and Rice, 1994. This list corresponds to a *de jure* classification and may suffer from a construction bias.

A first argument to justify our list is that the countries included appear in many other lists of tax havens. According to Chavagneux, Palan, and Murphy, 2010, our tax havens appear in at least 8 other lists (among eleven): Bermuda (11), Panama (11), Barbados (10), the British Virgin Islands (10), Hong-Kong (9), Singapore (9), Switzerland (9), Ireland (8), Luxembourg (8).

We can also justify this list empirically by simply looking at the tax bills of US affiliates in foreign countries. As noted by Kleinbard (2011), the ability to generate stateless income affects the US tax bill as well as the local tax bill. This explains why Google only paid 2.9% of its 2009 profits in taxes, which is much lower than the average statutory tax rate that should have applied. In figure 3.B.1, we plot the effective tax rate paid by US MNEs in tax havens and non tax havens and we compare it to the (weighted) statutory tax rate. In countries that are not tax havens, the average effective tax rate is almost equal to the weighted statutory tax rate. There is nonetheless a large dispersion around this average. In tax havens, the effective foreign tax rate line is almost flat and substantially lower than the statutory line, suggesting specific legislative arrangements that allow firms to lower their tax bills. The points are less dispersed and more cluster around the effective tax rate line.

[24]There is a growing body of evidence in the literature showing that tax agreements are ineffective at hindering harmful tax practices, see Bilicka and Fuest, 2014 or Johannesen and Zucman, 2014.

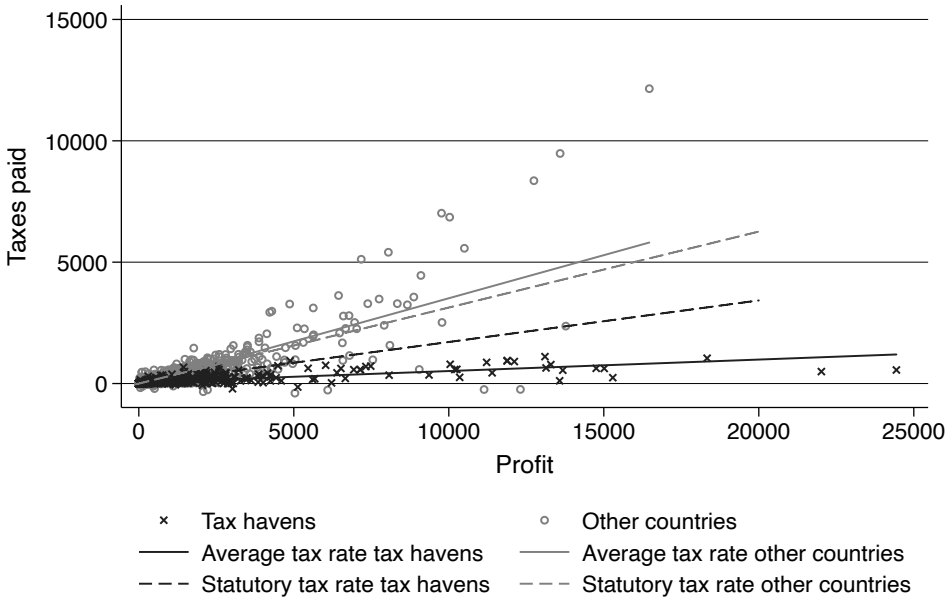


Figure 3.B.1: Statutory and effective tax rate.

3.B.2 . Foreign Market Access computation

Our methodology is based on Head and Mayer (2004) and Head and Mayer (2011) approaches. We first calculate the predicted bilateral transport costs between countries using a bilateral gravity equation. These predictions come from a regression analysis of bilateral trade against bilateral distance ($Distance_{ij}$), contiguity ($Contig_{ij}$), former colonial status ($Colony_{ij}$), common language ($ComLang_{ijt}$), regional trade agreements (RTA_{ijt}) and exporter×year (μ_{it}) and importer×year (μ_{jt}) fixed effects for the period 1999-2013.[25]

$$\begin{aligned} ln(Trade_{ijt}) &= \alpha + \beta_1 ln(Distance_{ij}) + \beta_2 Contig_{ij} + \beta_3 Colony_{ij} \\ &+ \beta_4 ComLang_{ijt} + \beta_5 RTA_{ijt} \\ &+ \mu_{it} + \mu_{jt} + \epsilon_{ijt} \end{aligned}$$

where ϵ_{ijt} is the error term. We compute the ease of access to market *j* for exporters in *i* at year *t*:

$$\hat{\phi_{ijt}} = Dist_{ij}^{\hat{\beta_1}} \times exp(\hat{\beta}_2 Contig_{ij} + \hat{\beta}_3 Colony_{ij} + \hat{\beta}_4 ComLang_{ijt} + \hat{\beta}_5 RTA_{ijt})$$

The foreign market access variable can be defined as $FMA_{it} = \sum_j (exp(\hat{\mu}_{jt}) \times \hat{\phi}_{ijt})$, which does not include the country's internal demand. The FMA is high for countries close to large foreign export markets and low for remote countries.

[25]This corresponds to a theoretically-founded gravity equation, with exporter×year (μ_{it}) and importer×year (μ_{jt}) fixed effects accounting for multilateral resistance terms (Head and Mayer, 2011).

The foreign market access variable is computed using data for all bilateral pairs of countries in the world. The series on bilateral trade were taken from the BACI database, constructed by the CEPII (Gaulier and Zignago, 2010) using the UN COMTRADE data on trade flows. The gravity variables are from the CEPII gravity database (Head, Mayer, and Ries, 2010) and the common language data from Melitz and Toubal (2014).

3.C . Descriptive statistics

The descriptive statistics of the estimation sample is given in Table 3.C.1 below .

Table 3.C.1: Descriptive Statistics

	Whole (56 countries, 5,905 obs.)	
	Mean	Std. Dev.
Foreign sales ratio	0.280	0.264
Profit	457.9	1,385
ln(Foreign Market Acc.)	16.34	1.418
Tax rate	0.285	0.0807
Tax Haven	0.161	0.367
Treaty of info. exchange	0.235	0.424
Double tax. agreement	0.698	0.459
ln(GDP)	13.08	1.534
ln(1+ Employment)	1.724	1.243
ln(1 + Productive Assets)	4.946	2.446

We report some statistics on employment, sales, and profit in tax havens and non-tax havens in Table 3.C.2. We show that U.S. foreign affiliates in tax havens report larger average sales per employee and larger profits per employee than foreign affiliates in other countries. Importantly, this table also shows that despite representing 7.2% of the total employment of foreign U.S. affiliates in 2013, total sales and total profits registered in tax havens amount to 30.8% and 35.8%, respectively. It is noteworthy that all these statistics are calculated using the regression sample, i.e. excluding financial affiliates and the *Utilities* sector.

Table 3.C.2: Descriptive Statistics (56 countries)

	Tax Havens	Other countries
Employees:		
Total employees in 2013	400500	5183700
Share employees in 2013 (%)	7.2	92.8
Average yearly number of employees	5412	14001
Sales (millions of $):		
Total sales in 2013	1155752	2602569.
Share sales in 2013 (%)	30.8	69.2
Average yearly sales	15618	7034
Average sales per 1000 employees	3523	549
Profits (millions of $):		
Total profits in 2013	98081	175960
Share profits in 2013 (%)	35.8	64.2
Average yearly profit	1325	476
Profits per 1000 employees	227	46

Average values are given at the country level. All years and sectors in the sample are pooled. Profits are shown pre-tax and excluding financial items.

3.D . Optimal profit shifting

This proof is based on Gumpert, Hines, and Schnitzer (2016). The maximisation problem at the firm level, given that it has a tax-haven affiliate is

$$\max_{d_i,\Psi_i} \sum_{i=1}^{n} d_i \Big[\Psi_i + (1-T_i)\Big(\rho_i - \Psi_i - \frac{a^{1/\gamma_i}}{2}\frac{\Psi_i^2}{\rho_i}\Big)\Big]$$

with $d_i \in \{0,1\}$, s.t

$$\rho_i - \Psi_i - \frac{a^{1/\gamma_i}}{2}\frac{\Psi_i^2}{\rho_i} \geq 0, \forall i = 1,\ldots,n$$

Following Gumpert, Hines, and Schnitzer (2016) and assuming that the constraint is fulfilled, the first-order condition for Ψ_i is

$$1 - (1-T_i) - (1-T_i)\frac{a^{1/\gamma_i}\Psi_i}{\rho_i} = 0$$

It implies

$$\Psi_i^* = \frac{T_i}{1-T_i}\frac{\rho_i}{a^{1/\gamma_i}}$$

We insert Ψ_i^* into our constraint in order to produce a condition under which the constraint holds

$$\rho_i - \frac{T_i}{1-T_i}\frac{\rho_i}{a^{1/\gamma_i}} - \frac{T_i^2}{(1-T_i)^2}\frac{\rho_i}{2a^{1/\gamma_i}} \geq 0 \tag{3.9}$$

$$\Leftrightarrow \quad T_i \leq 1 - \sqrt{\frac{1}{2a^{1/\gamma_i}+1}} \tag{3.10}$$

3.E . Additional Tables

This section contains additional tables. A first subsection is dedicated to extensions and a second one to robustness tests.

3.E.1 . Extensions

In Table 3.E.1, we examine the foreign sales ratio computed from goods and services transaction data separately. This information is yet only available at the country level. The table reveals that tax havens have a disproportionately large foreign sales ratio for both sales of goods and services.

Table 3.E.1: Foreign Sales Ratio - GLM (Country-Level)

Dep. Variable	FS Goods	FS Services
ln(FMA)	0.040	-0.000
	(0.013)	(0.014)
Tax Rate	-0.435	-0.104
	(0.207)	(0.174)
Tax haven	0.177	0.243
	(0.043)	(0.037)
Treaty of info. exchange	0.047	0.019
	(0.038)	(0.030)
Double tax. agreement	-0.041	0.043
	(0.041)	(0.037)
# DTC	0.079	0.098
	(0.083)	(0.064)
ln(GDP)	-0.047	-0.017
	(0.015)	(0.011)
Year FE	Yes	Yes
Countries	55	56
Observations	618	648
R2	0.615	0.641

The dependent variable, is the foreign to total sales ratio of goods of country i in year t in column (1), and the foreign to total sales ratio of services in column (2). Panel data (yearly) 1999–2013. GLM estimates with robust standard errors adjusted for clustering by country. Marginal effects at the sample mean are displayed. Standard errors are in parentheses.

Contrary to the conventional wisdom that multinational firms only record the sales of services in tax havens, our findings suggest that both service and goods transactions are concerned. An investigation of the BEA benchmark survey dataset on royalty payments and licence fees shows that both account for a small to moderate share of the total profits reported in European tax havens.[26] We find that royalty payments and licence fees account for a heterogeneous share of the total profit of large tax havens – from 0.1% in the primary and fabricated metals industry to 34% in professional, scientific, and technical services.

[26]The BEA benchmark survey reports data on intra-firm receipts of royalties and licence fees at the sector level for many countries. The available dataset allows us to get information on intra-firm payments or licence fees for some sectors in European countries. For instance, intra-firm payments in the chemical sector are not disclosed for tax havens. These payments are observed for Europe as a whole and for different European countries. In these cases, we allocate the difference between the intra-firm payments in the chemical sector in Europe and in other non-European tax havens to large tax havens.

In Table 3.E.2, we run sector-level regressions in order to study the sectoral heterogeneity of foreign sales platforms. We also dichotomize our main variable between large and small tax havens as defined in the paper. Each regression contains year fixed effects. The table reveals both sectoral and geographical heterogeneities both in manufacturing and in services sectors. Interestingly, we find a positive and (slightly) significant coefficient for small tax havens in the mining sector. It suggests that small tax havens may be used to shift sales in the mining sector, more than large tax havens, for which the point estimate is smaller and non-significantly different from zero. Small tax havens are also specialized in the wholesale sector and in the information sector. We obtain large positive and significant estimates for large tax havens in the "Chemicals", "Primary and fabricated metals", "Electrical Equipment", "Wholesale" , "Information" and "Professional, scientific and technical services" sectors.

Table 3.E.2: Sectoral and Geographic heterogeneity - GLM

Type of haven	Large	Small	Obs.	R^2
Manufacturing sectors:				
Mining	0.104	0.363	394	0.0968
	(0.128)	(0.188)		
Food	0.087	-2.157	503	0.189
	(0.095)	(0.268)		
Chemicals	0.285	-0.120	657	0.672
	(0.040)	(0.131)		
Primary Fabricated Met.	0.139	-0.886	466	0.367
	(0.052)	(0.223)		
Machinery	0.042	-2.950	554	0.484
	(0.065)	(0.220)		
Computer	0.020	-3.785	528	0.203
	(0.108)	(0.291)		
Electricat Eqp.	0.142	-2.818	463	0.489
	(0.082)	(0.283)		
Transportation eqp.	-0.018	-3.013	499	0.421
	(0.154)	(0.293)		
Service sectors:				
Wholesale	0.286	0.356	693	0.707
	(0.039)	(0.110)		
Information	0.200	0.175	543	0.475
	(0.050)	(0.100)		
Prof., Science, and Techn. Serv.	0.164	0.128	605	0.277
	(0.062)	(0.135)		

The dependent variable, FS_{ikt}, is the foreign to total sales ratio in sector k of country i in year t. Panel data (yearly) 1999–2013. GLM estimates with robust standard errors adjusted for clustering by country. Marginal effects at the sample mean are displayed. All regressions include standard control variables and a time fixed effect. Regressions with aggregates includes $sector \times year$ fixed effects. Each line corresponds to a sector-level regression. **Large havens:** Hong Kong, Ireland, Luxembourg, Netherlands, Singapore, and Switzerland. **Small havens:** Barbados, Bermuda, Panama, and the British Virgin Islands. Standard errors are in parentheses.

3.E.2 . Robustness tests

The robustness tests are described in the paper. We provide here more precisions on the placebo tests.

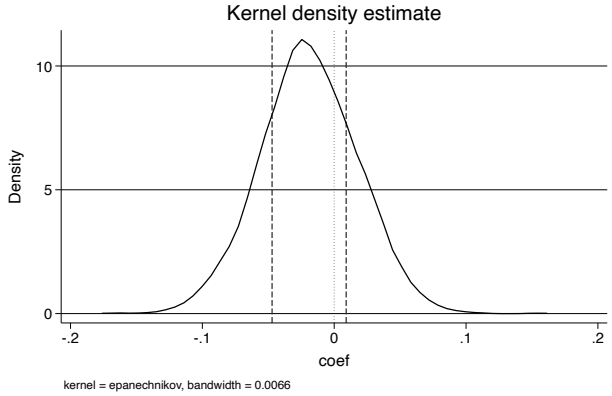
Placebo tests We construct a tax haven dummy variable which takes the value one for 9 randomly selected countries among the set of non-havens and zero otherwise.[27] We estimate specification (4) of Table 3.4.1 using the placebo tax haven variable and repeat the exercise 3,000 times in total. This placebo experiment allows us to confirm the specific impact of tax havens on the share of the foreign sales of U.S. foreign affiliates. We expect the average coefficient of the placebo tax haven variable to be insignificant.

Figure 3.E.1 displays the distribution of the estimated coefficients and the confidence intervals. The marginal effect is $\bar{\beta}_4 = -0.016$ and is insignificant at conventional levels of significance. The effect is slightly negative when the tax havens are kept in the control group. The second placebo experiment concerns the validity of Proposition 2. We again permute the tax havens and 9 randomly chosen countries among the set of non-tax havens. We estimate specification (6) of Table 3.4.1 using the placebo tax havens and repeat the exercise 3,000 times in total. We expect the average coefficient of the foreign market access variable to be significant contrary to our earlier finding.

Figure 3.E.2 displays the results. The marginal effect is positive and statistically significant ($\bar{\beta}_1 = 0.046$). This finding suggests that the absence of a significant effect of the market access variable is due to specific characteristics in tax havens.

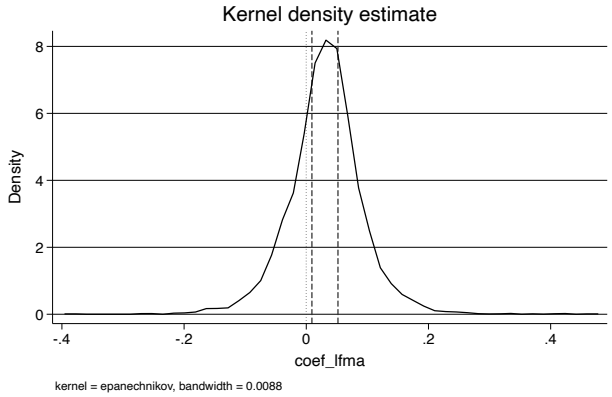
Other tests We propose other tests: we run an exercise with an alternative foreign sales ratio in Table 3.E.3, we replicate columns 5 to 8 of table 3.4.1 using the average tax rate in table 3.E.4 and we reproduce the profit regression with different specifications of the tax rate. In table 3.E.5 we replace the statutory tax rate by the average observed tax rate. In table 3.E.6, we allow for a non-linear response to taxes by adding a square term for the statutory tax rate (columns 1 to 3) and the average tax rate (columns 4 and 5).

[27] The (*real*) tax havens are therefore kept in the control group



Note: estimation of specification (4) of Table 3.4.1 using the permuted tax haven variable. Dark dashed lines represent 95% confidence intervals around the mean.

Figure 3.E.1: Tax haven dummy estimated coefficients with 9 randomly selected countries (3,000 permutations)



Note: estimation of specification (6) of Table 3.4.1 using the permuted countries. Dark dashed lines represent 95% confidence intervals around the mean.

Figure 3.E.2: Market access coefficients in the sample of permuted tax havens (3,000 permutations)

Table 3.E.3: Foreign Sales Ratio - Alternative dependent variable

Dep. Variable	$FS_{ikt}^{No\ US}$		
	(1)	(2)	(3)
ln(Foreign Market Acc.)	0.033	0.037	-0.023
	(0.013)	(0.014)	(0.035)
Tax rate	-0.277	-0.025	-0.858
	(0.177)	(0.146)	(0.292)
Tax Haven	0.088		
	(0.034)		
Treaty of info. exchange	-0.061	-0.068	-0.174
	(0.032)	(0.028)	(0.112)
Double tax. agreement	-0.028	0.011	0.003
	(0.024)	(0.023)	(0.068)
#DTC	0.193	0.171	
	(0.067)	(0.064)	
ln(GDP)	0.006	-0.014	0.030
	(0.012)	(0.011)	(0.020)
Sector × Year FE	Yes	Yes	Yes
Sample	Full	Non haven	Tax haven
Observations	4,862	4,046	816
R2	0.372	0.415	0.567
Countries	56	46	10
Sectors	11	11	11

Dependent variable, $FS_{ikt}^{No\ US}$, is a the foreign to total sales ratio that excludes sales to the U.S. from foreign sales in sector k of country i in year t. Panel data at yearly frequencies. GLM estimates with robust standard errors adjusted for clustering by country × industry. Marginal effects at the sample mean are displayed.

Table 3.E.4: Foreign Sales Ratio - GLM and OLS estimates

Dep. Variable	Foreign To Total Sales Ratio			
	(1)	(2)	(3)	(4)
ln(Foreign Market Acc.)	0.031	0.019	0.032	0.020
	(0.009)	(0.031)	(0.010)	(0.036)
Average Tax rate	-0.008	-0.072	-0.006	-0.067
	(0.005)	(0.039)	(0.005)	(0.040)
Treaty of info. exchange	0.041	-0.006	0.036	-0.008
	(0.038)	(0.094)	(0.037)	(0.112)
Double tax. agreement	-0.021	-0.000	-0.023	-0.002
	(0.023)	(0.080)	(0.024)	(0.093)
#DTC	0.114	0.179	0.117	0.181
	(0.053)	(0.160)	(0.053)	(0.189)
ln(GDP)	-0.027	-0.048	-0.027	-0.047
	(0.009)	(0.011)	(0.009)	(0.013)
Estimator	GLM	GLM	OLS	OLS
Sector $\times$ Year FE	Yes	Yes	Yes	Yes
Sample	Non tax haven	Tax haven	Non tax haven	Tax haven
# Countries	46	10	46	10
# Sectors	11	11	11	11
Observations	3,690	613	3,690	613
R2	0.378	0.453	0.368	0.448

The dependent variable, FS_{ikt}, is the foreign to total sales ratio in sector k of country i in year t. Panel data (yearly) 1999–2013. GLM estimates in columns 1 and 2, OLS estimates in columns 3 and 4. Robust standard errors adjusted for clustering by country. Marginal effects at the sample mean are displayed. e Standard errors are in parentheses.

Table 3.E.5: Profit Equation - Average Tax Rate as a Determinants

	(1) OLS	(2) Gamma
Dep. Variable	ln(Profit)	Profits
ln(Foreign Market Acc.)	0.010	0.086
	(0.039)	(0.044)
Foreign sales ratio	0.207	0.039
	(0.181)	(0.144)
Average Tax rate	-0.206	-1.384
	(0.371)	(0.623)
Tax Haven	0.154	-0.500
	(0.350)	(0.282)
FS times haven	1.298	2.290
	(0.577)	(0.379)
Treaty of info. exchange	0.039	-0.046
	(0.099)	(0.129)
Double tax. agreement	-0.055	0.132
	(0.079)	(0.109)
#DTC	0.239	-0.648
	(0.224)	(0.261)
ln(GDP)	0.049	0.038
	(0.045)	(0.049)
ln(1+ Employment)	0.401	0.306
	(0.066)	(0.083)
ln(1 + Productive Assets)	0.544	0.576
	(0.043)	(0.052)
Sector x Year FE	Yes	Yes
Countries	54	54
Sectors	11	11
Observations	2,761	2,761
R-squared	0.860	0.818

Robust standard errors adjusted for clustering by country level. Standard errors are in parentheses. The sample corresponds to observations with positive profits as the average tax rate is computed on positive profits only.

Table 3.E.6: Profit Equation: Non-linear tax specification

	(1) OLS	(2) Gamma	(3) CubeR	(4) OLS	(5) Gamma
Dep. Variable	ln(Profit)	Profit $\geq$ 0	All profits	ln(Profit)	Profit $\geq$ 0
ln(Foreign Market Acc.)	-0.027	0.041	-0.024	0.006	0.079
	(0.037)	(0.048)	(0.113)	(0.038)	(0.044)
FS times haven	1.493	1.986	5.076	1.273	2.230
	(0.455)	(0.469)	(1.562)	(0.574)	(0.384)
Tax Haven	-0.034	-0.704	-0.343	0.173	-0.441
	(0.241)	(0.305)	(0.604)	(0.348)	(0.280)
Foreign sales ratio	0.225	0.516	-0.344	0.194	0.016
	(0.162)	(0.204)	(0.585)	(0.181)	(0.149)
Tax rate	-10.040	-10.031	-15.218		
	(1.887)	(3.200)	(3.886)		
Tax ^{2}	18.231	16.636	27.936		
	(3.012)	(4.776)	(7.405)		
Average Tax rate				-2.389	-5.780
				(1.107)	(1.571)
Average Tax^2				6.184	12.417
				(2.741)	(3.313)
Treaty of info. exchange	0.062	-0.230	0.055	0.036	-0.062
	(0.092)	(0.121)	(0.280)	(0.097)	(0.125)
Double tax. agreement	0.110	0.196	0.173	-0.049	0.172
	(0.086)	(0.101)	(0.291)	(0.080)	(0.117)
#DTC	0.353	-0.062	0.039	0.280	-0.554
	(0.175)	(0.268)	(0.739)	(0.217)	(0.251)
ln(GDP)	0.000	0.030	-0.041	0.043	0.043
	(0.048)	(0.091)	(0.135)	(0.043)	(0.049)
ln(1+ Employment)	0.409	0.191	1.238	0.406	0.330
	(0.062)	(0.094)	(0.171)	(0.065)	(0.079)
ln(1 + Productive Assets)	0.564	0.637	0.536	0.539	0.551
	(0.041)	(0.056)	(0.109)	(0.043)	(0.052)
Semi-elasticity at t=0	-10.04	-10.03	-10.30	-2.389	-5.780
Semi-elasticity at t=0.5	8.191	6.605	8.609	3.796	6.637
Sector x Year FE	Yes	Yes	Yes	Yes	Yes
Countries	56	56	56	54	54
Sectors	11	11	11	11	11
Observations	4,691	5,284	5,905	2,761	2,761
R-squared	0.795	0.731	0.492	0.861	0.831

Robust standard errors adjusted for clustering by country level. Standard errors are in parentheses.

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4 - Profit Shifting Frictions and the Geography of Multinational Activity [1]

The current tax system has inherited the broad principles set out by the League of Nations in 1928. It treats multinational corporations (MNCs) as if they were a loose collection of legal entities across different host countries using separate accounting. Mounting empirical evidence shows that MNCs exploit the inadequacies of the international tax rules to shift profits to low or no-tax jurisdictions and avoid taxes.[2]

International taxation is undergoing an important reform supported by the OECD/G20 Inclusive Framework on Base Erosion and Profit Shifting (OECD, 2021). While this reform is meant to reduce the erosion of government tax revenues, its impact is hard to evaluate without considering the responses of multinationals, both in terms of the location of their real activities and profit-shifting. Estimating the outcomes of such reforms requires weighting potential tax revenue gains or losses against changes in countries' attractiveness for firms to locate their activity. Key to understanding these international real-location effects at stake in global reforms is the estimation of bilateral profit shifting frictions - the cost at which firms move profits from a country where they operate to a low-tax jurisdiction; but also, the extent to which these profits are elastic to effective changes in corporate taxation. Current models of multinational production ignore the role of profit-shifting frictions altogether and are therefore inadequate to study how firms' location choices optimally respond to changes in the international tax system.

In this paper, we propose a general equilibrium model of multinational production to study the consequences of changes in corporate tax rates and taxing rights allocation for the location and amounts of real resources and reported incomes of multinational corporations. In addition to (endogenous) country characteristics (market potential, production costs) and determinants to trade and investment, our model features profit-shifting frictions that impact the location choices of MNCs.[3] We discipline the model through a new, theory-consistent methodology to calibrate bilateral profit-shifting frictions based on accounting identities. Our framework is tractable and readily

[1]This chapter has been jointly written with Alessandro Ferrari, Mathieu Parenti and Farid Toubal.

[2]A large literature has documented the use of low-tax jurisdictions and in particular tax havens by multinational firms. See for instance Hines and Rice (1994), Desai, Foley, and Hines (2006), Gumpert, Hines, and Schnitzer (2016), Bilicka (2019) or Torslov, Wier, and Zucman (2022). Many papers have also discussed more precisely how these tax havens are used for tax avoidance purposes. See for instance Gravelle (2015) for a general perspective, Beer, Mooij, and Liu (2020) for a meta-study, Dyreng and Lindsey (2009), Clausing (2016), Dowd, Landefeld, and Moore (2017), Wright and Zucman (2018), Laffitte and Toubal (2021), Blouin and Robinson (2021) on U.S. multinational firms.

[3]Examples of these determinants include but are not limited to bilateral trade and investment frictions (Arkolakis, Ramondo, Rodrguez-Clare, and Yeaple, 2018, Head and Mayer, 2019) and corporate taxes (Grubert and Mutti, 1991, Grubert and Mutti, 2000, Altshuler, Grubert, and Newlon, 2000, Mutti and Ohrn, 2019).

applies to a broad range of taxation scenarios using widely available data. Importantly, it allows us to evaluate the effect of international and domestic tax reforms on real activity, accounting for the general equilibrium relocation of firms.

Theoretically, we develop a model in which the location of multinationals' real activity also depends on the ability of firms to shift their profits to tax havens. Relative to the existing literature we allow firms to jointly choose production, investment and income shifting worldwide (Egger, Merlo, and Wamser, 2014, Grubert, 2003, Grubert and Slemrod, 1998). In particular, firms choose their production location based on real forces (productivity of the production country, proximity to demand, wages) and profit-shifting forces (*e.g.*, proximity to tax havens). Profit-shifting frictions are bilateral and reflect different profit shifting abilities linked to many factors, including profit shifting technologies, bilateral communication costs, and compatibility between tax and legal systems of the source and tax haven countries. Our model delivers simple gravity equations of multinational production, bilateral profit shifting, and trade flows used to calibrate the model's key tax elasticities. Changes in the local or international tax system affect firms' profitability in a given location and therefore reshape the geography of international production. Importantly, the reallocation of profits and production across countries affects income in multiple ways. First, it directly impacts households' labor income. Second, it induces a reallocation of tax revenues across countries, which have both efficiency and distributional effects. At a macro-level, our model determines the winners and losers of corporate tax reforms.

The quantification of our model requires estimates of shifted profits flows. To this end, we provide a new, model-consistent methodology to estimate bilateral profit-shifting frictions based on accounting identities. In particular, an innovation of our methodology is to consider the ability of multinational firms headquartered in a country to shift profits to tax havens from each source country. We recover the distribution of profits shifted across pairs of source countries and tax havens and highlight the role of geography. We do so in two steps. First, we estimate a gravity model for direct investment income flows across countries, including the existence of tax havens as a predictor. We then use the estimated model to compute the direct investment income flows in absence of tax havens. The differences between predictions and data correspond to the profits shifted from residence countries to tax havens. In the second step, we use the model structural relationships to allocate these excessive profits between residence, source and haven triplets. The allocation of bilateral profit shifting depends on paper profits and tax base elasticities. A higher elasticity of paper profit compared to real profit implies that source countries with more multinational production attract disproportionately more tax avoiders.

The bilateral profit shifting equation improves on the reduced-form set-up à la Hines and Rice, 1994, standard in the literature, in which profit shifting is modeled as a quadratic cost and abstracts from other tax havens' attributes. It also improves on existing literature which provides estimates of profit shifting using unilateral data on pre-tax profits of U.S. MNEs or at the

global level. Torslov, Wier, and Zucman (2022) (TWZ, hereafter) is the first paper to propose a measure of bilateral profit shifting across pairs of production countries and tax havens. It uses the global amounts of shifted profits and an allocation key based on trade in services and interest payments to determine profit shifting between production countries and tax havens. While transfer mispricing of services might contribute to profit shifting (Dischinger and Riedel, 2011, Karkinsky and Riedel, 2012, Hebous and Johannesen, 2021), several works also suggest the importance of transfer mispricing of goods (Cristea and Nguyen, 2016, Davies, Martin, Parenti, and Toubal, 2018, Laffitte and Toubal, 2021 and Wier, 2020). We complement the TWZ methodology by developing an approach that relies on widely available data on foreign investment bilateral income and multinational production.

As predicted by our model, we find profit shifting to be subject to important costs. On average, shifting profits from a residence country to a tax haven through a source country generates an increase in the production cost of 23%, all else equal. We can decompose the profit shifting costs into two components. First, it is linked to the ability of residence countries to reduce their firms' profit-shifting costs. We show that U.S. and some European countries have better abilities than other residence countries. This finding echoes the recent literature that shows U.S., European (Torslov, Wier, and Zucman, 2022, TWZ hereafter) or Chinese firms (Garcia-Bernardo, Jansky, and Torslov, 2021) are more "aggressive" than firms from other countries. Second, the costs of shifting profits have a bilateral component. These bilateral frictions explain 26% of the variation of profit-shifting costs. We show that they are well explained by gravitational forces and correlate strongly and negatively with measures of tax avoidance technology.

Another key novelty of our approach is to allow for the distinction between profits generated by production activities and shifted incomes. Our structural (gravity) framework allows the estimation of two elasticities: one for tax base and one for income shifting. Recent empirical corporate taxation literature emphasizes the importance of considering the non-linear responses of incomes to corporate tax rates (e.g., Dowd, Landefeld, and Moore, 2017, Bratta, Santomartino, and Acciari, 2021, Fuest, Hugger, and Neumeier, 2021, Garcia-Bernardo and Jansky, 2021). These papers suggest that income tax sensitivity varies across high and low-tax jurisdictions. They use a methodology based on country-level data on profits that pool together tax havens – where observed profits include profits shifting, and high-tax countries – where profits only correspond to real activity. While the model cannot generate this non-linearity, we use our structural framework to disentangle both aspects of profits. We find the elasticity of profit shifting to be larger than the elasticity of real production. Since profits in tax havens result to a large extent in inward profit shifting, our finding thus rationalizes the observed non-linearity.

We use recent data on bilateral trade of goods and services, multinational sales, and profits for 40 countries to carefully calibrate the model. The quantification of profit shifting requires data on bilateral FDI income, multinational production, gravitational data, and country characteristics. Our sample includes seven major tax havens that differ markedly in terms of their economic

weight and populations, as noted by Hines and Rice, 1994, and their degree of transparency. We use the list proposed by Hines and Rice (1994) and later used by Dharmapala and Hines (2009). We follow Dowd, Landefeld, and Moore (2017), Clausing, 2020, and Torslov, Wier, and Zucman, 2022 add the Netherlands given the low amount of taxes paid by multinationals when operating there. The list of tax havens includes Hong Kong, Ireland, Luxembourg, Netherlands, Singapore, Switzerland, and Offshore Financial Centers (OFC, hereafter), an aggregate of small European, Caribbean, and Pacific islands.

We use the model as a laboratory for counterfactual policy experiments. To highlight the basic mechanisms of our framework, we start by studying the general equilibrium effects of a unilateral cut in the corporate tax rate in the US. This policy change brings about three main forces: i) a mechanical effect on tax revenues, which, for a given tax base, shrink; ii) a significant change in the tax base driven by firms relocating their production to the U.S. and by firms decreasing profit shifting to tax havens, therefore increasing the taxable profits; iii) as firms relocate, they demand more labor to both produce and potentially headquarter in the US, thereby increasing the equilibrium wage and households' income. These forces highlight the importance of considering the firm location problem in general equilibrium when assessing the effects of changes in international tax policy. In this sense, our analysis improves on the simulation exercises in static models (OECD, 2020a, Baraké, Neef, Chouc, and Zucman, 2021). In supplementary extensions of the model, we further explore the effect on other macroeconomic variables such as production efficiency or income inequalities.

In a second counterfactual, we simulate the impact of ending profit shifting multilaterally. This has a negative impact on production in the U.S., highlighting that profit shifting opportunities participate to firms' location decisions. This result confirms earlier work by Altshuler and Grubert, 2005, Hong and Smart, 2010 and Dharmapala, 2020 who show that non-haven countries might use lax enforcement of anti-abuse laws in order to attract mobile firms. Third, we predict the consequences of closing a tax haven. We examine the consequences of closing Singapore on the reallocation of production across non-haven countries and paper profits across tax havens. Our simulation shows that closing Singapore has negative consequences on the production of non-tax-haven countries, a result consistent with Suárez Serrato (2018). The effects are larger for countries that shifted more profits to Singapore. We also find a reallocation of paper profits in other tax havens, particularly in Hong Kong. Overall, our results underline the importance of bilateral profit shifting frictions and gravitational forces in explaining the reallocation of real and profit shifting activities.

Next, we focus on the consequences of the implementation of a global minimum tax of 15%. The effects of minimum taxation depend on whether the reform is implemented unilaterally or globally and on which country, source or residence, has the taxing rights. It also hinges on whether the real activity is fully deductible. We assume a full substance-based carve-out so that our simulations deliver lower bounds of the impacts. A common objection to introducing a minimum effective tax rate is the possibility of inversion. Corporations

might move their headquarters to a country that does not apply an effective minimum tax rate. Our model addresses the effects of inversion by considering a set of short-run scenarios – assuming the number of firms headquartered in each country to be fixed – and long-run scenarios – where the number of firms adjusts endogenously. The short-run scenario is akin to a situation where headquarters cannot exit residence countries with more stringent anti-avoidance tax policies and enter low-tax jurisdictions. While focusing on the U.S. for brevity, the mechanisms described are easily extendable to any non-tax-haven country. Overall, implementing minimum taxation, whether in the short- or long-run, increases tax revenues and decreases profit shifting. Our model allows us to dissect the sources of tax revenue gains under alternative scenarios. Firms might continue to shift profits and be taxed at the minimum rate or stop their avoidance activities and be taxed at the U.S. statutory tax rate. This second effect is generally not taken into account in static simulations of minimum taxation. Foreign firms might also relocate away from the U.S. All these effects contribute to assessing the importance of tax revenue gains and profit-shifting losses. In the short-run, implementing a scenario comparable to the OECD/G20 global minimum tax generates, for instance, gains in tax revenues in the U.S. by 4.33% and reduces profit shifting by almost 29%. We observe a reduction in the dispersion of corporate tax rates and an increase in corporate taxes everywhere. The implementation of the global minimum tax reduces the firms' incentives to produce in source countries only because of their tax advantages. After the reform, the location of production across source countries is more likely to reflect their real activity fundamentals. The global minimum tax generates thus efficiency gains and positive welfare effects. It is worth stressing that these effects are particularly strong when firms cannot change their residence country.

Perhaps the more striking results concerns the negative effects of minimum taxation on production and welfare in the long-run scenarios. Compared to the short-run cases, we now consider endogenous entry and exit. Changes in the tax environment affects now the firms' location across residence countries and also change the number of available varieties. We show that the OECD/G20 global minimum tax induces not only the reallocation of production across countries but also changes the likelihood of entry and exit of corporations whose presence is sensitive to the tax environment. The loss of production decreases the demand for labor, leading to a fall in workers' wages. In the long-run, the negative impact of a higher effective tax rate on firms' profits is magnified by the exit of firms which decreases the set of available products, contributing to a reduction of welfare. Minimum corporate taxation affects a country's efficiency by reshaping the geography of multinational production and changing the importance of real versus tax-related considerations in firms' location choices. Overall, our results show that the effects of the international relocation of firms across countries are of comparable magnitude as the direct gains in taxable income.

While the global tax deal has generally been assessed as an important step forward (OECD, 2021), it has also received some criticism - from some signatories that find it unfair or unambitious but also from academics who underline

that the global tax deal avoids the long-run challenges. Instead of reforming deeply the international tax system, the current agreement maintains the concepts of source taxation and fiscal residence that are no longer adapted to modern multinational production (Auerbach, 2021).[4] In ongoing work, we also examine how alternative tax systems perform compared to the global tax deal. We focus on the implementation of a destination-based taxation regime and analyze its effects on tax revenues, production, welfare and efficiency.

Related Literature. We contribute to the literature that estimates profit shifting of multinational firms using macro-level data (focusing on U.S. multinationals, Blouin and Robinson, 2021, Wright and Zucman, 2018, Clausing, 2020; Clausing, 2016, Guvenen, Mataloni, Rassier, and Ruhl, 2022, or at a global scale, Jansky and Palansky, 2019, Garcia-Bernardo, Jansky, and Torslov, 2021 and Torslov, Wier, and Zucman, 2022). The recent and important study by Torslov, Wier, and Zucman (2022) proposes an estimation of bilateral "missing profits" from production countries to tax havens. Their new methodology infers profit shifting from the comparison of the profitability of domestic and multinational firms in tax havens. While having many advantages, this approach provides estimates of unilateral profit shifting, which are allocated to bilateral pairs using an allocation factor based mainly on excess trade in services. Gravitational forces are therefore at play since trade in services is well predicted by gravity. Our quantitative model provides useful guidance as it delivers a gravity equation of bilateral profit shifting. We rely on bilateral FDI income data to compute excessive profits for each pair of residence and tax haven countries. We then use a set of accounting equations to allocate this estimated profit shifting to production countries. The model also rationalizes empirical evidence that income shifting depends on the nationality of the headquarter. In TWZ, for instance, U.S. MNEs conduct more aggressive tax planning than European firms.

Many empirical studies have found significant real effects of international taxation. Grubert and Slemrod (1998) show that tax-free investment in Puerto Rico strongly impacts U.S. tax revenues because it incentivizes U.S. multinationals to invest and shift incomes. The income-shifting activity is itself affected by the pattern of real activity. In a recent paper, Suárez Serrato (2018) shows that the repeal of section 936 of the Internal Revenue Code, which prevents U.S. MNEs from shifting profits to affiliates in Puerto Rico, has substantial real effects on the U.S. economy. Exposed MNEs responded to the repeal by lowering domestic investment and employment, with persistent effects on local employment. Using data on UK MNEs Bilicka, Qi, and Xing (2021) show that introducing a worldwide debt cap in the U.K. in 2010 reduced total assets, fixed assets, and employment in the U.K. Other studies have investigated the impact of changes in regulations on MNEs' foreign investments. de Mooij and Liu (2020) find a strong negative effect of the introduction of transfer pricing regulations on investment of MNEs compared to observationally equivalent do-

[4] We can note however some improvements coming from the Pillar I that aims at allocating some taxing rights to destination countries. Besides, the concept of digital permanent establishment could help to deal with the taxation of the digital economy.

mestic firms. The introduction of regulations does not affect total investment suggesting a reallocation of investment within MNEs and across affiliates' locations. de Mooij and Liu (2021) also find a strong negative impact on foreign investments following the introduction of thin capitalization rules. The effect is particularly relevant in countries with high corporate tax rates. Egger and Wamser (2015) examines whether limitations to foreign income exemptions in Germany affect foreign affiliates' investments. It shows that the German CFC rules decreased foreign subsidiaries' real investments. We contribute to this literature by introducing profit-shifting frictions into a quantitative model that allows us to calibrate the elasticities that govern real impacts that go beyond tax revenues. We discuss how the reallocation of activities following a tax reform affects the measured outcomes.

There is a scarce but burgeoning literature on the evaluation of the international tax reform (Hanappi and Cabral, 2020). Detailed discussions of the reforms of international taxation and potential impacts are discussed in Fuest, Parenti, and Toubal (2019), International Monetary Fund (2019) and Devereux, Auerbach, Keen, Oosterhuis, Schön, and Vella (2021). Most of the literature evaluates Pillar II, the effects of minimum taxation. OECD (2020a) and Baraké, Neef, Chouc, and Zucman (2021) propose estimations of the expected tax revenue gains from the implementation of Pillar II. None of these contributions allow for real and profit shifting responses of multinational firms. They moreover focus on tax revenues. We show the importance of variations in corporate taxation and the redistribution of taxing rights in countries' welfare. On the theoretical side, Johannesen (2022) provides an interesting contribution highlighting the importance of the minimum tax rate on welfare. When the minimum tax rate is sufficiently high to eliminate profit shifting, global minimum taxation leads to positive welfare gains for non-tax-haven countries. However, this tax competition model does not consider the real responses of multinational firms which might affect the welfare results.

Last, our quantitative analysis builds on recent advances from the quantitative trade and economic geography literature. We build our model from a multi-country Krugman-type model à la Head and Mayer (2004) that we augment with multinational firms and profit shifting. While the patterns of trade and multinational production have received a lot of attention (Arkolakis, Ramondo, Rodrguez-Clare, and Yeaple, 2018, Head and Mayer, 2019) with applications to corporate taxation (Suárez Serrato and Zidar, 2016, Fajgelbaum, Morales, Serrato, and Zidar, 2019, Wang, 2020), we focus instead on the geography of profit shifting frictions and how they affect the location of real activities. Contrary to trade flows or multinational production sales, the allocation of profit shifting across tax havens is unobserved. Therefore, the main input required for the calibration of our model needs to be estimated. Furthermore, by explicitly modeling profit shifting, we can separate the elasticity of profits to taxes that result from aggressive tax planning from those that result from the mobility of multinational production. These two elasticities are key to determining the impact of a global corporate tax reform on real outcomes. Importantly, we find that the elasticity of profits shifted to tax havens is twice as large as the elasticity of multinational production. Calibrating our model with

both these elasticities, we are thus able to disentangle the impact of global corporate tax reforms on profit shifting from its impact on multinationals' real activity.

We organize the paper as follows. In Section 4.1, we present the model used for the counterfactual analysis. The model guides the estimation of bilateral profit shifting and the tax base and profit shifting elasticities. In Section 4.2, we present the data, estimate bilateral profit shifting and calibrate the elasticity of substitution and the two corporate tax elasticities that govern the location of real activities and profit shifting. In Section 4.4, we present the counterfactual results.

4.1 . Model

In this section we describe the model that we use for our counterfactual analysis. Importantly, the model introduces tax havens and the ability of firms to shift profits. The model guides the empirical estimation of the two key elasticities that determine the responses of multinational corporations to corporate tax reforms.

4.1.1 . Set-up

Structure of the Model. The world economy is composed of $k = 1, \ldots, N$ countries, among which $h = 1, \ldots, H$ are labeled "tax havens". Each country is endowed with labor, the unique factor of production. The L_k workers are immobile across countries. They inelastically offer one unit of labor paid w_k. An endogenous number of corporations operate under monopolistic competition. Each corporate designs and produces a single variety which can be sold in any country. The set of varieties supplied in country n is Ω_n.

Demand. The demand for any variety in Ω_n at price p_n is given by $d_n(p_n) = Y_n \frac{p_n^{-\sigma}}{P_n^{1-\sigma}}$. The price-elasticity of demand is $\sigma > 1$; Y_n denotes total expenditures; P_n is the price-index given by

$$P_n = \left(\int_{\Omega_n} p_n(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}$$

We use the term "welfare" to denote real expenditure $U_n = Y_n / P_n$ (see also footnote 9).

Pricing-rule. A firm with productivity φ sets its headquarter in a residence country i, sources its production in one source country l, and serves all destination markets n through local sales or exports. Under CES preferences and monopolistic competition, the profit-maximizing mark-up equals $\frac{\sigma}{\sigma-1}$ and is independent of the destination market. The elasticity σ governs the sales-to-profit ratio in each production country and the price elasticity of demand. Anticipating the calibration of the model, we separate them by introducing a production-country specific wedge $\iota_l \leq \sigma$ between sales and profits. We return to the (exact) calibration of ι_l and σ in Section 4.2.

Labor costs in l and a set of frictions described below determine the firm production costs and its profitability.

Frictions and taxation. When the source country l and the residence country i differ, the cost to produce abroad involves a friction $\gamma_{il} > 1$, which reflects a technology transfer from the headquarter. Serving foreign destination markets $n \neq l$ comes with trade frictions $\tau_{ln} \geq 1$ for iceberg transport costs. Neither producing nor serving destination market n require the payment of a fixed cost. Therefore, firms serve all markets and $\Omega_n \equiv \Omega$.[5] The geography of a source country l - its economic size and that of its trade partners adjusted by trade frictions - are summarized by the endogenous market potential of country l, $\Xi_l^{1-\sigma} = \sum_n \Xi_{ln}^{1-\sigma} = \sum_n \tau_{ln}^{1-\sigma} Y_n P_n^{\sigma-1}$.[6] In the absence of tax optimization, all taxes are levied where production takes place, country l, at the rate t_{ll}, and the tax base's location mirrors the actual economic activities' location.

In our model, MNCs producing in non-haven countries have the opportunity to transfer their profits to a tax haven h. Compared to a low-tax jurisdiction, a tax haven h can also host and tax profits of foreign firms at the rate $t_{lh} < t_{ll}$ without requiring their physical presence, i.e., a production site. When shifting their profits, firms incur a bilateral cost α_{lh}. There are various reasons to expect these costs to be heterogeneous across production countries or tax-havens. Indeed, the type and intensity of profit shifting itself are expected to vary across sectors, thereby reflecting countries' specialization. Tax havens, on the other hand, differ in the characteristics that may facilitate profit shifting, like communications infrastructures or the legal technologies they offer to foreign firms (e.g., reduced incorporation time and costs, opacity and secrecy, accounting rules, treaty network). Our reduced-form friction α_{lh} goes further by allowing these determinants to be bilateral, so the cost of shifting profits to a tax haven differ whether they stem from production that is sourced in the U.S. or in France.[7]

Profits We denote global post-tax profits as

$$\pi_{ilh}(\varphi) = (1 - t_{ilh}) \frac{\iota_l}{\sigma} \left(\frac{\sigma}{\sigma - 1} \frac{\gamma_{il} \alpha_{lh}}{\varphi} w_l \Xi_l \right)^{1-\sigma}$$

We allow the tax rate t_{ilh} to be trilateral, acknowledging that even countries operating under a territorial regime may also partially levy taxes at the residence. Taxing rights at the origin also matter when discussing ongoing reforms e.g. the global minimum tax reform which gives taxing rights to residence countries.

[5] We discuss alternative hypothesis in section 4.1.5.

[6] Head and Mayer (2004) call it the "Krugman market potential" in reference to Krugman (1992).

[7] This is consistent with recent evidence about the sectoral and geographical specialization of tax havens discussed for instance in Garcia-Bernardo, Fichtner, Takes, and Heemskerk (2017), Bilicka, Qi, and Xing (2020) or Laffitte and Toubal (2021).

4.1.2 . From micro to macro

Firm heterogeneity. In this section, we parametrize the distribution of φ and tax avoidance abilities to relate our model to bilateral macroeconomic flows, e.g., trade shares, multinational production shares, and profit shifting. We write the model with the understanding that further micro heterogeneity at the firm level would be subsumed in sufficient statistics as in Arkolakis, Costinot, and Rodriguez-Clare, 2012; Arkolakis, Ramondo, Rodrguez-Clare, and Yeaple, 2018 and therefore specify the minimal structure to provide us with trade, multinational production and profit-shifting shares.

We introduce firm heterogeneity as follows: in each residence country, firms decide whether to enter or not, i.e., to set-up a headquarter in i upon the payment of a sunk cost $w_i f_E$.[8] Entrants find out how productive they would be when locating their production facility in any country l and recording their profits in any country h (where h is equal to l when the firm does not shift profits abroad). We assume that each productivity draw has two components. The first component, T_i is deterministic, inherited from the residence country. The second component φ_{lh} is idiosyncratic, specific to both the source country and the location of profits. A resident firm from i makes post-tax profits $\pi_{ilh}(T_i\varphi_{lh})$ if it chooses to source its production in l and book its profits in h.

Parametrization. The φ_{lh} draws by country i are distributed as follows:

$$(\varphi_{lh})_{l,h\in\mathcal{N}\times\mathcal{H}_l} \sim \mathcal{F}\left(\theta_i; (A_{lh})_{l,h\in\mathcal{N}\times\mathcal{H}_l}\right)$$

$\mathcal{F}$ is a multivariate Frechet distribution. Building on Lind and Ramondo, 2018, we consider a multivariate υ_1-Frechet distribution of productivities with scale parameters A_{lh} and a homogenous correlation function $G_i(.)$ so that:

$$\mathbb{P}\left(Z_{11}\leq z_{11};\ldots;Z_{lh}\leq z_{lh};\ldots;Z_{NH}\leq z_{NH}\right) \quad = \quad e^{-G_i\left(A_{11}z_{11}^{-\upsilon_1}\ldots,A_{lh}z_{lh}^{-\upsilon_1},\ldots,A_{NH}z_{NH}^{-\upsilon_1}\right)}$$

When $h=l$, the $A_{lh}=A_{ll}$ parameters reflect the production technology of the source country. Instead when $l\neq h$, A_{lh} captures both the production technology of country l and the ease of tax planning in h for firms producing in l. Together with the α_{lh} frictions, the A_{lh} parameters determine the intensity of profit shifting between l and h. Since we cannot disentangle A_{lh} from α_{lh}, we set $A_{lh}=A_{ll},\ forallh$ and therefore assume the bilateral variation in profit shifting to be captured by α_{lh}. This means that for a given country l, α_{lh} measures the *net* profit-shifing friction from l to h, adjusted for potential synergies between the production in l and tax avoidance in h. The function G_i gives the substitutability across lh pairs and, therefore, the mobility of the production and the tax base. In the baseline model, we parameterize G_i so that the implied elasticities governing the tax base are allowed to differ for tax-avoiding ($h\neq l$) and non-avoiding firms ($h=l$). Specifically, we assume for now that:

$$G_i(\mathbf{x})=\sum_{l=1}^{N}x_{ll}+\theta_i^{-\upsilon_1}\left(\sum_{l=1}^{N}\sum_{h=1}^{H}x_{lh}^{\frac{\upsilon_2}{\upsilon_1}}\right)^{\frac{\upsilon_1}{\upsilon_2}} \tag{4.1}$$

[8] Sunk entry costs f_E could be country-specific. As they are irrelevant to predicting relative changes, we stick to the simple case $f_{Ei}=f_E$ for all i.

where $\upsilon_2 \geq \upsilon_1$. We discuss alternative nesting structures in the Online Appendix. As will become clear below, this assumption comes down to assuming that profits from tax-avoiding firms are more elastic to corporate taxes. That correlation functions are i-specific allows for different residence countries i to have different profit-shifting intensities. A lower θ_i raises the likelihood of a firm with residence-country i to engage in profit shifting. It can thus be interpreted as an inverse measure of a residence country's "aggressiveness" in profit shifting.[9]

Sourcing and profit shifting decisions. After observing the φ_{lh} draws, firms from i select a unique pair lh that maximizes their profits. A firm from i chooses its profit-maximizing production site tax haven pair lh^*:

$$lh^*(i) \quad = \quad argmax_{lh} \left\{ (1 - t_{ilh})\, \iota_l \left(\frac{\gamma_{il}\alpha_{lh}}{\varphi_{lh}} w_l \Xi_l \right)^{1-\sigma} \right\} \tag{4.2}$$

Formally, this choice depends on i) each firm's idiosyncratic profitability, which reflects firms' production and tax-dodging technologies when operating through a source-haven pair lh, ii) bilateral frictions between the residence, source, destination and tax havens, and iii) country-specific variables such as labor costs, market potentials, and tax rates.

Structure of the theoretical framework. In Figure 4.1.1, we propose a schematic representation of the model in which we distinguish between real (in blue) and profit shifting parameters (in red). Parameters that are not discriminating for tax havens and non-tax-haven countries are left in black.

For non tax avoiders, all taxes are levied where production takes place, country l, and the location of the tax base mirrors the location of actual economic activities. The location choice depends on corporate tax rates t_{ll}, market size and geography embedded in Ξ_l, and wages, w_l. Multinationals producing in non-haven countries can transfer their profits to a tax haven upon paying a marginal bilateral cost α_{lh}. The tax "*aggressiveness*" parameter, θ_i, reflects different abilities of headquarters i to reduce the costs of shifting profits. In the baseline model, we allow the tax base's elasticity to differ for tax-avoiding and non-avoiding firms. The tax base elasticity υ_1 recovers how substitutable the different source countries are. The "*profit shifting*" elasticity υ_2 informs how substitutable are the different tax havens.

At the macro-level, the model determines the share of production in l undertaken by different countries i, the allocation of the production in l to different consumption markets n through trade, and the distribution of profits realized in l across tax jurisdictions h. A corporate tax reform will reallocate these three shares across countries that together determine the winners and losers of these reforms. Importantly, these changes are not zero-sum. The

[9] Our theoretical definition of aggressiveness echoes the empirical strategy of Garcia-Bernardo and Jansky (2021) who test whether "MNCs differ in the aggressiveness of their tax planning depending on the country of their headquarters" (p.8).

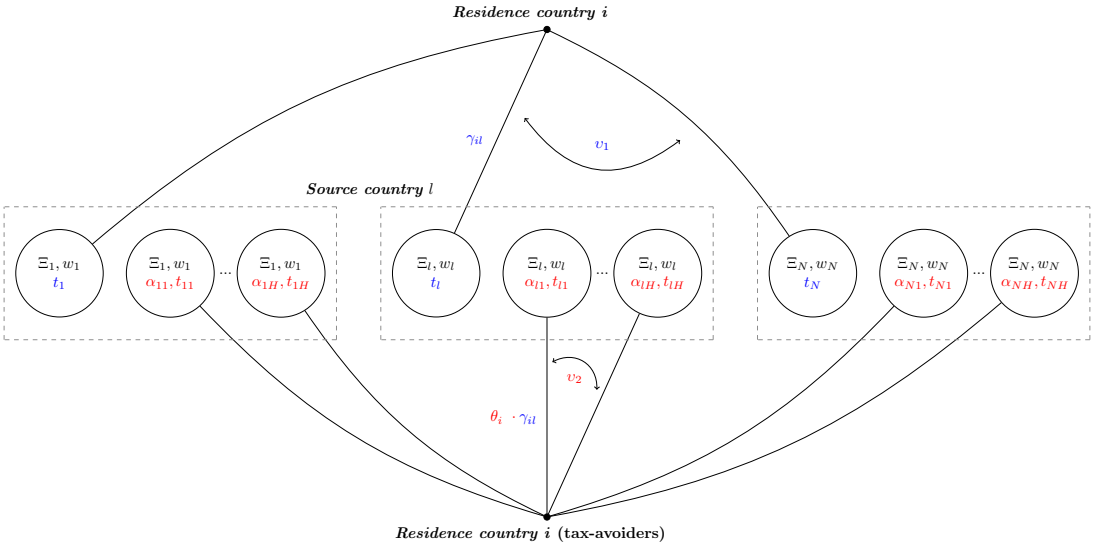

Figure 4.1.1: Structure of the theoretical framework

model also generates variations in overall profits and the number of firms operating in each country. These features allow us to discuss the efficiency of these reforms beyond their distributional impact.

4.1.3 . Equilibrium

The probability for a firm from country i to locate its production in l and book its profits in h is:

$$\mathbb{P}_{ilh} = \frac{\tilde{A}_{ilh} G_{i,lh}(\tilde{\mathbf{A}}_i, \mathbf{t}_i)}{G_i(\tilde{\mathbf{A}}_i, \mathbf{t}_i)} (1 - t_{ilh})^{\frac{\upsilon_1}{\sigma-1}} \tag{4.3}$$

where $\mathbf{t}_i = (t_{ilh})_{1 \leq l \leq N, 1 \leq h \leq H}$ encompasses corporate income tax rates; all the other determinants of firms' location decisions are contained in $\tilde{A}_{ilh}$, with $\tilde{A}_{ilh} = A_{ll} \left(\gamma_{il} \alpha_{lh} \iota_l^{\frac{1}{1-\sigma}} w_l \Xi_l \right)^{-\upsilon_1}$.

We denote by $G_{i,lh}$ the partial derivative of G_i with respect to the lh term and, with a slight abuse of notations, we denote by $G_i(\tilde{\mathbf{A}}_i, \mathbf{t_i})$ the correlation function evaluated at $\left(\tilde{A}_{ilh} (1 - t_{ilh})^{\frac{\upsilon_1}{\sigma-1}} \right)_{l \leq N, h \leq H}$.

Expression (4.3) results directly from McFadden (1978)'s discrete choice framework using GEV.[10] In the long-run monopolistically competitive equilibrium, the free-entry condition holds $\mathbb{E}\left[\pi_{i\{lh\}^*}\right] = w_i f_E$ so that aggregate profits cover the sunk entry cost. Using again the properties of the GEV, we get:

$$\frac{1}{\sigma T_i^{1-\sigma}} \left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma} G_i(\tilde{\mathbf{A}}_i, \mathbf{t}_i)^{\frac{\sigma-1}{\upsilon_1}} \Gamma \left(1 - \frac{\sigma - 1}{\upsilon_1} \right) = w_i f_E \tag{4.4}$$

[10] To obtain the above formula, note that using (4.1), profits π_{ilh} from a residence country i follow a multivariate $\frac{\upsilon_1}{\sigma-1}$-Frechet distribution with scale parameters $\tilde{A}_{ilh}(1 - t_{lh})^{\frac{\upsilon_1}{\sigma-1}}$ and the same correlation function $G_i(.)$.

Given profits we can build a government's tax revenue flow. Using the free-entry condition above, aggregate pre-tax profits of firms from i producing in l which book their profits in h are given by $N_i \mathbb{P}_{ilh} \frac{w_i f_E}{(1-t_{ilh})}$. Under a territorial taxation regime and in the absence of profit shifting, the subscript i can be removed and the relevant tax rate for country l's tax revenues is t_l if $l = h$ and zero otherwise. Hence tax revenues of country l are given by $B_l = \sum_i t_l N_i \mathbb{P}_{ill} \frac{w_i f_E}{1-t_{ill}}$.

Consider instead a minimum tax regime that allows country k to tax worldwide profits (i) generated by firms from k, (ii) shifted to tax havens, and (iii) taxed at a rate inferior to t_k^{min}, we would have that the tax rate is equal to the "normal" statutory tax rate in k if $l = h = k$, equal to $\max\{t_k^{min} - t_{lh}, 0\}$ if $i = k$ and $l \neq h$, and zero otherwise. In this case the tax revenue is given by $B_k = \sum_i t_k N_i \mathbb{P}_{ikk} \frac{w_i f_E}{1-t_{ikk}} + \sum_{l \neq h,h} \max\{t_k^{min} - t_{lh}, 0\} N_k \mathbb{P}_{klh} \frac{w_k f_E}{1-t_{klh}}$, where the first term describes the tax revenues generated by firms headquartered in k and the second term by firms located elsewhere whenever the mintax binds. To encompass all these cases we write compactly that tax revenues are described by

$$B_k = \sum_{i,l,h} t_{ilh}^{g_k} N_i \mathbb{P}_{ilh} \frac{w_i f_E}{1 - t_{ilh}}, \tag{4.5}$$

where t_{ilh}^{gk} is the tax rate which is relevant for the tax authorities of country k.

The production in the country l aggregates multinational production from all origin countries. Under CES preferences, production Q is proportional to profits with a factor σ/ι_l. Using the free-entry condition, we get:

$$Q_l = \sigma \sum_{i,h} N_i \frac{\mathbb{P}_{ilh} w_i f_E}{(1 - t_{ilh})\iota_l} \tag{4.6}$$

Wages clear the labor market in each country, hence:

$$w_i L_i = N_i w_i f_E + \frac{\sigma - 1}{\sigma} Q_i \tag{4.7}$$

The first term corresponds to wages paid to labor used for firm entry, while the second reflects wages paid to workers in the production process. Summing-up across all origin-source country pairs that sell in n, we can show that the country n price index verifies:

$$P_n = \left(\sum_l \frac{\tau_{ln}^{1-\sigma} Q_l}{\Xi_l^{1-\sigma}} \right)^{\frac{1}{1-\sigma}} \tag{4.8}$$

The price index can be low thanks to large and close trade partners. Finally, aggregate expenditures in country i result from labor income and corporate income tax revenues:[11]

$$Y_l = w_l L_l + B_l + \Delta_l \tag{4.9}$$

[11]There are several rationales for collecting corporate tax revenues that may differ across countries. We avoid taking a stand on country's heterogeneous preferences over the provision of a public good by assuming that tax revenues are redistributed in a lump-sump fashion. Our measure of welfare is thus better interpreted as an index of production efficiency rather than social welfare.

where the imbalances Δ_l.[12] The system of equations (4.4)-(4.9) solves Q_l, Y_n, w_i, N_i, P_n with a numeraire condition such that $P_1 = 1$.

4.1.4 . Tax-base and profit-shifting elasticities

As shown by Lind and Ramondo, 2018, the max-stable property of the Frechet distribution implies that $\mathbb{P}_{ilh}$ corresponds to the share of profits realized by firms from i in lh.[13] Denote X_{ilh} the overall sales of firms from i selecting the pair lh. The probability for a firm from i to select the pair lh is:

$$\mathbb{P}_{ilh} = \frac{X_{ilh}\iota_l\left(1-t_{ilh}\right)}{\sum_{lh} X_{ilh}\iota_l\left(1-t_{ilh}\right)} \tag{4.10}$$

Denote $X_i = \sum_{l,h} X_{ilh}$ the worldwide sales of firms from i. Equation (4.10) implies:

$$\frac{X_{ilh}}{X_i} = \frac{\mathbb{P}_{ilh}/\left(\iota_l\left(1-t_{ilh}\right)\right)}{\sum_{l,h}\mathbb{P}_{ilh}/\left(\iota_l\left(1-t_{ilh}\right)\right)} \tag{4.11}$$

Equation (4.11) means that tax rates influence firms' location choices, but they do not affect their sales conditional on the location of their production site. After combining equations (4.1), (4.3), and (4.11), we obtain:

$$\frac{X_{ilh}}{X_i} = \frac{\tilde{A}_{ilh}(1-t_{ilh})^{\frac{\upsilon_1}{\sigma-1}-1}G_{lh}(\tilde{\mathbf{A}}_i,\mathbf{t})}{\sum_{l,h}\tilde{A}_{ilh}(1-t_{ilh})^{\frac{\upsilon_1}{\sigma-1}-1}G_{lh}(\tilde{\mathbf{A}}_i,\mathbf{t})} \tag{4.12}$$

This yields a gravity-type equation for multinational production sales. In particular, the fraction of the taxable base that remains in each production location is given by:

$$\frac{X_{ill}}{X_i} = \frac{\tilde{A}_{ill}(1-t_{ill})^{\frac{\upsilon_1}{\sigma-1}-1}}{\sum_{l,h}\tilde{A}_{ilh}(1-t_{ilh})^{\frac{\upsilon_1}{\sigma-1}-1}G_{lh}(\tilde{\mathbf{A}}_i,\mathbf{t})} \tag{4.13}$$

Note that the (partial) elasticity of the tax base in l to $1-t_{ill}$ is then $\frac{\upsilon_1}{\sigma-1}-1$. Moreover, the allocation of sales generated in l and moved toward tax havens is given by:

$$\frac{X_{ilh}}{\sum_{l,h,h\neq l}X_{ilh}} = \frac{\tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}}(1-t_{ilh})^{\frac{\upsilon_2}{\sigma-1}-1}}{\sum_{l,h,h\neq l}\tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}}(1-t_{ilh})^{\frac{\upsilon_2}{\sigma-1}-1}} \tag{4.14}$$

This time, the (partial) elasticity of profits shifted from l to $1-t_{ilh}$ is equal to $\frac{\upsilon_2}{\sigma-1}-1$. We thus allow for two distinct elasticities. In addition, the above equation delivers a gravity equation for bilateral profit shifting. The multilateral resistance terms in the denominator show that beyond the characteristics of tax haven h, those of the other tax havens also matter for bilateral profit shifting. The model captures tax competition across tax havens. To see this,

[12] Whether imbalances are considered to remain constant in absolute terms instead of relative terms does not make a difference for our quantification exercises.

[13] See Lind and Ramondo, 2018, Lemma A.5. in the Online Appendix.

note that a decrease in a tax haven's tax rate t_{ilh} triggers two main effects. First, it increases the total share of profits shifted from l toward tax havens (see Equation 4.12). Second, it reshuffles these profits among tax havens (see Equation 4.14). Some non-avoiding firms in l start shifting their profits to h and some firms producing in $l' \neq l$ move their production site to l and engage in profit shifting. Moreover, some firms that were previously shifting their profits to $h' \neq h$ now switch for tax haven h instead of h'. This gravity-based profit shifting enriches the reduced-form set-up *à la* Hines and Rice, 1994, standard in the corporate tax avoidance literature, in which bilateral profit shifting abstracts from other tax havens' attributes and reallocation mechanisms across tax havens.[14]

4.1.5 . Discussion and extensions

As in Hines and Rice, 1994 or Huizinga and Laeven, 2008, we may also assume that for a bilateral pair, the marginal cost of shifting profits increases linearly with the ratio of shifted profits to true profits. This functional form would lead to a variable elasticity of shifted profits to tax rates, and would predict exactly zero shifted profit when tax rates are aligned across the pair. Instead, our framework implies that some residual profits would be located in h even without a lower tax rate, implying that tax havens would still get a profit "premium". This distinction makes little difference when exploring small changes in corporate tax policy. However, they could turn out to be important when investigating the impact of more ambitious reforms. In section 4.4, we explore in detail this question when turning to counterfactuals of implementing a global minimum tax rate with a redistribution of taxing rights to the residence country. Specifically, we extend our model to a non-constant elasticity of profits to effective tax rates that we estimate and use for our counterfactuals.

4.2 . Estimating profit shifting

A preliminary step to calibration is the estimation of profit shifting, which is not directly observable. This section describes the estimation procedure. The calibration of the model parameters, including elasticities, is addressed in section 4.3.

Our baseline model assumes a territorial tax system in which firms are taxed where production takes place. Its calibration requires quantifying the profits shifted from source countries to tax havens. Our model also shows that the probability and amounts of income shifting vary across residence countries. Some residence countries might have better abilities to reduce the costs of shifting profits. Their firms are thus more aggressive in profit shifting than in other countries. Consequently, we need to estimate the probability for firms headquartered in i to shift profits in tax haven h from source country l, and the distribution of profits shifted for all $i - l - h$ triplets.

This section proposes a structural quantification of profit shifting, consistent with our model. The probability and amounts of profits shifted from the

[14] In these models, bilateral profit shifting between l and h is proportional to the difference in tax rates between l and h.

source country to the tax haven depends on other tax havens' tax rate opportunities and factors in other production locations. The structural approach emphasizes the importance of disentangling real from paper-profit elasticities. It also rationalizes the variation of profit shifting across residence countries (e.g. European and U.S. firms in TWZ and Chinese firms in Garcia-Bernardo, Jansky, and Torslov, 2021).

4.2.1 . The structural approach

Our methodology. Equation (4.3) describes the probability for a firm from i to select the pair lh to locate its production and book its post-tax profits. The firm can either report its profit in the source country ($h = l$) or shift profits from the source country to a tax haven ($h \neq l$). We denote by Π_{ill} and PS_{ilh} respectively the absolute value of post-tax profits declared in l and shifted to h by $i-$firms sourcing in l. Total profits - shifted or not - by firms from i are denoted Π_i, while PS_i represent total shifted profits by firms from i. We use the separability of $\mathbb{P}_{ilh}$ across country pairs to derive a set of accounting equations that determine bilateral profit shifting. For $h \neq l$ equation (4.3) boils down to

$$\mathbb{P}_{ilh} = s_i \times s_{il} \times s_{lh} \; for \; h \neq l$$

where $s_i = \frac{PS_i}{\Pi_i}$ is the probability that firms headquartered in i shift profits;

$$s_{il} = \frac{\sum_{h,h\neq l} \tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}} (1-t_{lh})^{\frac{\upsilon_2}{\sigma-1}}}{\sum_{l,h,h\neq l} \tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}} (1-t_{lh})^{\frac{\upsilon_2}{\sigma-1}}} \quad \text{and} \quad s_{lh} = \frac{A_{ll}^{\frac{\upsilon_2}{\upsilon_1}} \left(\alpha_{lh} \left((1-t_{lh})\, \iota_l\right)^{\frac{1}{1-\sigma}}\right)^{-\upsilon_2}}{\sum_{l,h,h\neq l} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}} \left(\alpha_{lh} \left((1-t_{lh})\, \iota_l\right)^{\frac{1}{1-\sigma}}\right)^{-\upsilon_2}}.$$

None of these probabilities are observed in the data. In the next subsection, we show that conditional upon the overall profits shifted by firms from i to a country h, i.e. $PS_{ih} = \sum_l PS_{ilh}$, as well as PS_l, the overall amount of profits shifted from source country l, the model structure can be used to back-out all s_{il} and s_{lh}. Subsection 3.3 addresses the estimation of PS_{ih} and PS_l.

As common in the literature, we assume that there is no profit shifted out of tax havens ($\alpha_{lh} \to \infty$, when $h = l$). Therefore, we back out the profit-shifting shares for i and l being non-tax-haven countries.

4.2.2 . Bilateral profit shifting shares s_{il} and s_{lh}

We proceed in 3 steps.

1. In a first step, we compute the probability $s_{ih} = PS_{ih}/PS_i$ that a firm headquartered in i shifts its profits to country h conditional on being a tax avoider. We note that:

$$s_{ih} \;\; = \;\; \sum_l s_{il} \times s_{lh}. \tag{4.15}$$

   Compared to s_{il} or s_{lh}, the share s_{ih} can be more easily estimated because databases about MNCs' profits inform in general on ownership link (who owns profits) rather than on value-added links (who generates the value embedded in the profits). The system shown in (4.15) gives a set of

$N \times H$ equations, with N the number of non-haven countries and H the number of tax havens. In steps 2 and 3, we show how to derive s_{il}, which will leave us with a perfectly-identified linear system in s_{lh}.

2. In step 2, we further use the model's structure to determine s_{il}. We denote by $\Gamma_{il} = \left(\frac{\gamma_{il}/\gamma_{il_0}}{\gamma_{i_0 l}/\gamma_{i_0 l_0}} \right)^{\frac{\upsilon_2}{\upsilon_1}}$ the attractiveness of country l when i shifts its profits to a tax haven (relative to a reference country denoted by i_0). It is easily verified that

$$s_{il} = \frac{\Gamma_{il} s_{i_0 l}}{\sum_l \Gamma_{il} s_{i_0 l}}. \tag{4.16}$$

   To interpret the equation above, first, note that the share of profits generated in l should be positive to observe a positive share of profits shifted from l. The share of profits that can be shifted from country l depends on the amounts of multinational production located in the country l and on the ability to shift part of the profits stemming from this production to tax havens. The attractiveness of source country l for tax avoiders is therefore intrinsically linked to the tax base and profit-shifting elasticities. A higher elasticity of paper profits relative to real profits implies that differences in attractiveness for multinational production - governed by γ_{il} - are magnified when it comes to attracting tax avoiders, as shown by Γ_{il}. In other words, source countries with more multinational production activity tend to attract disproportionately more tax avoiders, all else being equal.

   Instead, whenever $\upsilon_2 = \upsilon_1$, the share of profits shifted from l is proportional to the share of profits reported in l. While simple heuristics might assume that doubling profits doubles profit-shifting, our model shows the importance of correcting for the differential in tax elasticities between real activity and paper profits.

   From Equation (4.16), we can recover all s_{il} from the reference country s_{i0l} and the frictions γ_{il}.

3. In a third step, we use an accounting identity to back out $s_{i_0 l}$. Profits shifted by multinational firms from source country l to tax havens are equal to the sum of the amounts of profits shifted from headquarters countries $PS_i \times s_{il}$.

$$PS_l = \sum_i PS_i \overbrace{\frac{\Gamma_{il} s_{i_0 l}}{\sum_l \Gamma_{il} s_{i_0 l}}}^{s_{il}}. \tag{4.17}$$

   There are N equations and N unknowns (s_{i0l}). Consequently, the (non-linear) system in (4.17) is perfectly identified. We show below how we estimate PS_i and PS_l.

To summarize, we use equation (4.17) to back-out $s_{i_0 l}$. Equation (4.16) is used to recover s_{il}. Given s_{il} and s_{ih}, the set of equations (4.15) is a linear system which solves for s_{lh}.

Our methodology can be summed up by figure 4.2.1. It proposes a schematic representation of profit shifting in our model: firms with residence in i make profits in source countries l. These firms may shift some profits to tax havens h. Profit shifting in h can finally be attributed to their owners from country i (they are either kept undistributed in the tax haven or distributed through dividends). Our goal is to triangulate profit shifting. By observing PS_i and PS_l, we can recover all production links between i and l. Using these links and s_{ih}, we are able to find profit shifting shares s_{lh}.

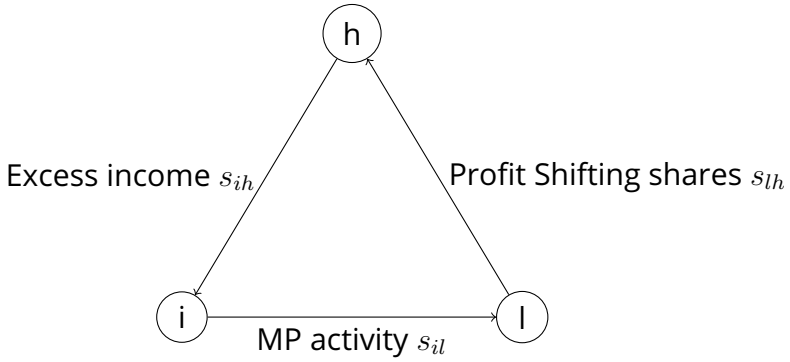

Figure 4.2.1: A schematic representation of profit shifting

It is also important to note that the calibration of profit shifting requires observing the parameters υ_1 and υ_2. The latter can only be calibrated using the information on profit shifting. We will thus use an iterative procedure to quantify bilateral profit shifting. The next section will describe the calibration of these two elasticities at length.

4.2.3 . Estimation of PS_{ih} and PS_l

We start with evaluating the amount of profits shifted from each headquarter country to each tax haven, PS_{ih} which will determine s_{ih} and PS_i.

Data: FDI and multinational production

We use data from a sample of 40 countries from 2010-2014. These countries account for 84% of the world GDP in 2014. The sample includes seven major tax havens (Hong Kong, Ireland, Luxembourg, Netherlands, Singapore, Switzerland, and Offshore Financial Centers, an aggregate of 29 small Caribbean and Pacific islands). As building blocks, we use the information on bilateral multinational production and FDI income from the OECD's direct investment statistics and Eurostat's balance of payment data. The construction of both datasets and all the related data sources are described in the Online Appendix. The FDI income dataset is the core statistical source from which we can observe the flows of reinvested earnings in tax havens and dividends from tax havens.[15]

[15]The literature which focuses on U.S. multinational firms shows large estimates of permanently reinvested earnings in tax havens. These funds are often held in U.S. financial institu-

The FDI income data also contain information on interest payments. As noted by Wright and Zucman, 2018, these differ from the two other income components. In a tax avoidance scheme, they would be paid from the parent company to the tax haven foreign affiliates. FDI income flows are presented on a *direct* ownership basis rather than on an *ultimate* ownership basis. The former definition gives more weight to conduit tax havens in the estimation of profits shifting. Damgaard, Elkjaer, and Johannesen (2019), present an interesting contribution that we use later on to account for the use of tax havens as conduits. Moreover, we need to evaluate the *excessive* amount of income booked in tax havens as only a fraction of FDI income is associated with profit-shifting. The quantification of excess income requires defining a benchmark (normal) income that we present below.

We follow the methodology of Ramondo, Rodriguez-Clare, and Tintelnot, 2015 to construct data on bilateral multinational production (MP). This methodology is now common in the literature related to multinational production. We construct X_{ill}, the sales resulting from the production in country l by firms headquartered in the country i. More details and comparisons with similar existing datasets are presented in Appendix 4.A.2. From multinational production, we can deduct bilateral multinational production shares and thus bilateral multinational production frictions γ_{il} (see Appendix 4.F). Last, we compute production by domestic firms (X_{iii}) for which we use data on country-level production (see Appendix 4.A).

Bilateral profit shifting as excess profits

The quantification of PS_{ih} requires the definition of a benchmark level of *normal* profit. We construct several benchmark levels, whose specifications are detailed in Table 4.2.1 and then predict the level of profits that would be observed if there were no tax haven among the sending countries k. The difference between the "*benchmark*" predicted profits and the predicted profits without tax havens is our measure of profit shifting from any country i to any tax haven h, PS_{ih}. We evaluate total profit shifting to range from $379bn to $411bn depending on the benchmark level.

Controlled Foreign Corporation (CFC) rules, employed to counteract the allocation of passive income to low-tax jurisdictions, are unlikely to be a concern for evaluating the amount of profit shifting. According to Clifford, 2019, firms react to CFC rules by reducing the revenues they locate in locations that enter the scope of CFC rules. Moreover, within the European Union, CFC rules are only applied to wholly artificial structures following the Cadbury-Schweppes judgment (see Schenkelberg, 2020). This limits the potential bias for pairs of i and h in E.U. countries.

Our estimation sample includes 33 origin (investing) countries and 52- destination countries – 33 non-haven countries, Hong Kong, Ireland, Luxembourg,

tions and are thus available to the U.S. capital market. Consequently, they constitute leverage for U.S. multinationals. Until the tax reform of 2018, they could not be returned as dividends to the U.S. parent company without incurring U.S. corporate taxation upon repatriation. See Kleinbard (2011) and Murphy, 2013, "Indefinitely Reinvested Foreign Earnings on the Rise", *The Wall Street Journal*, 7 May 2013.

Table 4.2.1: Estimating PS_{ih}

	Dependent variable: FDI income				
	(1)	(2)	(3)	(4)	(5)
$EATR_k - EATR_{k'}$	0.056***	0.036*	0.091***	0.091***	0.033*
	(0.019)	(0.019)	(0.017)	(0.016)	(0.017)
$Haven_{k'}$	1.565***	2.336***	2.767***	2.104***	2.682***
	(0.227)	(0.238)	(0.337)	(0.747)	(0.326)
$ln(GDP_{k'})$	0.497***	0.574***	-4.472***	-4.392***	-3.395***
	(0.058)	(0.080)	(0.737)	(0.722)	(0.607)
$ln(GDP_{k'})^2$			0.095***	0.093***	0.069***
			(0.014)	(0.014)	(0.012)
$ln(GDPpc_{k'})$	0.355*	0.372**	0.337***	0.304***	0.537***
	(0.191)	(0.157)	(0.111)	(0.109)	(0.100)
$ln(Dist_{kk'})$	-0.645***	-0.501***	2.592***	2.163*	2.617***
	(0.089)	(0.073)	(0.923)	(1.167)	(0.985)
$ln(Dist_{kk'})^2$			-0.198***	-0.173**	-0.188***
			(0.057)	(0.073)	(0.060)
Contiguity	-0.632**	-0.358*	0.115	0.279	-0.046
	(0.246)	(0.204)	(0.198)	(0.212)	(0.182)
Common Language	1.309***	1.809***	1.340***	1.067***	1.039**
	(0.412)	(0.520)	(0.514)	(0.398)	(0.499)
Colonial Linkage	0.436	0.272	0.088	-0.227	-0.263
	(0.294)	(0.302)	(0.248)	(0.224)	(0.245)
Common Colonizer	0.648**	0.822*	0.423	0.090	0.247
	(0.322)	(0.476)	(0.594)	(0.475)	(0.478)
Com. Legal Origin	0.507	0.099	0.409	1.045***	0.578
	(0.365)	(0.458)	(0.424)	(0.381)	(0.413)
ln(# employees)					0.393***
					(0.080)
HQ FE	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes
Region × Haven	No	Yes	Yes	Yes	Yes
HQ FE × Haven	No	No	No	Yes	Yes
Observations	1,444	1,444	1,444	1,444	1,216
Pseudo R2	0.819	0.836	0.861	0.884	0.873
Number of destination countries	52	52	52	52	52
Implied Aggregate Profit Shifting	**393551**	**397358**	**411327**	**408764**	**379089**

Dependent variable: FDI income that excludes income from interests. Poisson maximum likelihood (PPML) estimator as proposed by Santos Silva and Tenreyro, 2006. The PPML estimator successfully handles the heteroskedasticity in FDI income data and enables us to take advantage of the information contained in the zero FDI income series due to its multiplicative form. Robust standard errors clustered at the destination country level in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Netherlands, Singapore, Switzerland, and 13 tax havens that are later aggregated to form a composite country (named “Offshore Financial Centers"). We also correct conduit FDI using data on bilateral FDI recorded on an ultimate investor basis rather than on a direct investor basis from Damgaard, Elkjaer, and Johannesen, 2019. This correction does not affect the aggregate amount of PS_{ih}. Details on the construction of the sample and the methodology are given in Appendix 4.B.

Results are reported in Table 4.2.1 where each specification is estimated using Poisson pseudo-maximum likelihood (PPML) following Santos Silva and Tenreyro (2006). The estimated shifted profits are similar across specifications. The specification in column (1) does not include Region $\times$ Haven fixed effects. The impact of tax havens on FDI income is assumed to be the same for all tax havens. By using these specific effects from column (2) onward, we follow the recent literature that shows that tax havens are used differently according to their geographic location (Laffitte and Toubal, 2021). In column (3), we add quadratic terms for distance and GDP. In this specification, the contiguity dummy now has a positive impact, and the tax haven dummy coefficient appears larger than in column (2). In column (4), we interact each headquarter country fixed effect with the tax haven dummy. We therefore allow the origin countries to have a different propensity to use tax havens (Desai, Foley, and Hines, 2006, Garcia-Bernardo, Fichtner, Takes, and Heemskerk, 2017). In column (5), we add a measure of the number of employees in k working for a firm from i. This control is useful to consider the productive capacity of firms from i to k.[16]

We use the specification in column (2) to compute PS_{ih}, the estimated levels of bilateral profits that are shifted from residences to tax havens. From this, we can compute s_{ih} and PS^W the total amount of profits shifting. Total profit shifting is estimated at $397bn.

Quantification of PS_l

We quantify the total amounts of profit shifted from production country l to solve our system. Knowing total profit shifting, we only need to compute the share of profits shifted from l i.e. $s_l = PS_l/PS^W$. Our estimation of the relative profit shifting made from l relies on the differences between the share of profits reported ($\frac{\Pi_{ll}}{\sum_l \Pi_{ll}}$) and the share of production reported ($\frac{X_l \iota_l}{\sum_l X_l \iota_l}$) in countries l. To get an idea about s_l, we compare both shares. The ratio of production to profits can be seen as a measure of profit-shifting intensity in country l independently of the origin of FDI. For instance, usinh this measure, the U.S. as a source country has a profit-shifting intensity of 1.5, while it is equal to one for Germany. It suggests that firms that produce in the U.S. shift more profits than those that produce in Germany, all other things being equal. We then weight the size of each economy by this ratio to obtain s_l.

Alternatively, TWZ. also provides data on the amounts of profit shifting PS_l

[16] Note that this variable is partially interpolated following the same procedure as for the MP sales and leads to a decrease in the number of observations. See Appendix 4.A for more details.

by source countries. We use these amounts as inputs in our system as a robustness test. As shown in Figure 4.B.3 in Appendix, the level of bilateral profit shifting using both inputs is qualitatively similar for the sample of countries available in both TWZ. and our datasets.

4.2.4 . Results and comparison

Results. The Sankey diagram in Figure 4.2.2 shows the shares of profits shifted from residence (s_{ih}) and source countries (s_{lh}) to tax havens. For visualization, we display the top 10 countries and aggregate the bilateral shares for others.

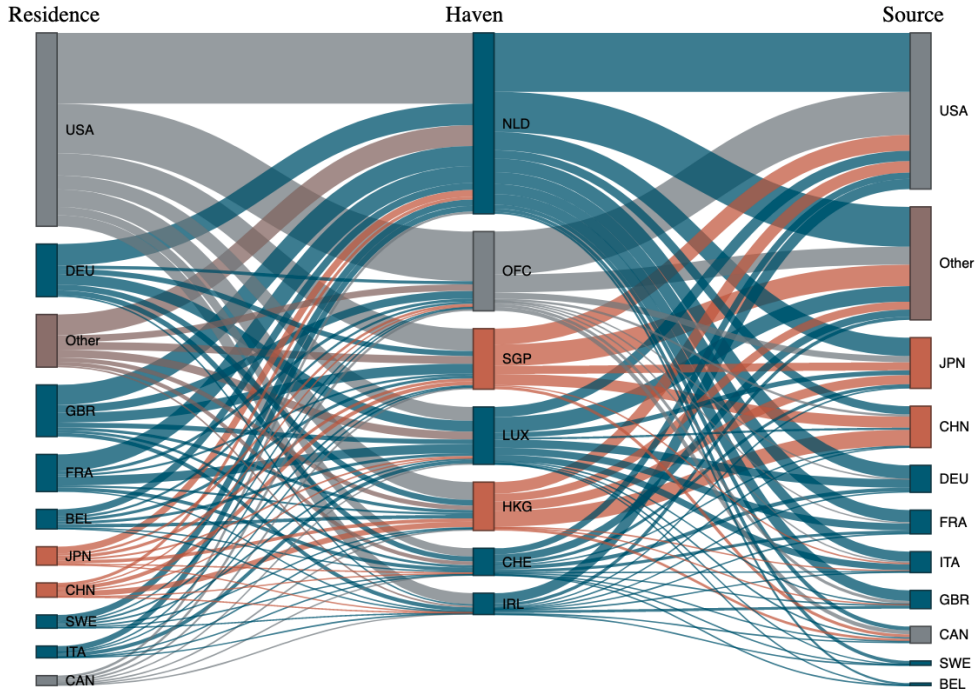

Figure 4.2.2: Profit shifting from i to h and l to h.

Note: This figure plots the estimated profit shifting from residence countries i (on the left), to tax haven h (in the center) and from source country l (on the right) to tax haven h. Details on the computation of profit shifting are given in section 4.2.

The figure shows the predominance of residence countries such as the U.S. and, to a lesser extent, Germany, the United Kingdom, and France in shifting profits to tax havens. It also shows the importance of European tax havens and, in particular, the Netherlands as a major destination of profit shifting. The Netherlands is also a major destination of profit shifted from source countries such as the U.S., Japan, and China. Furthermore, Figure 4.2.2 suggests larger shares of profit shifted from the U.S. as a residence country than as a source. This is also the case for France, Germany, and the United Kingdom but not Japan and China. The pattern displayed in Figure 4.2.2 confirms that gravitational frictions shape profit shifting. European tax havens prominently host profits from non-haven countries in the E.U. and the U.S., while China and Japan shift most of their profits to Hong Kong and Singapore.

Comparisons. Important papers based on macro-level generally provide estimates of profit shifting at the production country or tax haven level (Zucman, 2014, Clausing, 2016; Clausing, 2020, Jansky and Palansky, 2019, Garcia-Bernardo and Jansky, 2021 and Torslov, Wier, and Zucman, 2022). Torslov, Wier, and Zucman, 2022 is the first paper to propose a methodology to compute bilateral profit shifting across pairs of source and tax haven countries that are comparable to ours. They use the global amounts of shifted profits and an allocation key based on trade in high-risk services to determine profit shifting between source countries and tax havens.[17]

Table 4.2.2 reports the Spearman's rank correlation of our vector of estimated profit shifting with different estimates from the literature. We aggregate our bilateral measure of profit shifting for each production country and display the correlations of this vector with unilateral profit shifting measures constructed by TWZ., the Tax Justice Network (Cobham, Garcia-Bernardo, Palansky, and Bou Mansour, 2020), and the European Commission using the CORTEX model (Alvarez Martinez et al., 2016). We find positive and larger rank correlations at the unilateral level suggesting a stable relative position of each source country in profit shifting irrespective of the methodology used. In Appendix 4.C, we provide additional materials that compare our profit shifting estimates with other sources found in the literature. The estimates are rather similar on aggregate and for a vast majority of countries.

Table 4.2.2: Spearman's rank correlation

Source	Correlation	Obs.
Unilateral profit shifting:		
Torslov, Wier, and Zucman (2022)	0.90	33
Cobham, Garcia-Bernardo, Palansky, and Bou Mansour (2020)	0.92	33
Alvarez Martinez et al. (2016)	0.95	21
Bilateral profit shifting:		
Torslov, Wier, and Zucman (2022)	0.61	111

We also compare our estimations with the bilateral estimates of Torslov, Wier, and Zucman, 2022. We restrict our comparison to bilateral estimates for European tax havens as TWZ reports an aggregate for non-European tax-havens. We find a positive and significant rank correlation between our bilateral measure and the one of TWZ., slightly above 60%. While the relative rank of source countries using different profit shifting methodologies proves to be similar, we find the relative position of country pairs regarding profit shifting to be dissimilar. Indeed, TWZ's bilateral allocation of profit shifting relies mainly on bilateral trade in services. As found by Davies, Martin, Parenti, and Toubal (2018) and Wier (2020), not all source countries use services trade to shift profit to tax havens. The use of services transactions may also depend on the MNC's sector of activities (Laffitte and Toubal, 2021).

[17]Their approach is discussed in appendix 4.B.

We assess the correlation between our profit shifting allocation and an allocation based on excess trade in services with tax havens only. We use a reduced-form methodology to directly approximate PS_{lh} from the observations of bilateral services flows. For each pair of countries l and h, we estimate the amount of bilateral profit shifting as excessive high-risk services computed from a gravity equation. [18]

Figure 4.2.3 shows a positive and significant correlation between excessive high-risk services and the theoretically consistent measure of bilateral profit shifting. The Spearman rank correlation coefficient of 0.6 indicates a relatively high correlation between both series. This result suggests that services trade is an important driver of profit-shifting between source countries and tax havens but shall not be considered its unique determinant. In particular, the PS_{lh} estimated in this paper is generally larger than the excess of services, suggesting that services cannot explain all profit shifting.

In appendix figure 4.B.4, we explore the role of the parameters υ_1 and υ_2 on the allocation of profit shifting. Only the ratio, and not the level, of these elasticities matters. This ratio enters the calibration of profit shifting through Γ_{il}. As such, the ratio will mainly affect the determination of s_{il} (see equation 4.16). In figure 4.B.4, we plot the baseline estimation of s_{il} and alternative allocations obtained by i) setting υ_1 equal to υ_2, and ii) increasing the ratio $\frac{\upsilon_2}{\upsilon_1}$ to 3.5. In both cases the allocation of s_{il} is similar to the baseline allocation and displays a Spearman correlation coefficient larger than 0.95.

4.3 . Elasticities and bilateral frictions

This section describes the rest of the calibration exercise. We first set the elasticity of substitution σ, we then estimate υ_1 and υ_2 that govern the real and paper profits elasticities. Finally we back-out profit shifting frictions and explore their determinants.

4.3.1 . Elasticity of substitution and implication for profits

The CES monopolistic competition set-up implies a mark up equal to $\frac{\sigma}{\sigma-1}$. We use administrative French firm-level data from the FARE administrative dataset and follow the methodology provided by De Loecker and Warzynski, 2012 to calculate firm-level mark-ups. The results give a median mark-up equal to 17% which corresponds to $\sigma = 6.88$. This is in line with estimates found in

[18] We regress the value of trade in services exported from country k to country n for the service category s at date t on a dummy that is equal to one when a "high-risk" service s is exported by a tax haven k. High-risk services are defined following Torslov, Wier, and Zucman (2022) as insurance and pension services, financial services, charges for the use of intellectual property, telecommunications, computer and information services, and other business services. The methodology to estimate excesses follows the one used to estimate profit shifting in section 4.2. An advantage in the context of service data is that we can include exporting country $\times$ year fixed effects. Therefore, the estimation of excesses is based on the excess exports of high-risk services compared to standard services in tax havens compared to this excess in non-tax-haven countries. We estimate $Service_{knst} = \beta_1 High\text{-}Risk_s \times Haven_k + \mu_{nst} + \mu_{kt} + \mu_{kn} + \mu_s + \epsilon_{knst}$

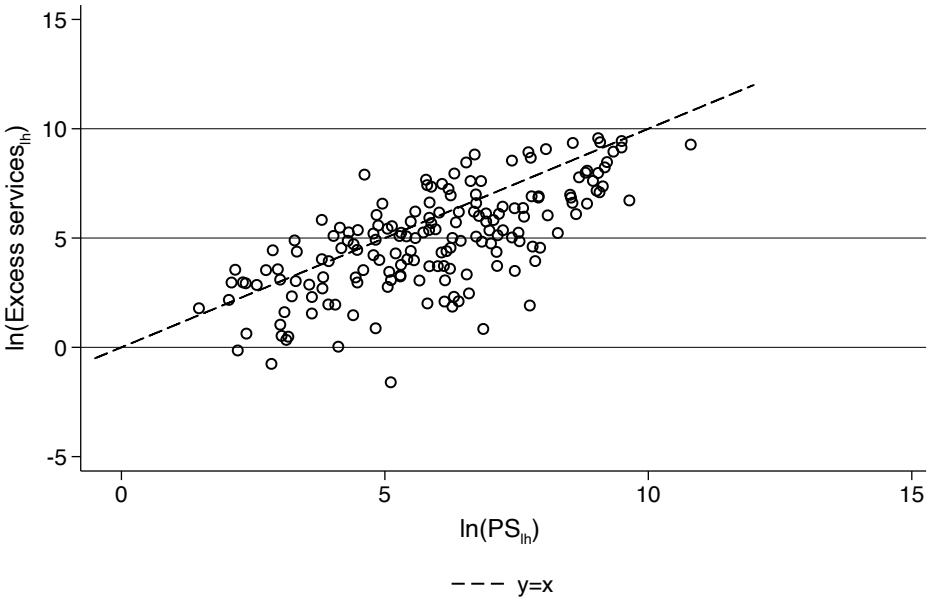

Figure 4.2.3: Comparison between excessive high-risk services and our measure of bilateral profit shifting

Note: This figure compares the estimation of profit shifting between production countries l to tax havens h, as detailed in section 4.2, to the excess of high-risk services exported by tax havens. High-risk services are defined following Torslov, Wier, and Zucman (2022) as insurance and pension services, financial services, charges for the use of intellectual property, telecommunications, computer, and information services and other business services.

the literature, e.g. Tintelnot, 2017.[19]

However, using a single parameter to map sales to profits in all countries is problematic. It does not allow for matching multinational production and profits for all countries and biases the counterfactuals concerning the real impact of tax reforms on production or tax revenues. This is why we have introduced a country-specific wedge ι_l. Recall that $\iota_l = \sigma\Pi_l/\sum_i X_{il}$, with Π_l being the observed profits generated in country l after correcting for profit-shifting. Profits are computed using National Accounts data (see Appendix 4.A for details). Since profits depend on σ/ι_l, these parameters indirectly determine the tax-GDP ratio. In this regard, it is worth noting that the average model-based tax-GDP ratio at the equilibrium is equal to 2.38%, which is similar to what is observed in our data (2.27% based on OECD Corporate tax revenues data).

By using multinational gross output, a large part of ι_l reflects expenditures on intermediate goods. In addition, ι_l can also absorb a gap stemming from fixed costs (or subsidies) that would impact net profits but not sales. We also ignore heterogeneous mark-ups across firms and, therefore, across countries.

4.3.2 . Real and paper-profit elasticities

[19]Moreover, De Loecker, Eeckhout, and Unger, 2020 find a median markup around 20 percent using Compustat data.

Tax elasticities are key for our counterfactual exercises. They determine how changes in the global tax environment affect entry, production, and profit-shifting decisions. A novelty of our approach is to allow for, and calibrate, two tax elasticities: one for real activity (governed by υ_1) and one for profit-shifting (governed by υ_2). It reflects that corporate tax changes generate different responses from real activities and profit shifting. In addition, the model restrictions impose $\upsilon_2 \geq \upsilon_1$, meaning that profit shifting is more elastic to taxes than real production. This approach speaks to the recent empirical corporate taxation literature, which emphasizes the non-linear responses of profits to corporate tax rates (e.g., Dowd, Landefeld, and Moore, 2017, Bratta, Santomartino, and Acciari, 2021, Fuest, Hugger, and Neumeier, 2021, Garcia-Bernardo and Jansky, 2021). These papers, however, do not distinguish between profits generated by production activities and shifted incomes. Rather, the elasticity is estimated using data that pool together tax havens (where a large share of profits are shifted) and high-tax countries. Conditional on real activity, their results suggest a larger impact of corporate tax rates on profits for countries with very low tax rates than for countries with higher tax rates. This finding is consistent with our setting, where the elasticity of profit shifting to taxes is larger than the elasticity of real activity, as shown below.

We now express equations (4.13) and (4.14) that identify the corporate tax elasticities in an estimable way in terms of observed variables with associated coefficients and fixed effects.

Tax base elasticity. The parameter that governs the elasticity of the tax base in country l, υ_1, is obtained by rearranging Equation (4.13) as:

$$\frac{X_{ill}}{\sum_l X_{ill}} = \frac{\tilde{A}_{ill}(1-t_{ll})^{\frac{\upsilon_1}{\sigma-1}-1}}{\sum_l \tilde{A}_{ill}(1-t_{ll})^{\frac{\upsilon_1}{\sigma-1}-1}} \quad \forall(i,l) \tag{4.18}$$

X_{ill} represents sales of firms from i generated and taxed in l. Because $X_{ill} = \frac{X_{ill}}{X_{il}}\frac{X_{il}}{X_i}X_i$, these sales can be recovered using data on PS shares $\frac{X_{ill}}{X_{il}} = 1 - \sum_{l,h,h\neq h}\beta_{ilh}$, MP shares $\frac{X_{il}}{X_i}$, and aggregated MP sales X_i – all of which are observable. We transform Equation (4.18) by taking its logarithm:

$$ln\left(\frac{X_{ill}}{\sum_l X_{ill}}\right) = \delta_0^0\, ln\,(1-t_{ll}) + \delta_1^0\, ln\tilde{A}_{ill} - ln\left(\sum_l \tilde{A}_{ill}(1-t_{ll})^{\frac{\upsilon_1}{\sigma-1}-1}\right) \tag{4.19}$$

where $\delta_0^0 = \frac{\upsilon_1}{\sigma-1} - 1$ is our coefficient of interest. $\tilde{A}_{ill}$ includes bilateral frictions between residence and source countries and the production market's wage level and size. The regression analysis includes total and per capita GDP (in logs) and gravity-related control variables such as distance, contiguity, and indicators for colonial relationships. The headquarter country fixed effect is $FE_i = ln\left(\sum_l \tilde{A}_{ill}(1-t_{ll})^{\frac{\upsilon_1}{\sigma-1}-1}\right)$. We, therefore, use the variation across production countries to identify our coefficients.

Table 4.3.1 reports the estimated coefficients and the corresponding parameter elasticities υ_1 for two values of $\sigma \in \{4; 6.88\}$. We use O.L.S. in column (1). In column (2), we show the validity of the results using the PPML estimator. Both estimations lead to similar positive coefficients for the corporate tax rates and thus similar values for υ_1.

Table 4.3.1: Tax base elasticity : υ_1

	Dependent variable:	
	$ln\left(\frac{X_{ill}}{\sum_i X_{ill}}\right)$	$\frac{X_{ill}}{\sum_i X_{ill}}$
$ln(\tilde{t}_l)$	2.639***	3.047*
	(0.688)	(1.674)
Residence country FE	Yes	Yes
Technology controls	Yes	Yes
Gravity controls	Yes	Yes
Observations	1,256	1,600
Estimator	OLS	PPML
Implied υ_1 (σ = 4)	10.90	12.10
Implied υ_1 (σ = 6.88)	21.40	23.80

Notes: Robust standard errors clustered at the $i \times l$ level in parentheses. Gravity controls include bilateral distance (in logarithm), a contiguity dummy, colonial linkages dummies, common legal origin dummies and common language dummies. Technology controls include GDP and GDP per capita (both in logarithm). *** p<0.01, ** p<0.05, * p<0.1.

Our preferred elasticity is the one presented in column (1) that uses the statutory tax rate as a proxy for corporate tax. We find a parameter $\upsilon_1 = 21.40$ using $\sigma = 6.88$, thereby suggesting that multinational production is relatively mobile across countries or, equivalently, that foreign and domestic production are close substitutes. The tax base elasticity would have been 10.9 assuming $\sigma = 4$. It is somewhat larger than the elasticity of multinational production to variable production costs found in the literature. Head and Mayer, 2019 estimate an elasticity of 7.7 exploiting variation in car tariffs. Assuming the same elasticity of substitution, Wang, 2020 also finds a tax base elasticity of 7.7 using cross-section variation in corporate tax rates on aggregated MP sales. This implies that the impact of multinational firms' production and profit-shifting frictions tend to be downplayed in our quantitative exercises compared to these estimates. In the event where domestic and foreign production are perfect substitutes (large υ_1), multinational production frictions would be mostly irrelevant for our quantitative exercises.

Profit shifting elasticity. We start by taking the logarithm of Equation (4.14):

$$ln\left(\frac{X_{ilh}}{\sum_{l,h,h\neq l} X_{ilh}}\right) = \delta_0^1 ln(1-t_{lh}) + \delta_1^1 ln\tilde{A}_{ilh} - ln\left(\sum_{l,h,h\neq l} \tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}}(1-t_{lh})^{\frac{\upsilon_2}{\sigma-1}-1}\right) \tag{4.20}$$

where $\delta_0^1 = \frac{\upsilon_2}{\sigma-1} - 1$ is our coefficient of interest. t_{lh} is the tax rate applicable in tax haven h to tax-avoiding firms producing in country l. This tax rate is not

observed as tax havens generally offer legal dispositions that allow effective tax rates to strongly differ from the observed statutory tax rate (except for the rare tax havens where the statutory tax rate is 0%). The average effective tax rates are computed as the ratio of tax paid to pre-tax profits using the OECD's Country-by-Country reporting (CbC-R) data.[20] The OECD collects this data as part of the Action 13 of the BEPS Project. It consists of the aggregation of firm-level country-by-country reports for 2016. Firms with over EUR 750 million in turnovers must report their files, including information on taxes paid and profits.[21] An interesting and unique feature of the CbC-R is that the aggregation distinguishes profit-making from loss-making firms. We keep profit-making firms in tax havens to avoid aggregating different types of firms. Unfortunately, the CbC-R data set is available for firms from only 25 reporting countries. There is not enough bilateral data to compute an effective tax rate, which would be specific to each pair between the 40 production countries in our sample and each tax haven. We therefore proxy the effective tax rate t_{lh} by the median effective tax rate observed in each tax haven, t_h. We use alternative proxies by computing the average effective tax rate or the lower quartile. The first quartile is representative of the lowest effective tax rates paid in tax havens. It is therefore likely to represent the effective tax rates of large avoiders. We, however, use the median effective tax rate as our main measure to be more conservative and the alternative rates in robustness exercises.

In Equation 4.20, $\tilde{A}_{ilh}$ comprises information about technologies A_{lh}, bilateral friction between headquarters and production countries γ_{il} and between production countries and the tax havens, α_{lh}. It also includes information on the source country's wage level and market potential. We add a set of headquarter $\times$ production country fixed effects, FE_{il}, which absorb the multinational production costs γ_{il}. These fixed effects are perfectly collinear with source countries' specific factors such as wages and market potential. They also absorb the production technology and ease of tax planning in l. Moreover, the headquarter $\times$ production country specific effects confounds with $FE_i = -ln\left(\sum_{l,h,h\neq l} \tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}}(1-t_{lh})^{\frac{\upsilon_2}{\sigma-1}-1}\right)$. We parametrize the frictions and technological parameters between the production country l and the tax haven h with gravity covariates. Importantly, we also add an index of the tax haven aggressiveness to proxy for the tax avoidance 'technology' of tax havens. It is taken from the TJN's Corporate Tax Haven Index (Jansky, Meinzer, et al., 2020). We construct our index using the information on different regulations and laws in tax havens that inform on the profit-shifting technology. Different loopholes and legislative gaps are reviewed as well as policies regarding transparency, anti-tax avoidance, tax rulings, and treaties. This index is mainly based on the legal features of tax havens, which makes it a good proxy for our understanding of how profits are booked in tax havens. We select the 13 out of 20 most relevant sub-indexes concerning our variable of interest and take their aver-

[20] This data have been used in other studies evaluating tax avoidance by multinational firms (Garcia-Bernardo, Jansky, and Torslov, 2021 at the macro level, Fuest, Hugger, and Neumeier, 2021 or Bratta, Santomartino, and Acciari, 2021 at the micro-level).

[21] The dataset covers, therefore, large firms that are more likely to avoid taxes than smaller firms.

age.[22] Further discussion on data sources and the details of the data treatment are provided in Appendix 4.A.4.

As noted earlier, υ_2 is needed to estimate profit shifting (see section 4.2) while it is also estimated using profit shifting data. To determine its value we follow an iterative procedure.[23]

Table 4.3.2 reports the estimation results of the last iteration. Our baseline specification uses the median effective tax rate. We find a coefficient of 7.8 which implies an elasticity $\upsilon_2 = 52.1$, when assuming $\sigma = 6.88$. The coefficient is precisely estimated and is approximately twice as large as $upsilon_1$, the elasticity of the real activity to taxes.

Table 4.3.2: Profit shifting elasticity : υ_2

	Dependent variable:	
	$ln\left(\frac{X_{ilh}}{\sum_i X_{ilh}}\right)$	$\frac{X_{ilh}}{\sum_i X_{ilh}}$
$ln(\tilde{t}_h)$ (Med.)	7.869***	8.625***
	(0.191)	(1.295)
il FE	Yes	Yes
Gravity controls	Yes	Yes
Observations	6,561	7,091
Estimator	OLS	PPML
Implied υ_2 (σ = 4)	26.60	28.90
Implied υ_2 (σ = 6.88)	52.10	56.60

Notes: Robust standard errors clustered at the il level in parentheses. Gravity controls include bilateral distance (in logarithm), a contiguity dummy, colonial linkages dummies, common legal origin and common language. *** p<0.01, ** p<0.05, * p<0.1

Profit shifting elasticity and the existing literature. How does the profit shifting elasticity derived here compare with estimates in the current literature? The parameter υ_2 governs the elasticity of profit shifting, conditional on shifting profits. It governs the allocation of profits shifted to tax haven h by firms producing in l. Associated with υ_1, that governs the international allocation of the tax base, it informs on how reported profits move with changes in tax rates.

To get a sense of the elasticities of corporate revenues that υ_1 and υ_2 imply, we simulate the effect of a unilateral 5% decrease in the statutory corporate tax rate in the U.S. (see below in section 4.4 for details on the implementation of

[22] We select the following variables: Foreign investment income treatment, Loss utilization, Capital gains taxation, Sectoral exemptions, Tax holidays and Economic zones, Fictional interest deduction, Public company accounts, Tax court secrecy, Interest deduction, Royalties deduction, Service payment deduction, CFC. rules, and Tax treaties.

[23] We solve equations 4.15 to 4.17 by setting up an initial value of υ_2. We estimate to determine a new value of υ_2. We replicate the steps until the same value is obtained in the output of two following iterations.

counterfactual scenarios). We find that the profits reported in the U.S. increase by 1.14% while production increases by 0.31%. Normalized to a 1% change in the tax rate, we obtain an elasticity of profits of 0.22, which can be decomposed between real activity responses (0.06) and profit shifting responses (0.16).

There is no direct comparison available in the literature. Indeed, the profit shifting literature computes *semi-elasticities* of reported profits to taxes using cross-country variations while our exercise highlights a within-country elasticity. This literature shows that keeping production constant, a 1-point decrease in the tax rate corresponds to 1% more reported profits (see the meta-study of Beer, Mooij, and Liu, 2020). At the country level, a few studies have estimated the *elasticity* of reported profits to corporate taxes in the U.S.. Gruber and Rauh (2007) report an elasticity of 0.2. A recent study by Coles, Patel, Seegert, and Smith (2022) finds an elasticity of profits of 0.9 which in decomposed between real responses (0.3) and optimization responses (0.6). This last study uses marginal tax rates and identifies its effects using small firms while the firms covered by Gruber and Rauh (2007) are larger. Due to their methodologies and coverage, in both cases the optimization responses of firms are likely to be different from ours.[24] The elasticity of taxable income implied by our estimates appears close to the one estimated by Gruber and Rauh (2007) and like Coles, Patel, Seegert, and Smith (2022) we find that optimization responses drive the larger part of this elasticity.

4.3.3 . Profit shifting frictions

In this subsection, we back out the profit-shifting frictions consistent with the observed flows of shifted profits by firms in residence i to tax haven h from source country l. We first detail the procedure and then explore the magnitude and determinants of these frictions.

Normalisation. The likelihood that firms shift their profits from l and h is specific to their residence country i. The country of residence may alleviate or dampen bilateral profit-shifting frictions α_{lh} through θ_i. In order to interpret θ_i, we first need to normalize it. We introduce $\bar{\theta}$ so that $\theta_i = \tilde{\theta}_i\bar{\theta}$ where $\bar{\theta}$ is defined such that in the absence of profit-shifting frictions, i.e., when $\tilde{\theta}_i = \alpha_{lh} = 1, \quad \forall i, l, h \in \mathcal{N} \times \mathcal{N} \times \mathcal{H}$ then

$$\sum_{l \neq h} A_{ll} = \bar{\theta} \left(H \sum_{l \neq h} A_{ll}^{\frac{v_2}{v_1}} \right)^{\frac{v_1}{v_2}}$$

or, equivalently

$$\bar{\theta} = \frac{\sum_l A_{ll}}{\left(H \sum_l A_{ll}^{\frac{v_2}{v_1}} \right)^{\frac{v_1}{v_2}}}$$

[24] Coles, Patel, Seegert, and Smith (2022) uses corporate tax bracket thresholds to identify their elasticities. These thresholds generally apply to small firms that are unlikely to shift profits in tax havens. The optimization responses correspond to income shifting between the corporate and the individual tax bases, or to inter-temporal optimization responses.

The normalization of $\bar{\theta}$ implies that everything else being equal, in the absence of frictions between any non-haven country l and any haven $h \in \mathcal{H}$, the probability of shifting and not shifting conditional on producing in a non-haven country are equal.

Profit-shifting frictions and interpretation. Backing-out $\tilde{\theta}_i$ and α_{lh} requires estimates of A_{ll}, γ_{il}, τ_{ln} and the endogenous variables w, Ξ in the initial equilibrium – the one that is consistent with the profit-shifting probabilities $\mathbb{P}_{ilh}$. The procedure is detailed in appendix 4.F.

We now turn to mapping these profit-shifting frictions and countries' tax aggressiveness into a trilateral cost of profit shifting. In the absence of all non-profit-shifting frictions and when endogenous variables are equal across all countries, the probability that firms from i engage in profit shifting over the probability that they do not reads as:

$$\frac{\sum_{l\neq h,h}\mathbb{P}_{ilh}}{\sum_{l\neq h}\mathbb{P}_{ill}} = \frac{\sum_{l\neq h,h} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}} \left(\theta_i \alpha_{lh}\right)^{-\upsilon_2}}{\sum_{l,h,h\neq l} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}} \left(\theta_i \alpha_{lh}\right)^{-\upsilon_2}} \times \frac{\left(\sum_{l,h,h\neq l} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}} \left(\theta_i \alpha_{lh}\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}}}{\sum A_{ll}}$$

Setting $\alpha_{l'h'} = \alpha_{lh}$ and rearranging, the above equation simplifies as

$$\frac{\sum_{l\neq h,h}\mathbb{P}_{ilh}}{\sum_{l\neq h}\mathbb{P}_{ill}} = \left(\frac{\theta_i}{\bar{\theta}}\alpha_{lh}\right)^{-\upsilon_1}$$

This expression shows that θ_i and α_{lh} can be mapped into a marginal cost equivalent $Cost_{ilh} := \tilde{\theta}_i \alpha_{lh}$. It is the marginal cost increment associated with profit shifting from any l to any h by i *would all profit shifting frictions be such that* $\alpha_{l'h'} = \alpha_{lh}$. Note that in contrast with the trade τ_{ln} or multinational production frictions γ_{il}, the interaction of real production and profit-shifting elasticities implies that bilateral profit-shifting flows do not verify the irrelevance of independent alternatives. The cost of shifting profits from l to h depends on the frictions to engage in profit shifting between other $l' - h'$ pairs.

Determinants of profit shifting costs. In Figure 4.3.1, we represent the distribution of average profit shifting costs between l and h. Conditional on observing profit shifting, the median value of profits shifting costs calculated in our sample is 1.23 – the average value of profits shifting costs is 1.24. A profit shifting cost of 1.23 means that shifting from a residence country i to a tax haven h through a production affiliate l generates an increase in the cost of production of 23%, all other things being equal.

The friction can be compared to the variable friction γ_{il}, which represents the costs of separating the location of production from headquarters. Given our sample, we find a median value of γ_{il} on the same sample is 1.40, slightly more than the multinational production costs figure of 1.31 provided by Head and Mayer (2019) for the car industry.

The profit shifting cost has two components: the tax aggressiveness of the residence country $\tilde{\theta}_i$ and the bilateral friction α_{lh}. We decompose them using a simple fixed effects regression. We estimate the following equation:

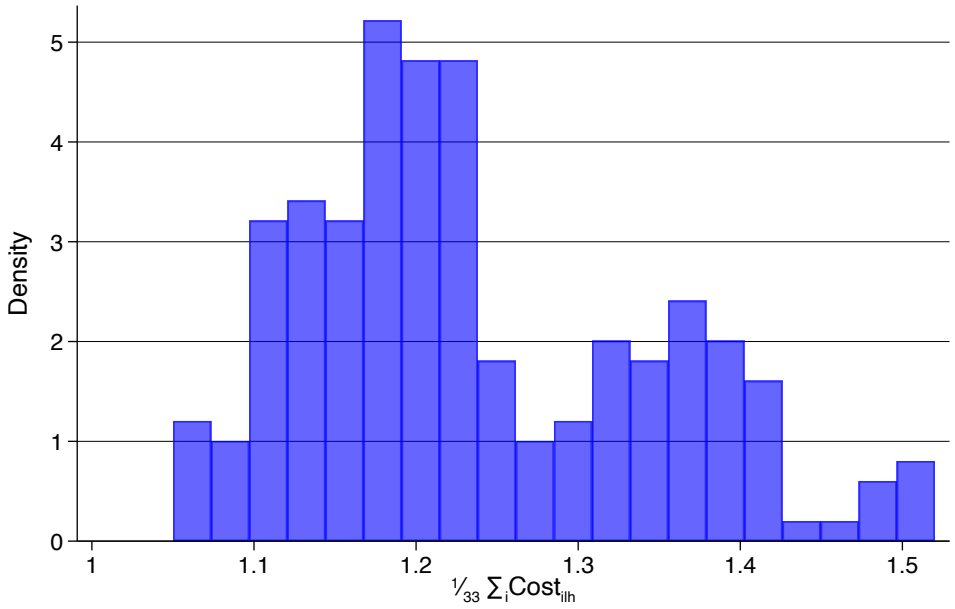

Figure 4.3.1: Average cost of profit shifting ($cost_{ilh}$)

Note: This figure plot the distribution of the profit shifting cost $cost_{ilh}$ averaged over i countries.

$$ln(cost_{ilh}) = ln(\tilde{\theta}_i) + ln(\alpha_{lh}) + \epsilon_{ilh} \tag{4.21}$$

with $ln(Cost_{ilh})$, the logarithm of the profit-shifting costs. The residence country fixed effects correspond to the log of θ_i. The source and tax haven dyadic fixed effects capture the bilateral profit shifting frictions α_{lh}. Note that the different abilities of each residence country to reduce the costs of shifting profits should be interpreted as deviations from the tax aggressiveness of one reference country. We choose the U.S.A. About 26% of the variation in the profit-shifting costs is explained by the (log) bilateral frictions, α_{lh}.

In Figure 4.3.2, we display the cross-country distribution of the log of θ_i. Compared to U.S. MNCs, Turkish firms experience a profit-shifting cost penalty of 41%. Belgian MNCs benefit from a 14% reduction of profit-shifting costs. The differences in tax aggressiveness across residence countries highlighted by figure 4.3.2 show the key role of headquarters in firms' profit-shifting behavior.

We turn to the examination of bilateral profit-shifting frictions. In Table 4.3.3, we show the results of estimations of the log of α_{lh} on gravitational variables, tax rates, and the TJN's Corporate Tax Haven index (CTHI). The CTHI ranks tax havens by combining information on the scope for corporate tax abuse allowed by the jurisdiction's tax and financial systems and the amount of financial activity from MNCs.

Distance and colonial linkages coefficients have the expected signs. Institutional and cultural linkages lower profit-shifting costs while higher bilateral distances increase them. Moving Switzerland, the closest tax haven to France,

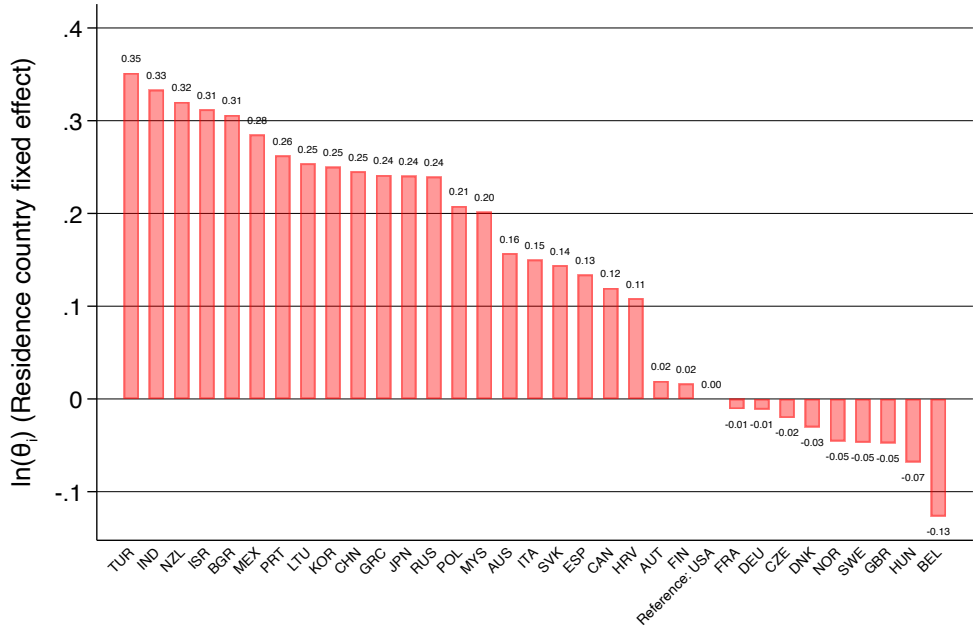

Figure 4.3.2: Distribution of $ln(\theta_i)$

Note: This figure plots the residence country fixed effect obtained by estimating equation 4.21. It theoretically corresponds to $ln(\theta_i)$.

to the same location as Singapore, the most remote tax haven from France, would increase the costs of shifting profits from France to Switzerland by about 17%– based on the distance elasticity in column (1). Interestingly, the distance elasticities vary between 0.01 to 0.013 and are comparable to the bottom estimate of the distance elasticities of trade costs which generally range between 0.01 and 0.07 (Head and Mayer, 2013).

We find a negative correlation between the composite corporate tax haven index, which we can see as a proxy for the country-specific tax avoidance technology, and the bilateral profit-shifting frictions. We find similar results using the information on the extent of transparency or tax loopholes and exemptions introduced by tax havens. Moving the CTHI ladder from Luxembourg (62 points over 100) to OFCs (92 points over 100) would decrease the costs of profit shifting by 0.03% (estimate in column (3)).

The corporate tax rate difference between the source and the tax haven countries negatively correlates with the bilateral profit-shifting costs. However, we find a larger difference in inducing lower costs, all other things equal. This finding has important consequences for minimum taxation. Consider a tax haven with a tax rate of 0% and a non-haven country with a tax rate of 20%. The introduction of a minimum tax of 15% decreases the tax rate differential by 75%. All other things being equal, this would increase profit-shifting costs by 0.9% (estimate in column (3)).

All other things being equal, we find weak evidence that tax haven size and level of development negatively correlate with bilateral profit-shifting frictions. The GDP and per-capita GDP variables become insignificant once we include an

Table 4.3.3: Gravitational determinants of profit-shifting frictions

	(1)	(2)	(3)	(4)	(5)
			$ln(\alpha_{lh})$		
$ln(distance_{lh})$	0.0117***	0.00962***	0.0114***	0.00957***	0.0129***
	(0.00250)	(0.00213)	(0.00206)	(0.00207)	(0.00238)
Ever colony $_{lh}$	-0.00989*	-0.0157***	-0.0173**	-0.0163**	-0.0176***
	(0.00513)	(0.00553)	(0.00654)	(0.00681)	(0.00569)
Common colonizer $_{lh}$	-0.00951**	-0.0178***	-0.0122**	-0.0151***	-0.0116**
	(0.00452)	(0.00440)	(0.00448)	(0.00460)	(0.00452)
Common legal origin $_{lh}$	-0.00343	-0.000954	-0.00559	-0.00671	-0.00154
	(0.00499)	(0.00554)	(0.00537)	(0.00563)	(0.00522)
Contiguity $_{lh}$	-0.00222	-0.00371	0.00133	-0.00239	0.00360
	(0.00702)	(0.00957)	(0.00979)	(0.00970)	(0.00982)
$ln(GDP_h)$		-0.00697***	-0.00423**	-0.00792***	-0.00221
		(0.00110)	(0.00179)	(0.00147)	(0.00241)
$ln(GDPpc_h)$		-0.00191	-0.0108***	-0.00749**	-0.00442
		(0.00212)	(0.00310)	(0.00312)	(0.00335)
$ln(t_l - t_{lh})$			-0.0124**	-0.00553**	-0.0209*
			(0.00584)	(0.00267)	(0.0112)
Corporate tax haven index $_h$			-0.000979***		
			(0.000154)		
Loopholes and exemptions $_h$				-0.000311***	
				(7.87e-05)	
Transparency $_h$					-0.000796***
					(0.000138)
Observations	212	212	212	212	212
R-squared	0.983	0.963	0.966	0.966	0.967
Source Fixed Effects	Yes	Yes	Yes	Yes	Yes
Haven Fixed Effects	Yes	No	No	No	No

Robust standard errors clustered at the l level in parentheses. *** p<0.01, ** p<0.05, * p<0.1

indicator of the level of transparency. This result suggests that less transparent havens, mostly of larger size and a higher level of development, have lower bilateral profit-shifting costs.

4.4 . Counterfactual Results

In this section, we use calibrated parameters from the previous section combined with estimates of bilateral profit shifting and other inputs to investigate counterfactual tax policies (see table 4.4.1 for an overview). Beyond tax revenues, the model allows us to study tax policy changes in each country's GDP level, profit shifting, and welfare. We start by presenting the effects of simple tax policy changes in order to illustrate the model's key mechanisms. We then discuss the principle of minimum taxation and investigate its impact for a fixed and endogenous number of corporations. This distinction allows us to discuss both short and long-run effects from tax policies.

In ongoing work, we also consider alternative criteria for welfare – by introducing a public good to finance and disentangle consumer welfare from production efficiency. We also examine the level of welfare-maximizing minimum tax rates when minimum taxation is implemented multilaterally or unilaterally. We finally study the impact of the implementation of a Destination-Based Cash Flow Tax (Auerbach, Devereux, Keen, and Vella, 2017) as an alternative

tax system that we compare to minimum taxation.

We adopt the exact hat algebra (EHA) methodology popularized by Dekle, Eaton, and Kortum (2007) and Costinot and Rodriguez-Clare (2014) to provide the results of our hypothetical scenarios. This technique consists of writing the new equilibrium in proportional changes to obtain counterfactual predictions. We refer the reader to Appendix 4.G for details on the algorithm.

We focus on the U.S. as an example throughout the discussion for clarity and simplicity. However, the concepts expressed can readily be generalized to all non-haven countries in our sample.

Table 4.4.1: Calibration overview

Variables	**Definition/Source/Methodology/Reference**	**Section**
Endogenous variables		
X_{ln}	Trade. Trade in goods from Comtrade, Trade in services from EBOPS, Own trade from OECD's TiVA.	Appendix 4.A.1
X_{ill}	Multinational Production Sales. Methodology from Ramondo, Rodriguez-Clare, and Tintelnot (2015). Data: OECD's AMNE, Eurostat's FATS, BEA's USDIA, Thomson Reuters' Merger and Acquisition.	Appendix 4.A.2
X_{ilh}	Profit shifting. Estimated using accounting models' equations and using data from OECD and Eurostat bilateral balance of payments, IMF Balance of payments data, ECFIN's Financial Flows Dataset.	Section 4.2, Appendix 4.A.3
Parameters		
t_l	Statutory tax rate. KPMG Statutory Corporate tax rate tables.	Appendix 4.A.4
t_{lh}	Tax havens' tax rate. OECD's Country-by-Country reporting.	Appendix 4.A.4
Π_l	Profits recorded in l. National Accounts, methodology from Torslov, Wier, and Zucman (2022).	Appendix 4.A.5
ι_l	Profits-sales gap. Computed using: $\iota_l = \sigma \frac{\Pi_l}{\sum_i X_{ill}}$.	Section 4.3.1
σ	Elasticity of substitution. Set to 6.88 following a 17% mark-up in French firm level data (De Loecker, Eeckhout, and Unger, 2020 methodology).	Section 4.3.1
υ_1	Elasticity of the tax base. Estimated following equation 4.19. Set to 21.4	Section 4.3.2
υ_2	Elasticity of profit shifting. Estimated following equation 4.20. Set to 52.1	Section 4.3.2
Frictions		
γ_{il}	Multinational production frictions. Backed-out from X_{ill} shares.	Appendix 4.F
τ_{ln}	Trade frictions. Backed-out from X_{ln} shares.	Appendix 4.F
α_{lh}	Profit shifting frictions. Backed-out from X_{ilh}.	Section 4.3.3, Appendix 4.F

4.4.1 . Preliminary counterfactuals: Model mechanisms

Unilateral tax reforms. *What are the effects of a 5% unilateral reduction of U.S. statutory tax rate on tax revenues, profit shifting, production, and consumer welfare*? In our model, the cross-country reallocation of production affects tax revenues. The hypothetical scenario of reducing the U.S. statutory tax rate would directly impact U.S. GDP, and the amounts of profits shifted to tax havens. Reducing production costs would increase the U.S. tax base by raising its attractiveness. Additionally, profit shifting decreases because it would not be profitable for some firms to continue to shift profits to tax havens at a lower U.S. tax rate. In Figure 4.D.1 in the appendix, we illustrate the effects of an unilateral reduction of the U.S. statutory tax rate by 5%. Tax revenues decrease by 3.91%. The static effect of the unilateral tax reduction on tax revenues is compensated by the reduction in profit-shifting activities (-9.95%) and by a modest increase in U.S. GDP (+0.31%). Overall, welfare measured by real expenditures increases by 0.33%.

The impact of unilateral tax reform on U.S. consumers' welfare depends on the effects of the reform on the components of real expenditure U_n (aggregate expenditure deflated by the price index). From equation (4.9), U.S. aggregate expenditures result from corporate income tax revenues and labor income. All else being equal, a 5% unilateral reduction of the U.S. statutory tax rate would reduce corporate income tax revenues and thus consumers' income because of lesser lump-sum transfers. The unilateral reduction of the U.S. statutory tax rate would increase U.S. attractiveness, production, and labor demand. Workers would therefore enjoy higher wages from this channel. A reduction in the price index drives a slight positive effect on real trade imbalances. In Figure 4.D.2, we illustrate the effects of a 5% unilateral reduction of U.S. statutory tax rate on consumer welfare. A unilateral decrease of the tax rate by 5% generates an increase in welfare by 0.33%. This positive effect stems from a large and positive response of wages (+0.39%) that is not offset by the effect of the unilateral reform on the redistribution of tax revenues (-0.08%). The impact of trade imbalances on consumer welfare remains negligible (+0.03%).

Effective anti-abuse laws. *What are the effects of implementing multilateral effective anti-abuse laws in non-haven countries*? Implementing multilateral effective anti-abuse laws would eliminate profit shifting to tax havens. The hypothetical scenario shows how profit shifting might benefit non-haven countries. For the sake of clarity, we consider that this implementation is costless. Figure 4.D.3 shows the effects on the U.S. economy of the multilateral implementation of effective anti-abuse laws. The policy increases the U.S. effective tax rate, increasing U.S. tax revenues (+7.64%) at the expense of production (-0.61%). The net effect on consumer welfare depends on whether the potential loss of production due to the reduction of the level of attractiveness is more than compensated by the increase in tax revenues due to the elimination of profit shifting. We find a net welfare loss of 0.42%. All else equal, firms that would have found it beneficial to locate their production in the U.S. and shift their profits to a tax haven may relocate their activities elsewhere. In Figure 4.D.4, we break down the increase in U.S. tax revenues into the part stemming

from the reduction in profit shifting and the part coming from the reallocation of production. As shown, the reform would lead to higher tax revenues (+8.31%) if production would not reallocate (-0.66%). This finding, which can be generalized to all non-haven countries, illustrates that high-tax countries benefit from tax havens to attract foreign production.[25] Lax enforcement of anti-abuse laws might therefore be used by non-haven countries in order to attract mobile firms (for instance Altshuler and Grubert, 2005, Hong and Smart, 2010 or Dharmapala, 2020).

Closing a tax haven. *What are the tax revenues and real effects of closing a tax haven*? Equation 4.14 shows that bilateral profit shifting depends on the tax haven's characteristics and those of other tax havens. The hypothetical scenario of closing a tax haven would have important consequences on reallocating profits, production, and tax revenues. We choose Singapore and continue to illustrate the effects on the U.S.

First, some firms would not find it advantageous to shift profits to other tax havens because of larger bilateral profit shifting frictions α_{lh}. These firms stop shifting profits to tax havens generating more tax revenues in source countries. We illustrate these effects by shutting down profit shifting to Singapore and examining the changes in U.S. tax revenues, GDP, profit shifting, and consumer welfare. Appendix figure 4.D.5 illustrates the results. We find a positive effect on tax revenues (+0.21%) mostly due to profit-shifting reduction (-3.30%). The U.S. loses GDP (-0.07%) because its effective tax rate increases relatively and slightly more than in other countries. Eliminating the possibility of shifting profit in Singapore would lead some firms to leave the U.S. – leading to a net welfare loss. The negative effect on welfare is relatively small (-0.02%).[26] These findings are consistent with Suárez Serrato, 2018 who shows that eliminating a tax haven generates real effects beyond those on tax revenues.

Second, a share of profits would be reallocated to other tax havens following bilateral profit shifting frictions α_{lh}: more "aggressive" and closer tax havens would gain more. We consider the hypothetical scenario of closing Singapore and show in appendix Figure 4.D.6 the changes in tax revenues across tax havens. Our findings suggest a substitution of profit shifting across tax-havens. Shutting down Singapore induces a larger reallocation of profits to Hong Kong than Luxembourg or Ireland. This result underlines the importance of bilateral profit shifting frictions and gravitational forces in explaining profit shifting to tax havens.

Third, closing a tax haven would increase the effective tax rate in all source countries that previously shifted profits. It would therefore affect their attractiveness. Given the gravitational structure of profit shifting, the impact is smaller for source countries that shifted few profits to the closed tax haven. Following this increase in the effective tax rate, some firms may relocate their production and profit shifting activities. In appendix Figure 4.D.7, we show tax revenues changes across non tax haven countries after closing Singapore.

[25] Source countries that are relatively more attractive in production because of easier access to tax havens are also likely to lose more once the reform is implemented.

[26] For comparison, 5% statutory tax rate increase in the U.S. decreases welfare by 0.34%.

Sensitivity and extensions. In appendix 4.D, we propose two different scenarios to analyze the sensitivity of our results. In each scenario, we modify one or several key calibrated parameters: υ_1 and υ_2. In the first scenario, the profit shifting elasticity (υ_2) is equal to the tax base elasticity (υ_1). This scenario reflects a hypothetical case in which profit shifting is less sensible to changes in corporate taxes. In the second scenario, we keep υ_2 constant, and we consider a lower value of υ_1, that we set to 15. Under this scenario, the tax base elasticity would be lower and firms' location more responsive to their costs. Intuitively, the lower υ_1, the higher the real effects from tax reforms. These scenarios are implemented when simulating an unilateral 5% decrease in the corporate tax rate in the U.S. and when ending profit shifting at the world level.

Results for the unilateral decrease on the statutory tax rate are displayed in figure 4.D.8. We observe slightly less tax revenues in both alternative scenarios, driven by a lower decrease in profit shifting than in the baseline scenario. When υ_2 is lowered, profit shifting is less sensible to taxes, which explains this result. In the second scenario, decreasing υ_1 while keeping υ_2 constant means that production is less mobile internationally. Therefore the decrease in shifted profits relative to the tax base is lower for a lower υ_1. Production and welfare are almost unaffected. This is expected given the small shock we are imposing on the equilibrium.

We repeat the same sensitivity exercise in the case where the profit shifting is multilaterally stopped (figures 4.D.9 to 4.D.11). In the first alternative scenario, where υ_1 is fixed and υ_2 decreased, there is no effect on any outcome. This is expected since when profit shifting stops, there is no room for υ_2. When the elasticity of real profits in lowered to 15, keeping the elasticity of profit shifting constant, we observe systematically (slightly) lower tax revenues from ending profit shifting than in the baseline parametrization. This is explained by the effect of the reform on production. Production appears more negatively affected when υ_1 is decreased. Indeed, a lower υ_1 means that the costs faced by MNEs becomes more important in their decision. Countries which relied on profit shifting to attract MNE activity are now hardly affected. This is for instance the case of Belgium, France or the U.S. This effect also translates in more negative changes in welfare.

4.4.2 . Minimum taxation

The general principle of minimum taxation implies that no foreign affiliate can escape a minimum rate of taxation t^{min} by declaring its operations in a low-tax jurisdiction. Minimum taxation gives the countries which own the taxing rights the ability to tax foreign profits of corporations that would have been taxed at a lower rate than the minimum tax rate. Addressing which jurisdictions should have the taxing rights is delicate since, in effect, value creation stems from the joint location of headquarters, the location of research and development, and the place of production of physical output (see Devereux, Auerbach, Keen, Oosterhuis, Schön, and Vella, 2021). Therefore, the taxing rights could be either allocated to the source or to the residence

countries.[27] Moreover, minimum taxation can be implemented unilaterally or multilaterally. Notice that the implementation of the minimum rate could also include a substance-based carve-out.[28] In this case, minimum taxation should not strongly affect tax competition for real activities but tackle directly profit-shifting incentives. It is, however, conceivable to apply minimum taxation broadly on any activities, meaning that all firms will be taxed at least at the minimum rate on all their foreign profits. In this case, it impacts tax competition directly by moving the tax rate floor from zero to the chosen minimum tax rate.

A common objection to introducing a minimum effective tax rate is the possibility of corporations moving their headquarters to a country that does not apply an effective minimum tax rate.[29] Our model allows dissecting the effect of minimum taxation in the short-run (assuming a fixed number of firms) and in the long-run (once the number of firms adjusts endogenously). In both cases, multinational firms may relocate their production across countries. In the longer run, headquarters may also enter or exit markets. The short-run scenarios correspond to situations where headquarters cannot exit or enter following a tax-policy change. In particular, the short-run scenario does not allow for corporate inversions - the relocation of HQ to low-tax jurisdictions.

Model's implementation. We operationalize the implementation of the reform by applying minimum taxation either to shifted profits only, $\sum_{l,h,l\neq h} PS_{ilh}$ (a version with carve-outs), or to total profits $\sum_{l,h} PS_{ilh}$ (a version without carve-outs), as long as they are taxed under the minimum tax rate. Here, we implement a polar version where the real activity is fully deductible for the minimum taxation (full substance-based carve-out). The simulations deliver

[27]The recent reform of international taxation allocates the residual taxing right on foreign profits to residence countries (see OECD, 2021). Taxing rights to residence countries rather than source countries is still hotly debated. This is discussed for instance in Englisch and Becker (2019).

[28]The initial proposal of the Biden Administration in 2020 specified that the profits of U.S. corporations made even by real activity in low-tax countries would no longer be deductible from their U.S. tax base (as it is the case with the QBAI exemption). The idea was, among other things, to counteract the decline in tax revenues following the implementation of the "GILTI" (Global Intangible Low-taxed Income) taxation system, which provides an exemption for income generated by tangible assets abroad (labeled "QBAI" for Qualified Business Asset Investment). Whereas this exemption was intended not to penalize productive investment, the U.S. administration notes that it has encouraged U.S. corporations to invest more abroad to reduce their tax base via GILTI. This is a reminder that tangible investment is indeed affected by the tax policy.

[29]This issue has been a concern of the U.S. administration for many years because of its tax regime. Effective tools such as "*BEAT*", recently replaced by "*SHIELD*", have therefore been put in place, limiting the legal possibilities of this type of arrangement. The BEAT (Base Erosion Anti-Abuse Tax) clause is an anti-abuse clause introduced to stem the erosion of the tax base due to so-called "erosive" payments made to a group's foreign entities. The SHIELD (Stopping Harmful Inversions and Ending Low-tax Developments) clause, proposed by the Biden Administration, concerns payments leaving the U.S. to countries where the effective rate is less than the U.S. effective rate. It provides for the elimination of deductions on such payments. As noted by Fuest, Parenti, and Toubal (2019), the implementation of minimum taxation relies on two legal instruments, the income inclusion rule (IIR) and the tax on the base erosion payment. These two rules make it possible to reduce the occurrence of inversion significantly.

lower bounds of the impacts.

The profit shifting response varies according to tax rate differentials between the source and the tax haven countries. We expect larger responses of profit shifting when the tax differential is small. It has implications for implementing the minimum tax rate as a higher rate would reduce profit shifting more than proportionally.

The calibration of υ_2 rests on the assumption that the share of profits shifted to tax havens is a constant elasticity function of the corporate tax rate. While this assumption is reasonable for small changes in corporate tax rates, a minimum taxation reform could generate large variations in effective tax rates and tax rate differentials. We refine our parametrization of the profit-shifting elasticity and allow for an additional variable profit-shifting elasticity. We augment our profit shifting friction α_{lh} with $(t_l - t_{lh})^k$ where k is a shape parameter. The partial elasticity of profit shifting then becomes $\left(\frac{\upsilon_2}{\sigma-1} - 1\right) + \frac{k\upsilon_2}{\upsilon_1}\frac{(1-t_{lh})}{(t_l-t_{lh})}$. We recover the shape parameter k from the data.This alternative calibration yields a profit shifting elasticity $\upsilon_2 = 43.6$ (estimated parameter of 6.41 with a standard error of 0.23) and $k = 0.23$ (estimated parameter of 0.23 with a standard error of 0.01).

Figure 4.4.1 below visualizes the implied elasticities of profit shifting when the elasticity of profit shifting to corporate tax rate differentials is constant and when it is allowed to vary with tax rate differentials. The figure shows that the constant elasticity is above the non-linear elasticity for large tax differentials. It is largely below when the tax differential gets closer to zero.

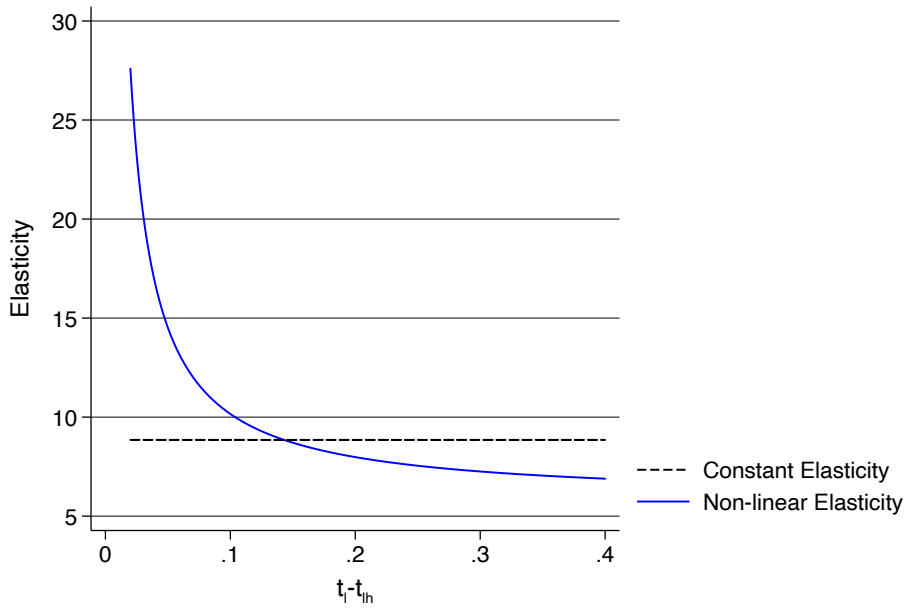

Figure 4.4.1: Implied elasticities of profit shifting at equilibrium

This result has implications for the implementation of the minimum tax rate. A higher rate would reduce profit shifting more than proportionally. We observe large elasticities for tax differentials that are smaller than 10%. This result suggests larger responses of profit shifting when the tax differential is

small. We implement this non-linear specification of the profit-shifting elasticity throughout this section.

Results. The effects of minimum taxation depend on whether the reform is implemented unilaterally or globally. They also rest on which source or residence country has the taxing rights. We assume a full substance-based carve-out and variable-elasticity υ_2. We summarize the results in Table 4.4.2 which distinguishes two panels. In panel A, we present the results of short-run scenarios where the number of firms (and therefore Ω_n) is fixed. Minimum taxation induces a cross-country reallocation of production. In panel B, we present the results of long-run scenarios when we allow the model to endogenously adjust the number of firms. These latter scenarios consider entry and exit in addition to real reallocation effects.

Table 4.4.2: Impact of minimum taxation for the U.S. (Minimum taxation rate: 15%)

Minimum Taxation	Tax revenues	Percent change in ... Profit Shifting	Production	Consumer Welfare
		A. Short Run Effects		
Unilateral				
– Residence	4.18	-28.37	0.05	0.04
– Source	4.45	-38.68	-0.01	-0.03
Multilateral				
– Residence	4.33	-29.37	0.09	0.13
– Source	3.98	-29.37	0.09	0.07
		B. Long Run Effects		
Unilateral				
– Residence	3.85	-27.77	-0.18	-0.17
– Source	4.31	-38.60	-0.14	-0.12
Multilateral				
– Residence	3.95	-28.94	-0.19	-0.12
– Source	3.64	-28.95	-0.20	-0.13
– Tax havens' adjustment	2.18	-28.95	-0.22	-0.16

The U.S. implements *unilaterally residence-based minimum taxation.* The reform raises the effective tax rate of U.S. firms which increases corporate tax revenues in the U.S. (+4.18%). The increase in tax revenues is due to two effects. The "profit shifting" effect is an increase in the U.S. tax base because of the reduction of profit-shifting activities. Each dollar of profit not shifted anymore generates t_l additional dollars of tax revenues. Profit shifting decreases

by -28.37%. The “minimum taxation effect" corresponds to a gain in tax revenues on the activities of U.S. multinationals, which continue to shift profits to tax havens. The U.S. (their residence country) can now tax them at a rate that equals the difference between the minimum rate and their effective tax rate. Each dollar of profit taxed at the minimum rate adds $t^{min} - t_{ilh}$ dollar of tax revenues. Note that the marginal gains of tax revenues of the “profit shifting effect" are larger than those of the “minimum taxation effect." The effect on production is ambiguous. U.S. foreign affiliates which do not find it profitable to shift taxes from their foreign location after the introduction of minimum taxation might reallocate production in the U.S. This reallocation has a positive effect on production. The effective tax rate of firms increases leading to a potential drop in production. Overall, we find a positive effect on production (+0.05%). The demand for labor increases, leading to larger workers' wages. We find a positive welfare effect (+0.04%).

The results of a scenario where the U.S. implements a *unilateral source-based minimum tax* are different. Minimum taxation does not apply to the profits of U.S. MNEs that produce in foreign countries. Compared to the previous scenario, the U.S. now applies minimum taxation to the profits from firms producing in the U.S. These firms might continue to shift profits and be taxed at the minimum rate or stop their avoidance activities and be taxed at the U.S. statutory tax rate. Moreover, foreign firms might relocate their production to foreign countries. This scenario unambiguously increases the effective tax rate of firms shifting profits out of the U.S. by decreasing their profit-shifting incentives. Overall, the impact on production is negative (-0.01%). Despite the tax revenues increase, the overall welfare effect is negative (-0.03%).

The multilateral implementation of minimum taxation reduces the dispersion of corporate tax rates and increases corporate taxes everywhere. Therefore, the corporate-tax determinants of location are less binding, and the location of firm production increasingly reflects countries' fundamentals, e.g., source countries' technology A_{ll}. The distribution of corporate tax rates across countries is the same in both residence and source scenarios. The effects on profit shifting and production are therefore the same. The allocation of taxing rights is, however, different. Minimum taxation reduces firms' incentives to choose a source country only because it offers tax advantages. Therefore, its implementation generates efficiency gains. This effect should be particularly important in the short-run scenario because firms cannot exit the residence country – as they might in the long run. The multilateral residence-based implementation of minimum taxation generates more revenues than the source-based implementation because foreign-owned firms might reallocate their production to other countries. Welfare effects are smaller in the source-based scenario because labor demand decreases more. Notice that the effects of minimum taxation might differ across countries because of different non-tax frictions. For instance, in the multilateral implementation of minimum taxation, production in Bulgaria, Greece, Turkey, or Portugal decreases compared to the U.S., Germany or Denmark where production increases.

Compared to the short-run cases, we now allow endogenous entry and exit. Corporate taxes might affect firms' location across residence country and can

also change the number of varieties. Panel B of Table 4.4.2 presents the results. Compared to the short-run results, we add a case in which tax havens adjust their corporate tax rates to the minimum tax rate in the long run.

Implementing the long-run scenario generates similar effects on tax revenues and profit shifting than in the short-run scenarios. Tax revenues are lower due to more firms exiting the market following the increase in effective tax rates. As previously mentioned, the reforms reduce profit shifting. Notice that the unilateral source-based scenario raises 8% more revenues than the unilateral residence-based scenario. Profit shifting by the U.S. and foreign multinationals in the U.S. reduces by 36.11%, almost 30% more than in the previous scenario. The source-based scenario applies minimum taxation to all firms producing in the U.S., while the residence-based scenario only applies to U.S.-headquartered firms producing in the U.S. and does not affect their amounts of profit-shifting. In long-run scenarios, implementing a minimum tax induces not only the reallocation of production across countries but also changes the likelihood of entry and exit of corporations whose presence is sensitive to the tax environment. The loss of production decreases the demand for labor, leading to a fall in workers' wages and firms' profits. The decrease in product variety magnifies the negative impact of the reform on profits in the short-run, contribution to reducing welfare.

The quantification of the implementation of minimum taxation also has to consider the tax havens' incentive to adjust their corporate tax rates to the minimum tax rate (Johannesen, 2022). Under residence-based minimum taxation, the residence country taxes under-taxed profits of tax haven affiliates so that their effective tax rates reach the minimum. If tax havens maintain their corporate tax rate t_{lh}, the headquarter country applies a tax rate equal to the difference $t^{min} - t_{lh}$. This mechanism might incentivize tax havens to set their tax rate at the minimum tax rate: $t_{lh} = t^{min}$. As a first-order effect, compared to the situation where tax havens do not change their rates, such adjustment would only affect the distribution of tax revenues without affecting the effective tax rate of firms. In both cases, firms make decisions based on the minimum tax rate and the corporate tax rates of tax havens. Consequently, when tax havens adjust, no minimum tax is levied, and it does not matter if taxing rights are allocated to source or residence countries. Because no minimum tax is levied, the "minimum taxation effect" disappears reducing revenue gains in non-haven countries compared to the scenario where tax havens do not adjust.

4.5 . Conclusion

We develop a quantitative general equilibrium model of multinational production to analyze reforms of international corporate taxation. In addition to bilateral trade and investment frictions, our model incorporates profit-shifting frictions. These frictions determine the intensity of profit shifting, shaping thereby the impact of international taxation reforms across countries. We show that profit-shifting frictions are sizeable: their magnitude is comparable to other frictions that determine the geography of multinational production.

We provide a new, model-consistent methodology to calibrate profit-shifting between source and tax haven country pairs. We highlight the role of gravitational forces in determining profit shifting from residence and source countries to tax havens. For instance, we shed light on the importance of European tax havens for the U.S. and European source countries, and Singapore and Hong Kong for China and Japan. Examining profit-shifting, we show the predominance of some residence countries – such as the U.S., France, Germany, and the U.K. Firms from these countries benefit from a cost advantage when it comes to shifting their profits to offshore havens.

Our approach allows to disentangle real from profit-shifting activities separately. Profit shifting estimates depend on the interaction between elasticties that govern the mobility of multinational production and paper profits respectively. These elasticities are also key determinants of how changes in the tax environment affect entry, production, and profit-shifting decisions. A higher elasticity of paper profits relative to real profits implies that source countries with more production attract disproportionately more tax avoiders.

We simulate various tax reforms aimed at curbing the tax-dodging practices of multinationals and their impact on a range of outcomes, including tax revenues, profit-shifting, production, and consumer welfare. We estimate the impact of minimum taxation, the Pillar II of the tax reform promoted by the OECD (OECD, 2020b). Our approach takes into account two mechanisms that have been overlooked so far by the empirical literature estimating the effects of minimum taxation. First, firms react to minimum taxation by adapting their profit shifting behavior. After the implementation of the reform, profit shifting decreases, which generates additional tax revenues. Second, firms react to minimum taxation by reallocating their activity across residence and source countries. We show that these channels are quantitatively relevant to assess the macroeconomic impact of international tax reforms. Minimum corporate taxation affects a country's efficiency by reshaping the geography of multinational production and changing the importance of real versus tax-related considerations in firms' location choices.

The effect of minimum taxation on consumer's welfare depends mostly on which from the tax revenues or labor income dominate for a given minimum tax rate. In ongoing work, we simulate the optimal level of minimum taxation. We also analyze alternative reforms such as the Destination-Based Cash Flow Taxation (see Auerbach, Devereux, Keen, and Vella, 2017). Under a DBCFT regime, corporate income taxes would be paid in the place of final consumption. This is in contrast with the current international system that aims at taxing profits where corporate activity generates value. A consequence of the destination-based tax system is that exports are not taxed by the country of production, while imports are. This proposition has the advantage of curbing profit shifting incentives when implemented multilaterally. DBCFT can be implemented in our current setting through a broad-base VAT combined with a labor subsidy. Our model allows to simulate the quantitative impact of such a reform taking into account its effect on real activity and profit shifting. Future work will compare the efficiency and welfare gains of DBCFT to those of minimum taxation.

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Appendix

4.A . Data

4.A.1 . Trade

Our trade data covers both trade in goods and trade in services. Trade in goods comes from the UN Comtrade database. Trade in services comes from the EBOPS database. Own trade is constructed using OECD's TiVA database as a difference between the total production of a country and its total exports.

Production data is missing for "Offshore Financial Centers", our composite tax haven. Consequently we simply impute it by regressing production on GDP (GDP is observed for all countries). The R^2 of the regression is equal to 0.98, confirming the precision of the imputation.

4.A.2 . Multinational Production Sales

Multinational production sales (MP sales) correspond to the sales made in the production country l by firms headquartered in country i and reported in l (country l may identical to country i). It corresponds to X_{ill}. We build a 40×40 matrix of MP sales that are averaged over the period between 2010 and 2014. We follow recent methodologies and sources used to create similar databases (Ramondo, Rodriguez-Clare, and Tintelnot, 2015; Alviarez, 2019).

Our dataset is constructed using various sources of Foreign Affiliate Trade Statistics (FATS) including Eurostat FATS (inward and outward), OECD AMNE (inward and outward) statistics and the BEA USDIA statistics on majority-owned U.S. foreign affiliates as well as information on Merger and Acquisition (M&A) using the Thomson Reuters dataset. The FATS datasets provide information at the country level on the affiliates sales of multinational firms by nationality of the ultimate controlling owner. We use *Turnover* as the variable to construct our MP sales matrix.

These different datasets may overlap. When the information on bilateral multinational production is available in different datasets, we choose the highest value. When all MP sales are recorded as zero or missing, we rely on the number of M&A during the period 2001-2014 to differentiate between true zeros and missing values. We follow Ramondo, Rodriguez-Clare, and Tintelnot, 2015 by assigning value of zero to the cell when we observe zero or missing MP sales and zero M&A transactions. We impute the observations when we observe a strictly positive number of M&A and no MP data. As in Ramondo, Rodriguez-Clare, and Tintelnot, 2015, our main extrapolation is based on the conditional correlation between MP sales and mergers and acquisitions. As argued by Ramondo, Rodriguez-Clare, and Tintelnot, 2015 there is a "tight correlation between the number of cross-M&A deals and [...] affiliate sales" (Data documentation of Ramondo et al., 2015, p.4). Following their strategy, we run the following regression:

$$ln(MP_{ij}) = \beta ln(\#M\&A) + \mu_i + \mu_j + \epsilon_{ij} \tag{4.22}$$

We estimate $\beta = 0.508$ (standard error of 0.0710, $R^2 = 0.75$). Out of 1560, 178 values are extrapolated using this procedure and 148 are true zeros. We follow the same procedure to interpolate the missing values for the number of employees in country l by firms headquartered in country i.

In Figure 4.A.1, we compare our MP sales matrix with the data from Ramondo, Rodriguez-Clare, and Tintelnot, 2015, Alviarez, 2019, from the Country-by-country reports (CbCR) data released by the OECD in 2020 for the year 2016 and from the Analytical AMNE dataset developped by the OECD (Cadestin et al., 2018). The Figure visualizes a large correlation between MP sales found in different datasets. We show, moreover, that the average MP sales for the period 2010-2014 appear, as expected, larger than the average MP sales between 1996 and 2001 (top-left panel) and than the average MP sales between 2003 and 2012 (top-right panel). They appear to be lower than the MP sales computed from revenue data from the CbCR of 2016 (bottom-left panel). In this later case the correlation is somewhat lower than with previous dataset. This may be due to the different variable definitions and threshold of the CbCR data.[30] Our MP sales appear lower than those from analytical AMNE dataset for the same period as ours. This difference may come from different sources: different industry coverages, different imputation procedures.[31]

We then compute intra-national MP sales. It corresponds to the domestic sales made by domestic firms. We use a key accounting equation, that is that total production in a country must equal total exports (included intra-national exports). Intra-national MP sales correspond to the part of trade, including intra-national trade, that is not explained by the MP sales made by foreign countries. Therefore, we obtain intra-national MP sales made by country l in country l by summing the exports of country l and its intra-national trade and subtracting the MP sales made in l by other countries i, with $i \neq l$.

4.A.3 . Tax rates

Statutory tax rates The calibration of the model requires data on statutory corporate tax rates. We use the KPMG Corporate Tax Rate Table.[32]

4.A.4 . FDI Income

We collect informaton on bilateral FDI incomes from 2010 to 2014 using bilateral balance of payments data from Eurostat and the OECD. As we show later on, we impute values of FDI incomes for countries that are poorly covered by the Eurostat and the OECD datasets. FDI income has three components: reinvested earnings, dividends and interest payments. As noted by Wright and Zucman, 2018, interest payments differ from the two other income components as in a tax avoidance scheme they would be paid from the parent company to the foreign affiliates in the tax haven. Therefore, we focus on FDI

[30] In a disclaimer released with the data, the OECD describes the limitations of the 2020 release of CbCR: https://www.oecd.org/tax/tax-policy/anonymised-and-aggregated-cbcr-statistics-disclaimer.pdf.

[31] In particular, the Analytical AMNE dataset is constructed at the industry level, with a large share of values being imputed from a gravity-like equation.

[32] https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/corporate-tax-rates-table.html

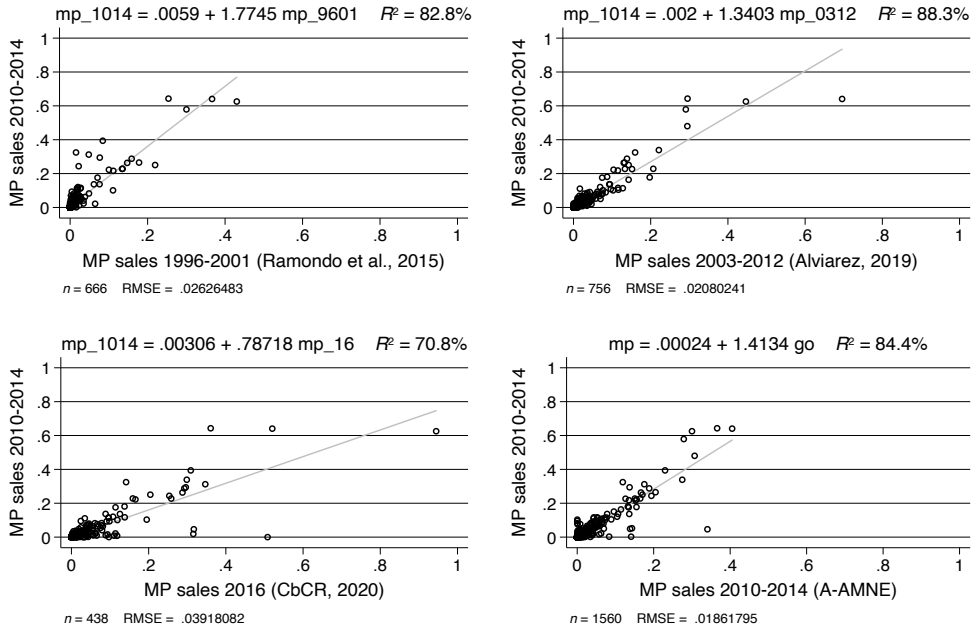


Figure 4.A.1: Comparison of MP sales with other datasets.

Note: This figure compares the MP sales used in this paper with other measures in the literature: Ramondo, Rodriguez-Clare, and Tintelnot (2015) (top-left corner), Alviarez (2019) (top-right corner), OECD's Country-by-Country reporting (bottom-left corner) and OECD's Analytical AMNE, Cadestin, Backer, Desnoyers-James, Miroudot, Rigo, and Ye (2018) (bottom-right corner).

income coming from reinvested earnings and dividends.

We assume that tax havens do not shift profit.[33] The information is averaged to get a single cross-section. The dataset includes 33 investing (non-haven) countries and 68 destination countries – 33 non-haven countries, Hong-Kong, Ireland, Luxembourg, Netherlands, Singapore, Switzerland and 29 countries that are latter aggregated to form the OFC a composite tax haven.

The information from Eurostat and OECD does not cover the full sample. For small countries, usually tax havens, we develop a two-step methodology to impute the data. First, we use the unilateral balance of payment from the IMF, which informs on inward FDI income, inward FDI stock, outward FDI income and outward FDI stock. This datasets help us to compute the unilateral rates of return of inward and outward investments. Second, we apply the unilateral rates of returns of bilateral FDI stock data from the *Financial Flows Dataset* produced by the ECFIN and JRC (see Nardo, Ndacyayisenga, Pagano, and Zeugner, 2017).[34] We use the outward rate of return only in the case of missing information on the inward rate. This strategy allows us to recover 31% of our estimation sample. The correlation between imputed bilateral rates of return and observed rates of return in our dataset is 0.79.

[33]This further allows us to reduce any noise created by cross-border investment positions between tax havens

[34]https://finflows.jrc.ec.europa.eu/.

Finally, it happens for a very few cases that we have information on total income but no information on FDI income excluding debt instruments. In this case, we apply a conservative imputation by assuming that the value of FDI income excluding debts instrument is equal to 75% of the total flow.

Tax havens tax rates An essential parameter of the model is the tax rate available to tax-avoiding firms in tax havens, t_{lh}. This parameter is not observed as tax havens generally offer legal dispositions that allow the effective tax rate of a firm to differ strongly from the observed statutory tax rate (except for the rare tax havens where the statutory tax rate is 0%). The ideal measure would be the effective tax rate paid by tax-avoiding firms. It can be proxied by various effective tax rate measures.

The forward-looking effective tax rate corresponds to the average tax rate that will apply to a hypothetical investment considering available tax credits. It is generally viewed in the literature as the rate that determines incentives to invest because it represents the actual tax cost a firm will incur. It is not adapted to our setting as we are interested in the profit-shifting behavior of firms in tax havens, which is generally not covered by available measures of forward-looking effective tax rates.

Backward-looking effective tax rates are more adapted to our needs. It corresponds to ex-post measures of tax rates over pre-tax profits. In particular, Torslov, Wier, and Zucman (2022) compute the effective tax rate for many countries based on national accounts data. However, in our perspective, this would measure t_{lh} with a bias induced by firms having a real activity in tax havens and then paying a different tax rate than tax-avoiding firms. This is especially the case in large tax havens.

Alternatively, the OECD CbC-R provides data closer to our ideal one. The OECD has collected this data as part of the Action 13 of the BEPS Project. It consists in the aggregation of firm-level country-by-country reports at the (origin country $\times$ destination country) level. These reports are available for 2016 and filled by firms from 25 different headquarter countries.

Importantly, these reports contain information on taxes paid and profits. Only large firms, with turnover larger than EUR 750 million, are required to submit CbC-R. This feature prevents the data from being contaminated by smaller firms that are likely to be non-avoiding firms. This data have been used in other studies evaluating the tax avoidance of multinational firms (Garcia-Bernardo and Jansky, 2021 at the macro level, Fuest, Hugger, and Neumeier, 2021, Fuest, Hugger, and Neumeier, 2021 or Delpeuch and Laffitte, 2019 at the micro-level). Another interesting and unique feature of the CbC-R is that the aggregation distinguishes profit-making from loss-making firms. We concentrate on profit-making firms in tax havens to avoid an aggregation bias and exclude firms realizing negative profits in tax havens.

We apply a minimal treatment to the raw data. We compute effective tax rates as the ratio of tax paid to pre-tax profits. We then delete observations with negative effective tax rates and with effective tax rates larger than the statutory tax rate, thus eliminating outliers probably caused by unprecise reporting. At this stage, we observe for each tax haven in our sample, the ef-

fective tax rate paid by firms from each headquarter country reporting activity in the tax haven. We observe the effective tax rate from 12 origin countries for Switzerland, 14 for Hong Kong, 8 for Ireland, 10 for Luxembourg, 15 for the Netherlands, 14 for OFCs, and 11 for Singapore. We define t_{lh} as the median effective tax rate observed in each tax haven.

4.A.5 . Profits

For each country of the sample, we need to compute its profits. For this we follow the methodology of Torslov, Wier, and Zucman (2022) presented in the appendix of their paper. We use national accounts data. Profit correspond to gross operating surplus minus depreciation minus net interest paid. The main data source is the UN National Accounts (United Nations, n.d.). The data is complemented with data gathered from Australian's official statistics. The information on one of the component may be missing for a limited number of countries. In this case, we impute it using the ratio of the component to the Gross Operating Surplus of other countries in the sample. This allows us to construct a complete database of the components of profits for the majority of countries. The data on profits in Singapore is directly taken from Singapore's National Accounts. At this stage, information is missing for Honk-Kong and OFCs. We impute their profits by predicting their value based on a regression of profits on GNI (adjusted R^2 of 0.88).

4.B . Estimation of profit shifting

4.B.1 . Bilateral profit shifting: State of the art

A large amount of information on various cases and techniques of tax avoidance has been released in the press, leading to a number of papers on different aspects of corporate tax avoidance (see for instance Clausing, 2020; Clausing, 2003; Clausing, 2006, Cristea and Nguyen, 2016 and Davies, Martin, Parenti, and Toubal, 2018 for transfer mispricing of goods, Hebous and Johannesen, 2015 for transfer mispricing of services, Laffitte and Toubal, 2021 for sales shifting). In essence, the basic strategy multinational corporations use to shift profit is to shift sales from high-tax to low-tax jurisdictions, while moving expenses in the opposite direction. The measurement of profit shifting is challenging because it is not directly observable. Most of the literature follows the approach pioneered by Hines and Rice, 1994, which delivers estimated amounts of profit shifting that are unilateral. The premise of their methodology is that the observed pre-tax profits of a firm correspond to the sum of *normal* profits and *shifted* profits. Normal profits are determined by the combination of inputs and technology in production countries. Shifted profits are generated thanks to the fiscal environment and the incentives to shift profits out of production countries. Profit shifting is then estimated as the difference between total profits and estimated normal profits (excess profits). When the countries of interest are tax havens these are "excess profits" and when the countries of interest are non-haven these are "missing profits". Important papers based on macro-level data estimate the amount of profit shifted to tax havens for the U.S. or at the global level (Zucman, 2014, Clausing, 2016; Clausing, 2020, Torslov, Wier, and Zucman, 2022, Jansky and Palansky, 2019 or Garcia-Bernardo and Jansky, 2021). They generally provide estimates of unilateral profit shifting (either excess profits or missing profits). This amount might then be allocated to bilateral pairs using an allocation key. Torslov, Wier, and Zucman, 2022 (TWZ hereafter) is the first paper to propose a bilateral allocation of profit shifting across production countries-tax havens pairs. However, while having many advantages, their approach is not suited to consistently estimate bilateral profit shifting in our framework.

In order to estimate profit shifting, TWZ collect (and extrapolate when missing) data on the geography of profits by local and foreign companies. They proceed in two independent steps. They first compute a benchmark level of *normal* profitability level from national account data. This benchmark is defined as the ratio of pre-tax profits to wages of domestic-controlled firms. The methodology rests on the assumption that, in the absence of profit shifting, the average ratio of pre-tax profits to wages of domestic-controlled firms is the same as that of foreign-controlled firms. They show that the ratio of foreign-controlled firms in tax havens is an order of magnitude larger than the one of local firms. In these countries, the profits that are above the benchmark level of profitability are considered as "excessive". The difference between the excessive level of profits and the benchmark level is the amount of profit shifted. TWZ provide estimates of profit shifting to each tax haven and then aggregate it to obtain a worldwide estimate of $616bn in 2015.

In a second step, the profit shifted to tax havens is allocated across non-haven countries. It relies on the assumption that multinational corporations in high-tax countries use intra-firm interest payments I_{lh} from production countries l to tax havens h and services imports S_{lh} from these countries to shift profits. Following Hebous and Johannesen, 2021, TWZ identify "high-risk" services categories such as royalties and headquarter services (information and communication technologies, insurance, financial and management) which are generally used to shift profits in tax havens using transfer pricing. Hebous and Johannesen, 2021 note however that even within these categories, not all services imported from tax haven are traded intra-firm (it corresponds to less than 50% of them), and not all intra-firm flows to tax havens reflect profit shifting. Given the quality of the data, TWZ focus on European countries and define as a benchmark, the share of high-risk services and intra-firm interest in the Gross National Income (GNI) of non-haven EU countries. Similar shares are computed for each tax haven. The ratios of these shares to the benchmark inform on excessive flows. They are computed for each tax haven and can be written as: $s_h^{Y_k} = 1 - \frac{\sum_{l,l\neq h} {}^{Y_l/GNI\ EU\ 22}}{Y_h/GNI_h}$ where Y_k is country k's amounts of total interest received or its exports of high-risk services. TWZ determine a allocation matrix of bilateral interest payments and service flows that allows to allocate the aggregate worldwide estimate of profit shifting across production and tax haven countries: $PS_{lh}^{TWZ} = 616 \times \frac{I_{lh} \times s_h^I + S_{lh} \times s_h^S}{\sum_{l,h} I_{lh} \times s_h^I + \sum_{l,h} S_{lh} \times s_h^S}$.

This allocation methodology implies that the total amount of profits shifted in a tax haven ($\sum_l PS_{lh}^{TWZ}$) is not necessarily equal to the ones computed in the first step. While this gap is not necessarily important, it prevents a direct use of profit shifting shares as an input to calibrate our model. Figure 4.B.1 illustrates the distribution of bilateral profit shifting in TWZ.

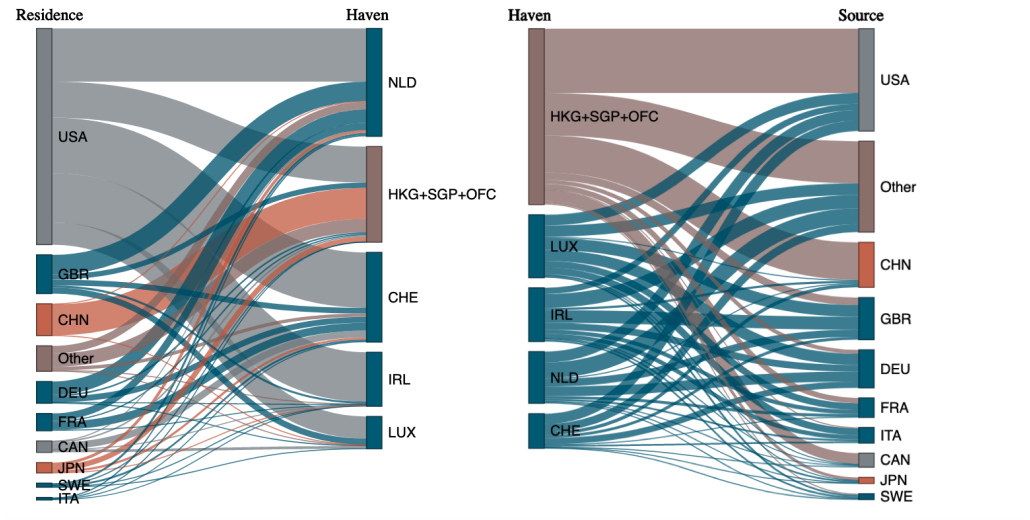


Figure 4.B.1: Profit shifting from i to h and l to h in Torslov, Wier, and Zucman (2022)

Note: This figure shows the profit shifting estimates in Torslov, Wier, and Zucman (2022). The residence country i is located on the left, the tax haven country h in the middle and the source country l on the right. Data from Torslov, Wier, and Zucman (2022), Appendix table C4.

4.B.2 . Estimation of excessive incomes: PS_{ih}

The excessive income in some tax havens may be inflated due to the geographical breakdowns of FDI incomes which are made according to the immediate counterparts country. Damgaard, Elkjaer, and Johannesen (2019), construct a FDI dataset which combines the detailed information of the OECD and the IMFs Coordinated Direct Investment Survey (CDIS) datasets. They propose bilateral direct investment statistics on an ultimate ownership basis rather than on a direct ownership basis.

They also breakdown total inward FDI between inward FDI in Special Purpose Entities (henceforth SPEs) used as conduit between two other countries, and inward FDI in non-SPEs. By comparing the bilateral FDI positions recorded in each tax haven on an ultimate ownership basis and on a direct ownership basis, we can compute the proportion of FDI that transit through a tax haven to reach another one. Assuming proportionality, we then reallocate the share of income to the ultimate owner of the transaction. In the schematic representation of Figure 2, we reallocate the profit shifted in h' to h when h' is the conduit tax haven. It means that we do not correct for all conduit FDI. For instance an FDI between two non-haven countries channelled through a conduit tax haven need not to be reallocated. We only reallocate excessive income that are mistakenly attributed to a tax haven h' instead of a tax haven h.

Using Damgaard, Elkjaer, and Johannesen (2019) data, we define conduit FDI as FDI in SPE going from a non-haven country to a tax haven as $Conduit_{ih'} = FDI_{ih'}^{SPE}$. We compute an allocation key which corresponds to the share of conduit FDI from country i to country h':

$$\Theta_{ih'} = \frac{Conduit_{ih'}}{FDI_{ih'}}$$

$\Theta_{ih'}$ informs on the percentage of total FDI (conduit FDI and non-conduit FDI) by non-haven country i in country h' that needs to be reallocated to another country h because country h' is not the ultimate investor but a conduit tax haven.

We then reallocate a share $\Theta_{ih'}$ of excessive income between h' and i to h countries. We allocate it to h countries according to h' non-SPE investment in any tax haven h.

$$Total\ Reallocation_{ih'h} = \Theta_{ih'} \times \frac{FDI_{h'h}^{Non-SPEs}}{\sum_k FDI_{h'k}^{Non-SPEs}}$$

The United Kingdom, and on a smaller scale, Belgium are generally identified as conduit countries too (see for instance Garcia-Bernardo, Fichtner, Takes, and Heemskerk, 2017). We account for both countries by computing another reallocation factor $\gamma_{ii'}$ where i' is either U.K. or Belgium.

$$\gamma_{ii'} = \frac{Conduit_{ii'}}{\sum_i FDI_{ii'}}$$

We obtain that 8.9% of excess FDI income in the United Kingdom and 7.1% of excess FDI income in Belgium are reallocated to other non-haven headquarter countries.

In figure 4.B.2, we display the share of profit shifting in each tax haven before and after correction for conduit investment using DEJ data. It indicates how much a country is used as a conduit between a non-haven country and an other tax haven (it is then a subset of total conduit investment). We see that the correction is generally small. The nature of the data currently available for such corrections does not allow us to proceed to large reallocation. Figure 4.B.2 shows that Ireland and OFC seem to be used as conduit to reach other tax havens (their share decrease after correction). Switzerland's and Netherlands' share increase after correction, indicating that they are reached through other tax havens.

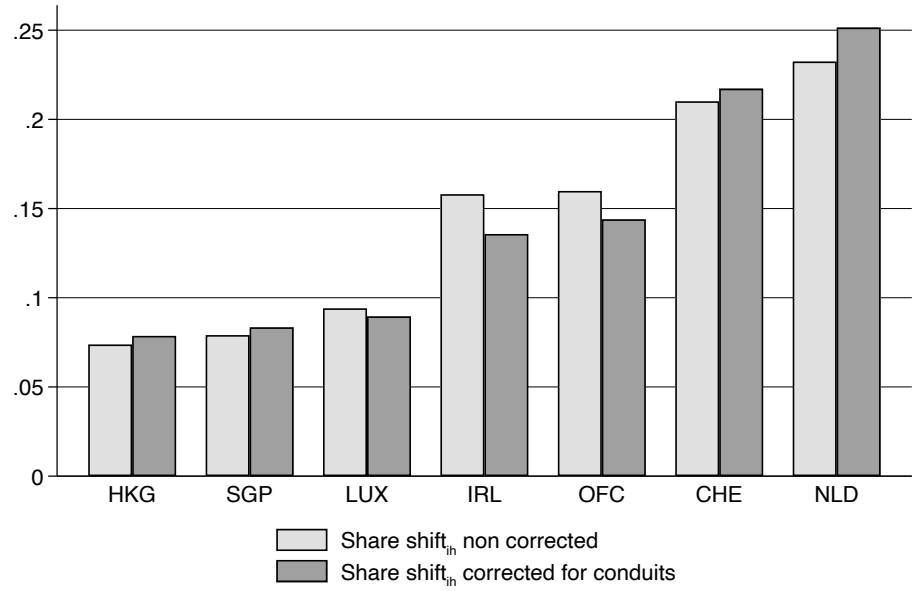


Figure 4.B.2: Profit shifting before and after taking conduits into account

Note: This figure shows the world share of profit shifting located in each tax haven before and after correcting it for conduit use.

4.B.3 . Robustness figures

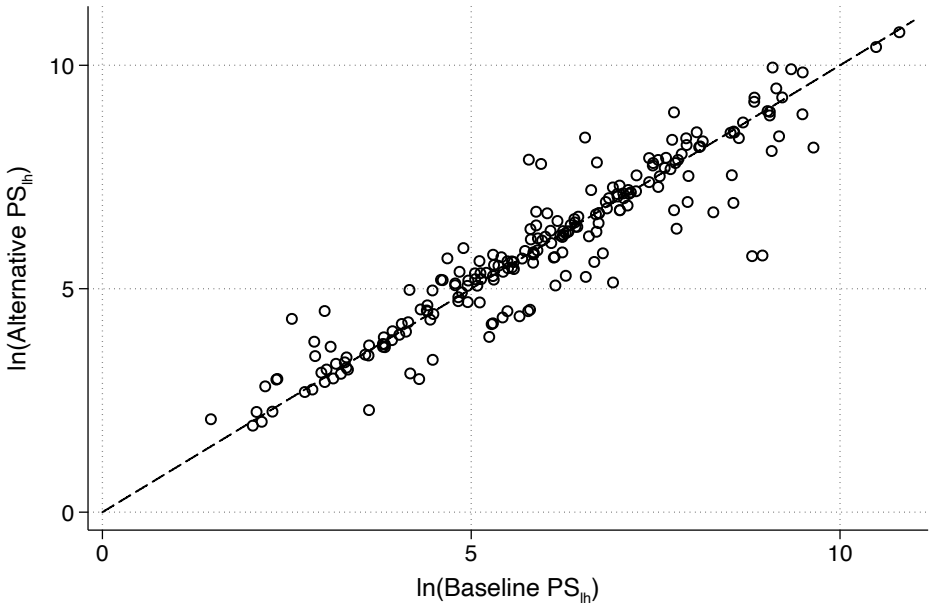


Figure 4.B.3: Profit shifting: sensitivity to s_l calibration

This figure plots the log value of PS_{lh} obtained in the baseline exercise and the log value of PS_{lh} obtained when we calibrate PS_l using TWZ data.

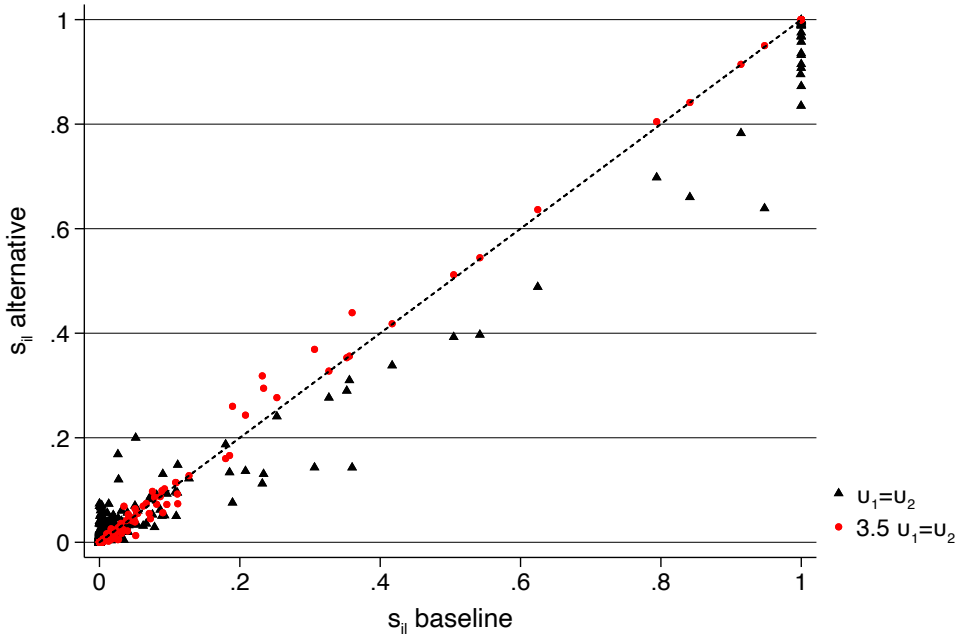


Figure 4.B.4: Profit shifting: sensitivity to elasticities calibration

This figure plots s_{il} as obtained in the baseline exercise (horizontal axis) and compares it to alternative s_{il} obtained with a different calibration of the ratio $\frac{\upsilon_2}{\upsilon_1}$.

4.C . Comparing PS_{lh} to other estimations

Comparison with TWZ To our knowledge Torslov, Wier, and Zucman (2022) is the only other paper in the literature that proposes a bilateral measure of profit shifting. As described earlier our approach is different to their, making both estimates complementary.

In this appendix section we compare our measure of bilateral profit shifting to the one of TWZ. We also compare our estimates of profit shifting aggregated at the country level with other estimates from the literature. First note that our measure concentrates on years 2013-2014 while TWZ estimates concern year 2015. This may explain some deviations of the values as we expect profit shifting to increase over time.

In figure 4.C.1, we show for European tax havens the correlation between TWZ estimation of profit shifting and ours (in neperian logarithm).[35] Figure 4.C.1 overall displays a positive relationship between the two variables. The Pearson correlation between both variables is 0.63 and the Spearman rank correlation is 0.61. It reveals both similarities and differences between our approaches.

In particular when we concentrate on large values of profit shifting in figure 4.C.2 we observe large differences. While few pair of countries are located close to the $y = x$ line, some pairs that include Ireland as tax haven imply systematically more bilateral profit shifting in TWZ estimates than in ours. On the contrary, profit shifting to Netherlands is generally larger in our estimates.

Comparison with unilateral estimations We now compare our estimates aggregated at the production-country level with other estimates available in the literature. These estimates are taken from TWZ, the Tax Justice Network report (Cobham, Garcia-Bernardo, Palansky, and Bou Mansour, 2020) and CORTAX, the model of the European Commission (Alvarez Martinez et al., 2016). To match with CORTAX data, we transform estimates of profit shifting into tax losses by multiplying them by the statutory tax rate.

Figure 4.C.3 displays the comparison from each l countries available in the CORTAX estimations, the study with the smallest sample of countries. This graph first reveal that the estimations of profit shifting are sensitive to methodologies and data. However, these studies may converge on the order of magnitude for some countries.

The CORTAX estimation is particularly high for the U.S while our estimation, despite being higher than others is close from the one from the Tax Justice Network and the ones from TWZ. Overall, the numbers that we estimate are in the range of the other studies and no pattern is identifiable.

[35] Due to aggregation of OFC, Hong-Kong and Singapore in TWZ files, we are not able to display a similar graph that separately includes these countries.

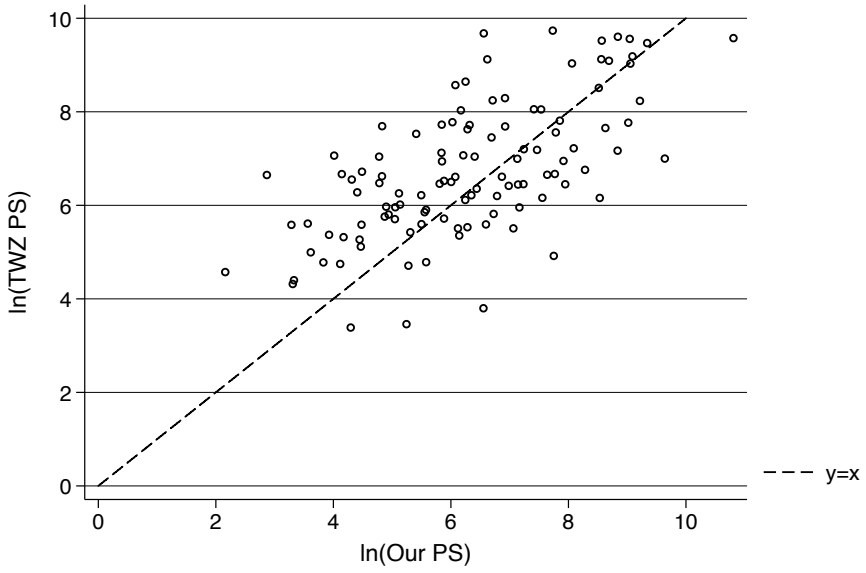


Figure 4.C.1: Comparison between Torslov, Wier, and Zucman (2022) estimation of PS and our for European tax havens.

Note: This figure compares the logarithms of the bilateral profit shifting from source countries l to tax havens h in this paper and in Torslov, Wier, and Zucman (2022).

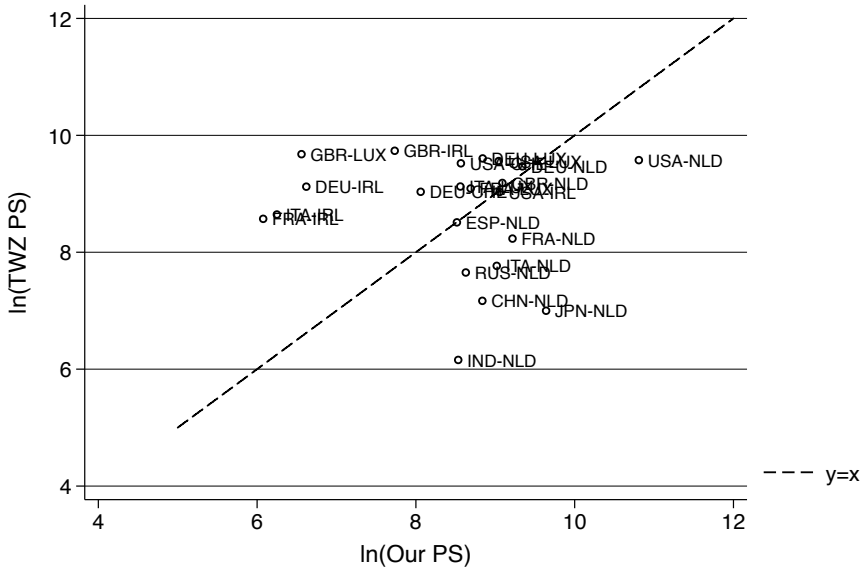


Figure 4.C.2: Comparison between TWZ estimation of PS and ours for large profit shifting.

Note: This figure compares the logarithms of the bilateral profit shifting from source countries l to tax havens h in this paper and in Torslov, Wier, and Zucman (2022). It corresponds to a focus into large values of bilateral profit shifting.

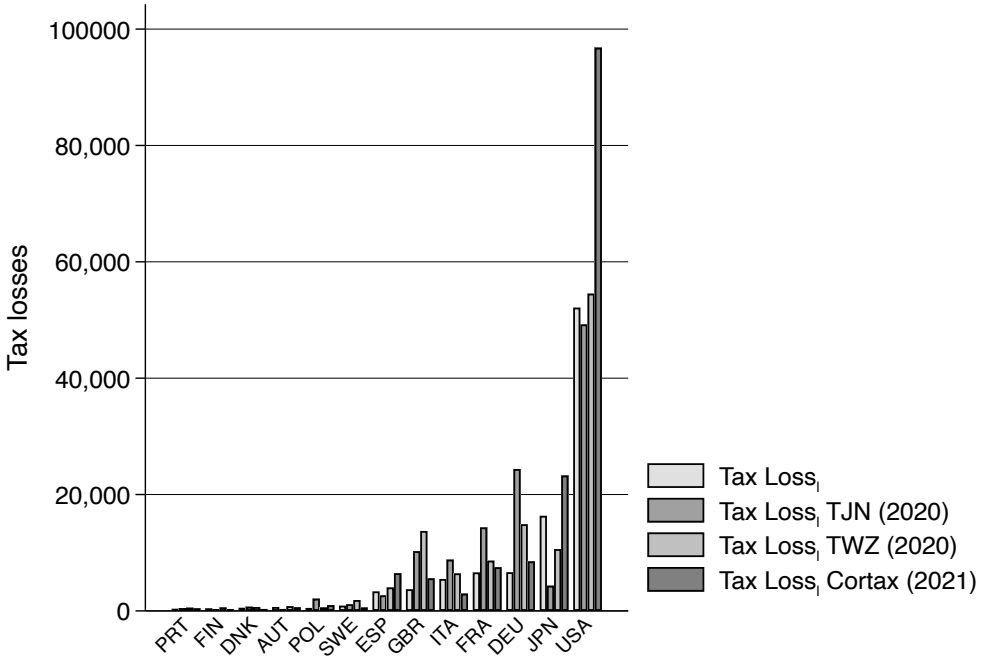


Figure 4.C.3: Comparison with other estimations.

Note: This figure compares the (unilateral) tax losses from profit shifting with Cobham, Garcia-Bernardo, Palansky, and Bou Mansour (2020), Torslov, Wier, and Zucman (2022) and Alvarez Martinez et al. (2016). Tax losses are obtained by multiplying profit shifting out of source countries l by their statutory tax rate.

4.D . Supplementary figures

4.D.1 . Illustrating model mechanisms

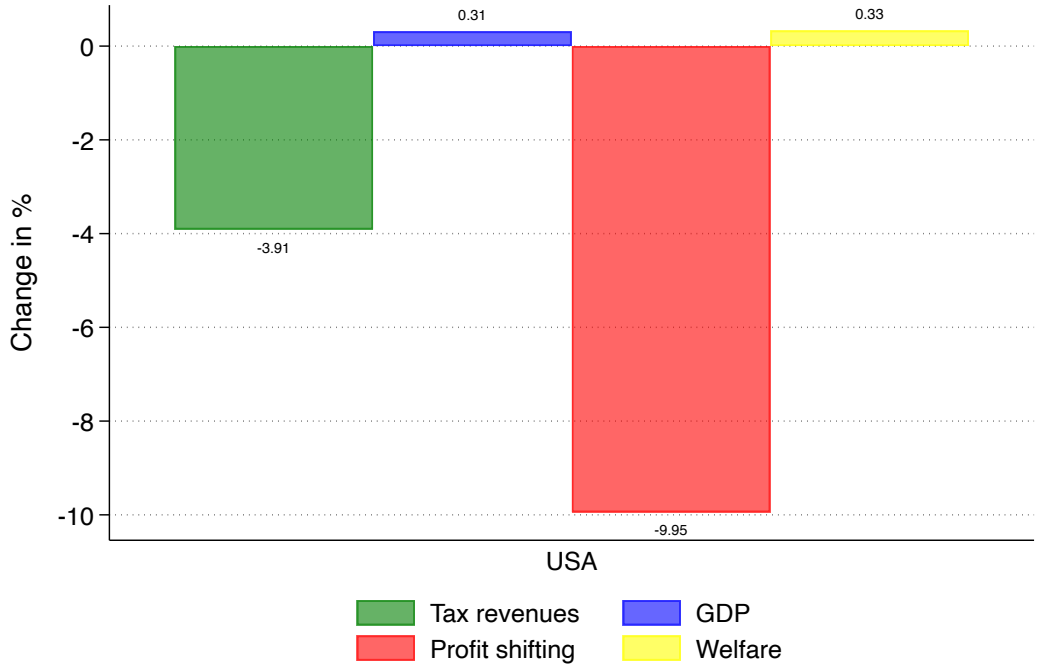


Figure 4.D.1: Unilateral tax decrease of 5% in the U.S.

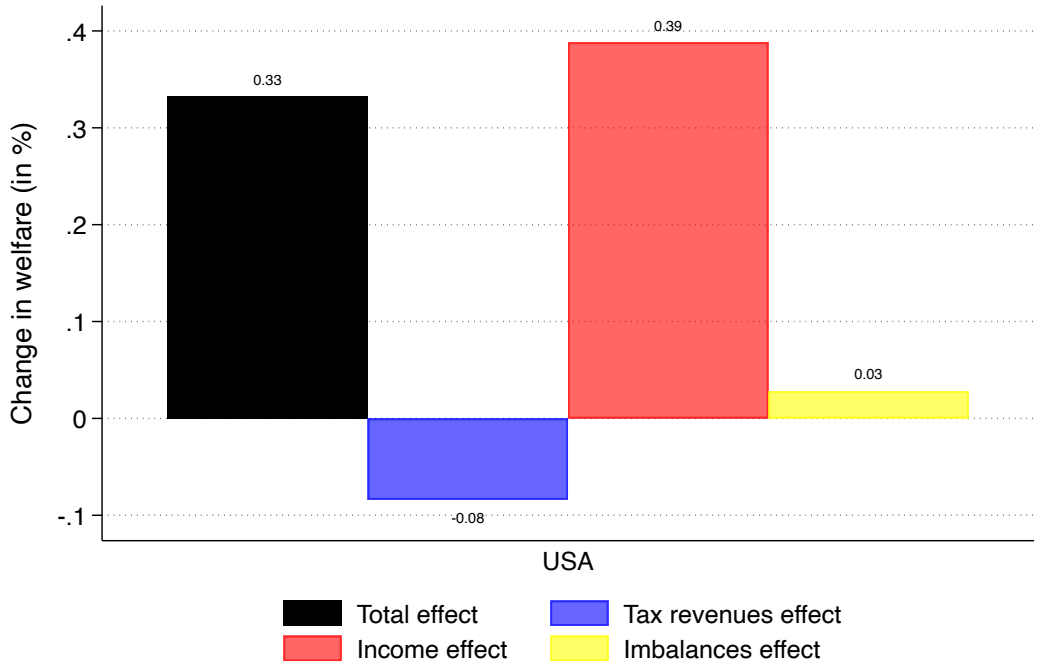


Figure 4.D.2: Unilateral tax decrease of 5% in the U.S.: decomposition of welfare effects

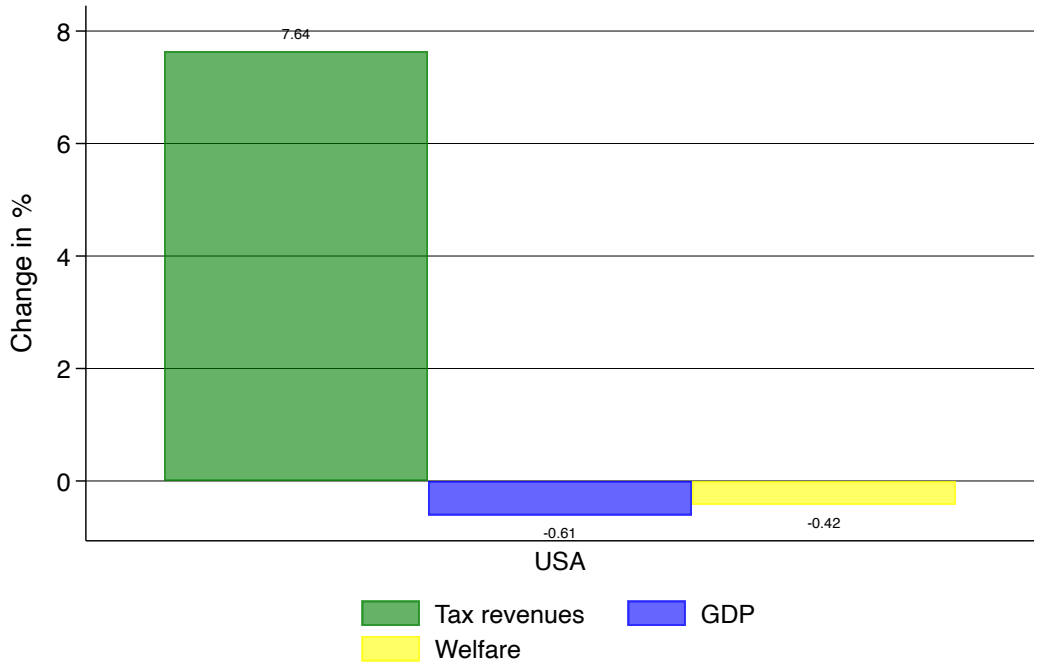


Figure 4.D.3: Effect of multilaterally ending profit shifting on tax revenues GDP and welfare in the U.S.

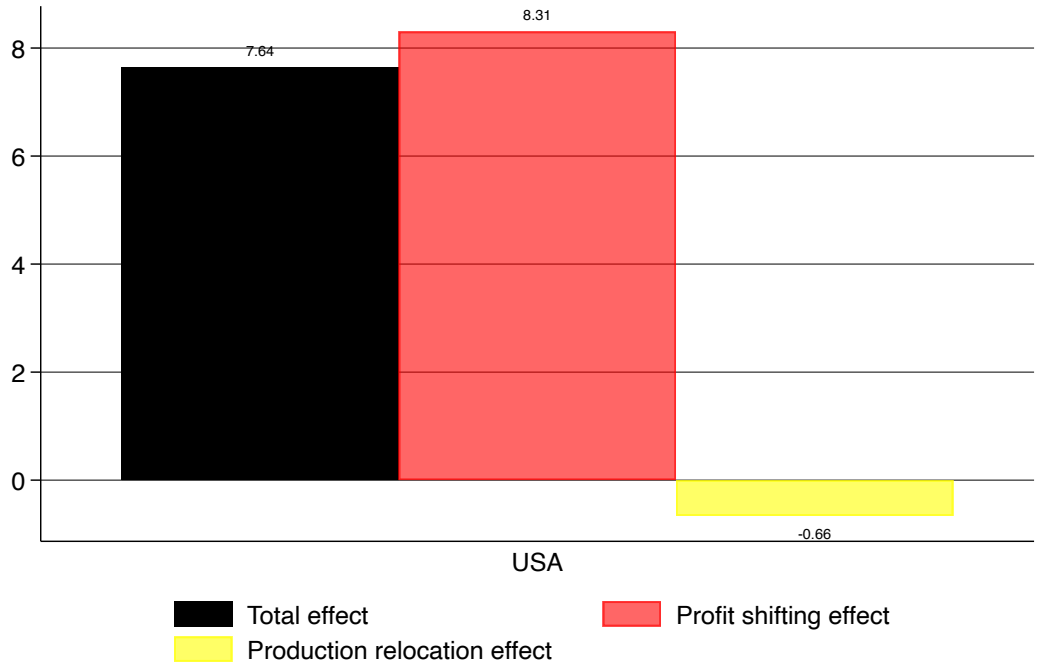


Figure 4.D.4: Effect of multilaterally ending profit shifting: decomposition of tax revenues effects in the U.S.

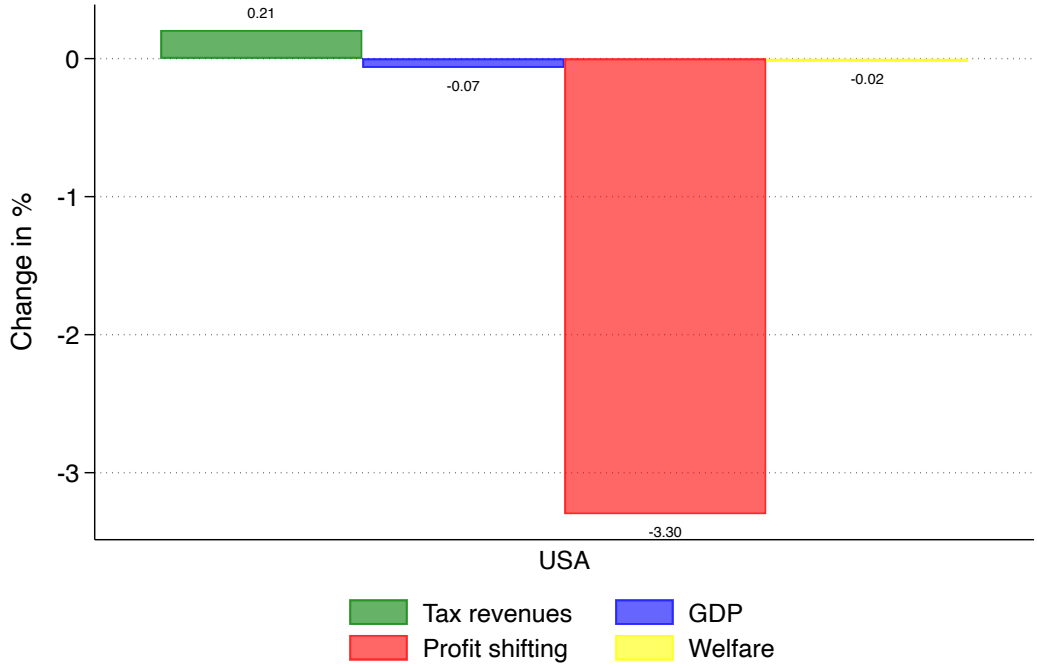


Figure 4.D.5: Effect of closing Singapore on the U.S.

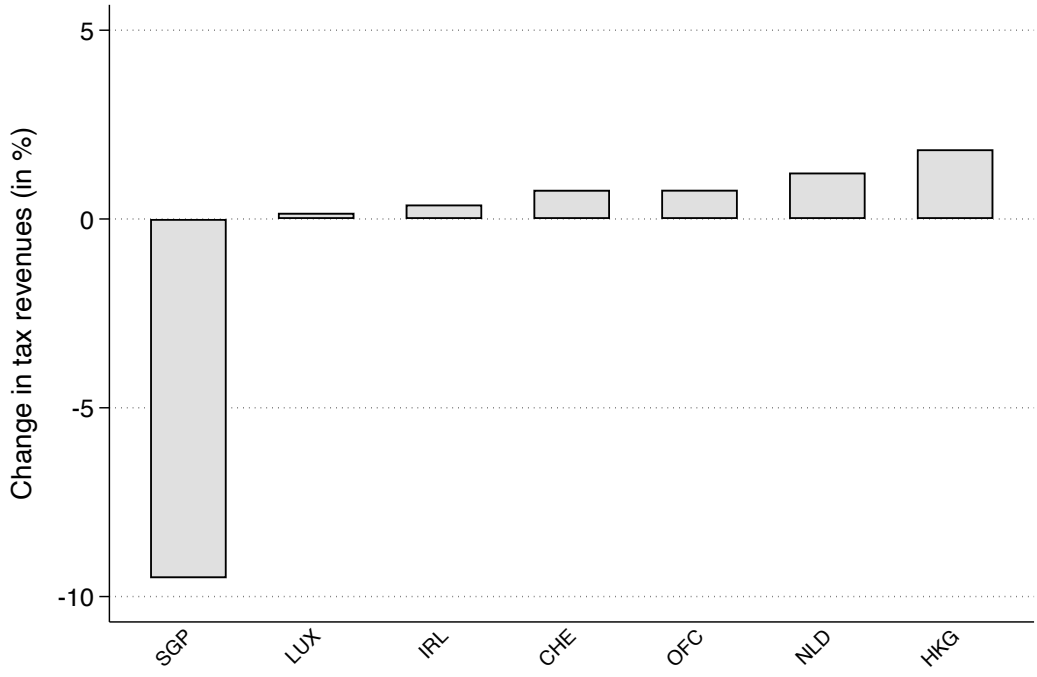


Figure 4.D.6: Effect of closing Singapore on tax revenues in tax havens

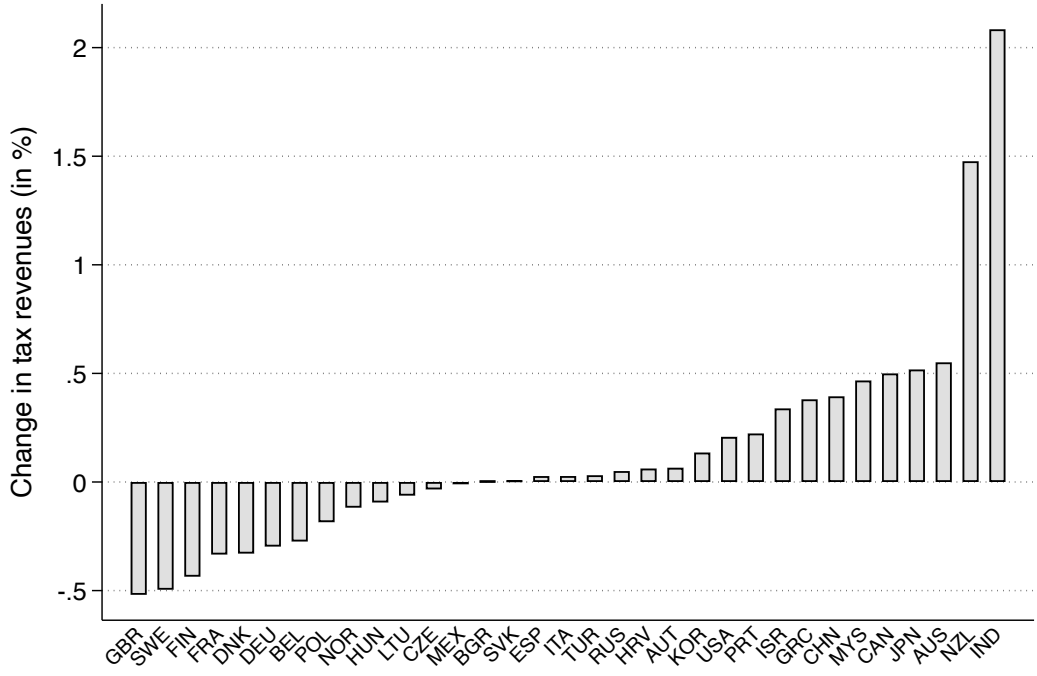


Figure 4.D.7: Effect of closing Singapore on tax revenues in non-havens

4.D.2 . Sensitivity

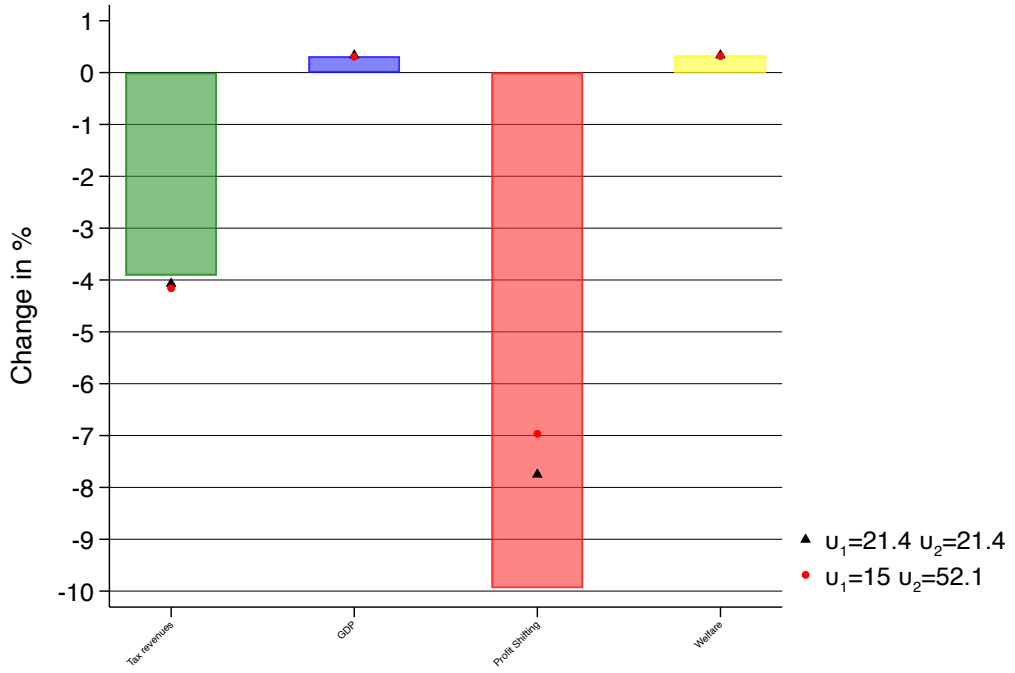


Figure 4.D.8: Unilateral tax decrease of 5% in the U.S.: sensitivity to parameters calibration

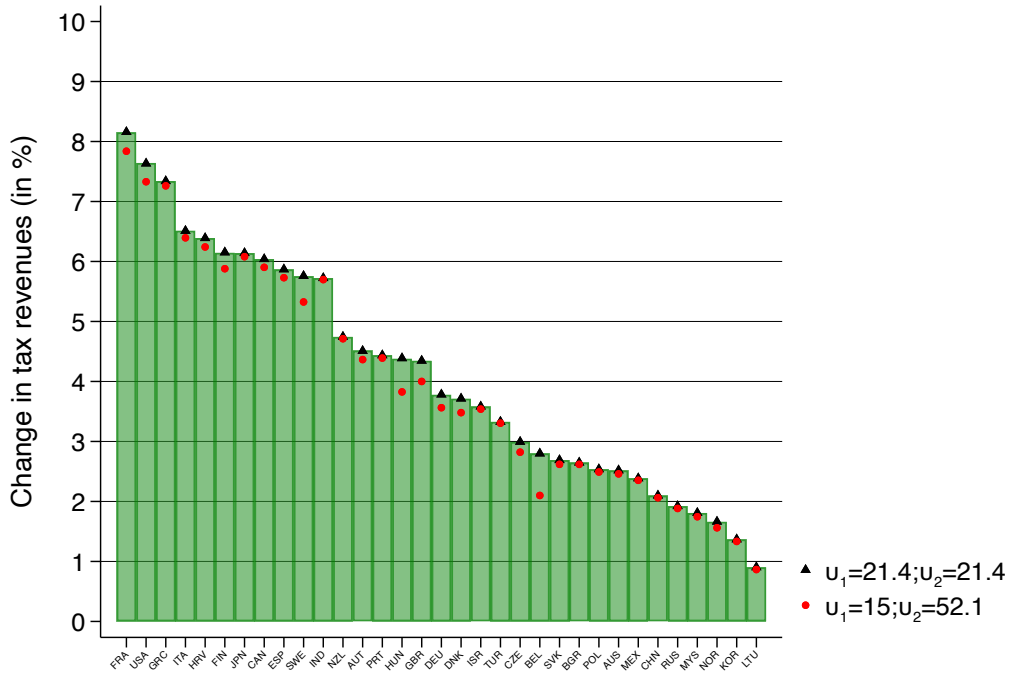


Figure 4.D.9: Effect of multilaterally ending profit shifting on tax revenues: sensitivity to parameters calibration

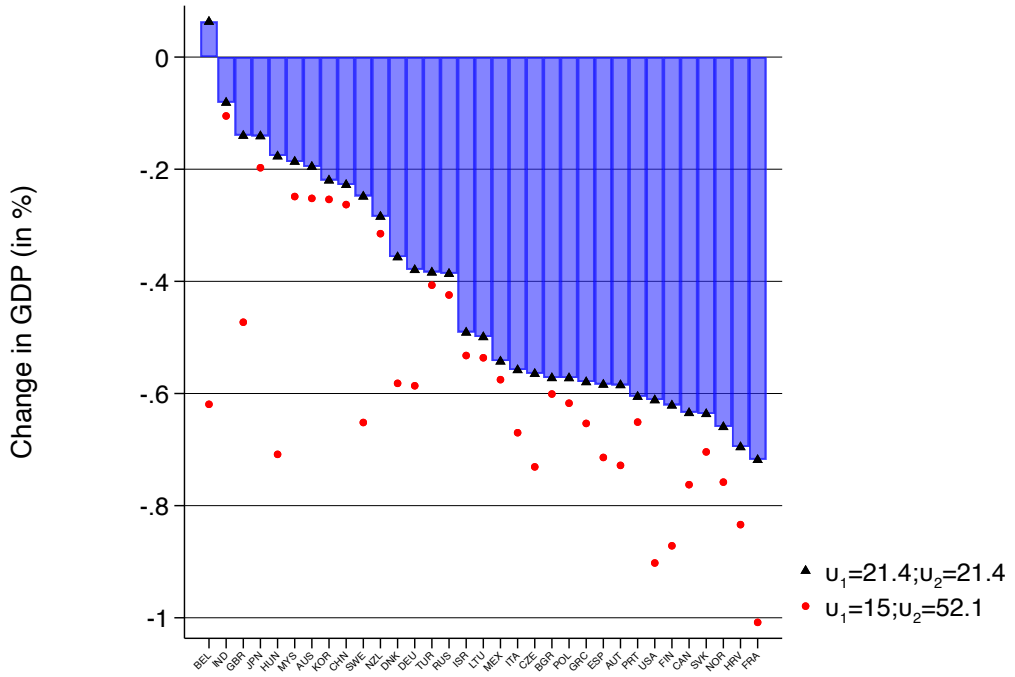


Figure 4.D.10: Effect of multilaterally ending profit shifting on production: sensitivity to parameters calibration

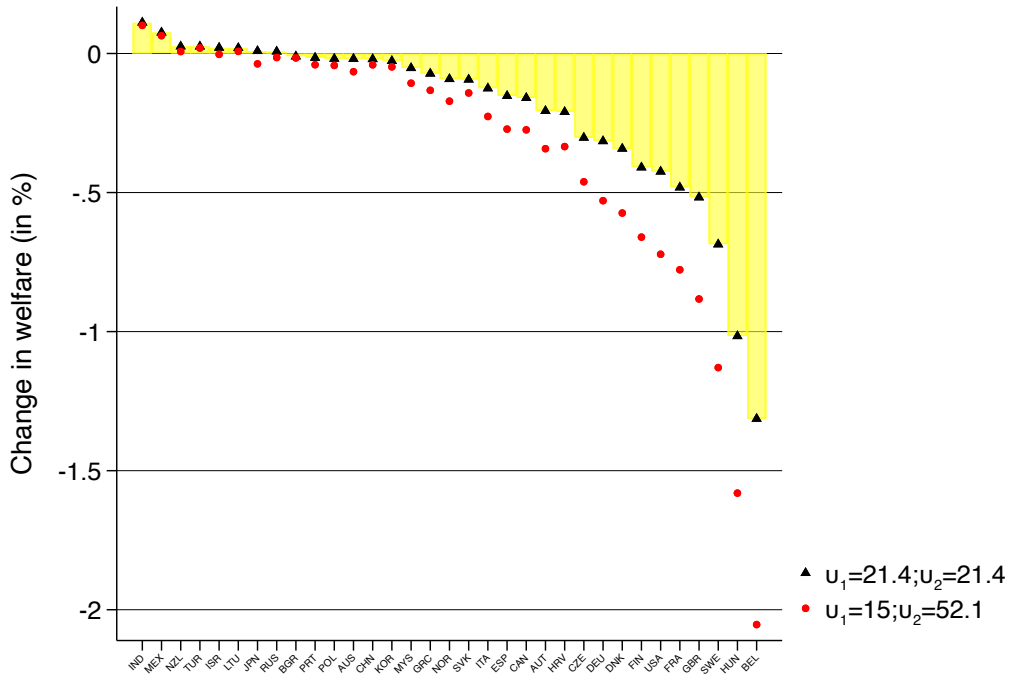


Figure 4.D.11: Effect of multilaterally ending profit shifting on welfare: sensitivity to parameters calibration

4.E . Theory (baseline model)

Proof of equation (14) From equation 4.12, we have:

$$\begin{aligned}
\frac{X_{ilh}}{\sum_{l,h,h\neq l} X_{ilh}} &= \frac{\tilde{A}_{ilh}(1-t_{lh})^{\frac{\upsilon_1}{\sigma-1}-1}G_{i,lh}(\tilde{\mathbf{A}}_i,\mathbf{t})}{\sum_{l,h,h\neq l}\tilde{A}_{ilh}(1-t_{lh})^{\frac{\upsilon_1}{\sigma-1}-1}G_{i,lh}(\tilde{\mathbf{A}}_i,\mathbf{t})} \\
&= \frac{\tilde{A}_{ilh}(1-t_{lh})^{\frac{\upsilon_1}{\sigma-1}-1}\tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}-1}(1-t_{lh})^{\frac{\upsilon_2-\upsilon_1}{\sigma-1}}}{\sum_{l,h,h\neq l}\tilde{A}_{ilh}(1-t_{lh})^{\frac{\upsilon_1}{\sigma-1}-1}\tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}}(1-t_{lh})^{\frac{\upsilon_2-\upsilon_1}{\sigma-1}}} \\
&= \frac{\tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}}(1-t_{lh})^{\frac{\upsilon_2}{\sigma-1}-1}}{\sum_{l,h,h\neq l}\tilde{A}_{ilh}^{\frac{\upsilon_2}{\upsilon_1}}(1-t_{lh})^{\frac{\upsilon_2}{\sigma-1}-1}}
\end{aligned}$$

Price index The price-index can be computed directly decomposing the set of varieties Ω_n across origin country i and production country l:

$$P_n^{1-\sigma} = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\sum_i\sum_{lh} N_i\mathbb{P}_{ilh}\tau_{ln}^{1-\sigma}\mathbb{E}\left[\left(\frac{\gamma_{il}w_l\alpha_{lh}}{T_i\varphi_{lh}}\right)^{1-\sigma} \mid lh = lh^*\right]$$

where $\frac{\gamma_{il}w_l\alpha_{lh}}{T_i\varphi_{lh}}$ is the marginal cost of production of one variety by a firm from i, sourcing in l, shifting its profits to h. The mass of firms - and thus varieties - produced at this cost is $N_i\mathbb{P}_{ilh}$. Re-arranging the above expression so as to use the free-entry condition in each country i, we obtain that

$$P_n^{1-\sigma} = \sum_l \tau_{ln}^{1-\sigma}\Xi_l^{\sigma-1}Q_l$$

.

4.F . Profit shifting, trade and multinational production frictions

Profit shares We start by computing $\mathbb{P}_{ill}$ the probability that a firm from country i produces in l and locates its profits in l.

$$\mathbb{P}_{ill} = \frac{A_{ll}\left(\gamma_{il}\tilde{t}_{ll}w_l\Xi_l\right)^{-\upsilon_1}}{\sum_l A_{ll}\left(\gamma_{il}\tilde{t}_{ll}w_l\Xi_l\right)^{-\upsilon_1} + \theta_i^{-\upsilon_1}\left(\sum_{l,h,h\neq l} A_{ll}\alpha_{lh}^{\frac{\upsilon_2}{\upsilon_1}}\left(\gamma_{il}\tilde{t}_{ilh}\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}}} \tag{4.23}$$

and $\mathbb{P}_{ilh}$, the probability that a firm from country i produces in l and shifts its profits in h.

$$\mathbb{P}_{ilh} = \frac{A_{ll}^{\frac{\upsilon_2}{\upsilon_1}}\left(\gamma_{il}\tilde{t}_{ilh}\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\theta_i^{-\upsilon_1}\left(\sum_{l,h,h\neq l} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}}\left(\gamma_{il}\tilde{t}_{ilh}\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}-1}}{\sum_l A_{ll}\left(\gamma_{il}\tilde{t}_{ll}w_l^p\Xi_l\right)^{-\upsilon_1} + \theta_i^{-\upsilon_1}\left(\sum_{l,h,h\neq l} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}}\left(\gamma_{il}\tilde{t}_{ilh}\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}}} \tag{4.24}$$

Or, equivalently

$$\mathbb{P}_{ilh} = \frac{A_{ll}^{\frac{\upsilon_2}{\upsilon_1}}\left(\gamma_{il}\tilde{t}_{ilh}\theta_i\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\left(\sum_{l,h,h\neq l} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}}\left(\gamma_{il}\tilde{t}_{ilh}\theta_i\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}-1}}{\sum_l A_{ll}\left(\gamma_{il}\tilde{t}_{ll}w_l\Xi_l\right)^{-\upsilon_1} + \left(\sum_{l,h,h\neq l} A_{ll}^{\frac{\upsilon_2}{\upsilon_1}}\left(\gamma_{il}\tilde{t}_{ilh}\theta_i\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}}}$$

Observing equations (4.23) and (4.24), we notice that backing-out profit shifting frictions and thereby computing $Cost_{ilh}$ requires a series of parameters A_{ll}, γ_{il}, τ_{ilh} and the endogenous variables w, Ξ in the initial equilibrium - the one that is consistent with all the $\mathbb{P}_{ilh}$.

Backing-out price indices, trade frictions and market potential The endogenous variables w are easily recovered from the labor market constraint, while Ξ depends on the (unobserved) price index and trade frictions.

Price indices in the initial equilibrium are not themselves identified as they cannot be disentangled from trade costs. Intuitively, their combination matters to replicate the observed trade shares from a source country l to a market n:

$$\frac{\tau_{ln}^{1-\sigma}P_n^{\sigma-1}}{\tau_{ll}^{1-\sigma}P_l^{\sigma-1}} = \frac{X_{ln}Y_l}{X_{ll}Y_n}$$

We thus look for a matrix of trade costs that departs as little as possible from the symmetry assumption often made in the literature (Head and Mayer, 2014). This, in turn, pins down market potentials Ξ_l across countries and perfectly replicates the observed trade shares at the same time.

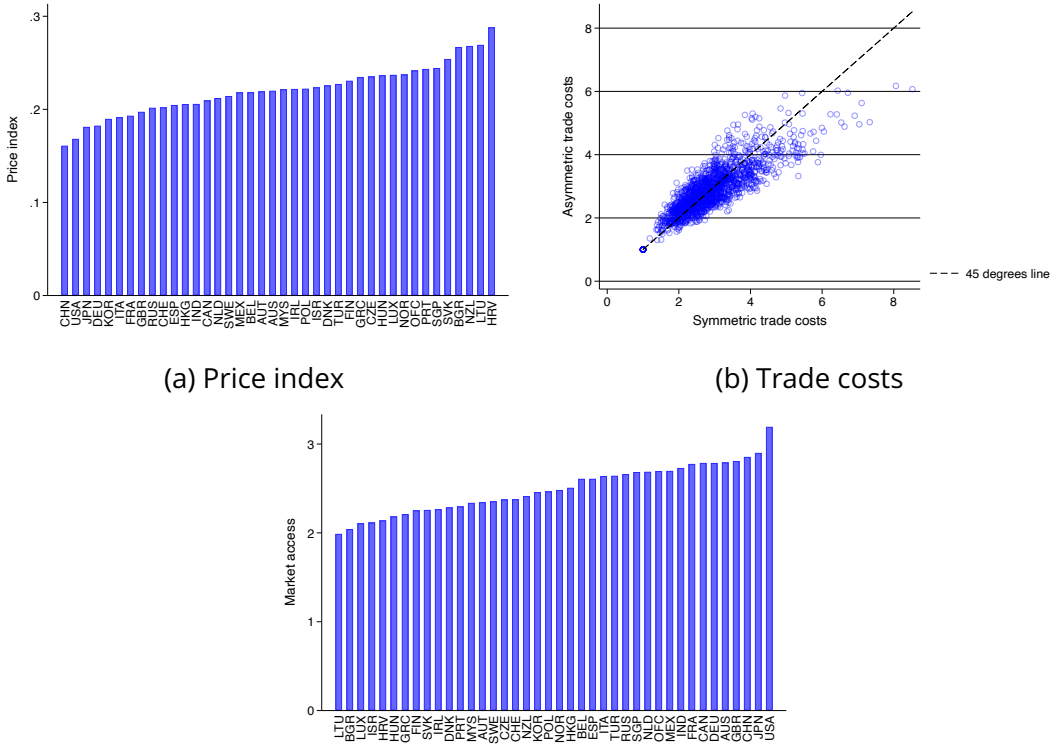
We normalize domestic trade frictions, i.e., $\tau_{ll} = 1$ for all l. We obtain:

$$\tau_{ln} = \left(\frac{X_{ln}Y_lP_l^{\sigma-1}}{X_{ll}Y_nP_n^{\sigma-1}}\right)^{\frac{1}{1-\sigma}}$$

We look for a matrix of trade costs that departs as little as possible from the symmetry assumption both to (i) perfectly reproduce observed trade shares

and (ii) have variation in market potentials across countries.

In practice, trade shares and imports are observed. We thus treat the vector of price indexes P as a vector of unknowns and search for values minimizing $\sum_{l,n}\left(\tau_{ln}-\tau_{nl}\right)^2$. Figure 4.F.1 plots the results: the price indexes, the corresponding asymmetric trade costs (comparing the latter with what symmetric trade costs would look like in our model, i.e., $\tau_{ln}=\left(X_{ln}/Y_l\right)/\left(X_{nn}/Y_n\right)$), and the market potentials.



(a) Price index

(b) Trade costs

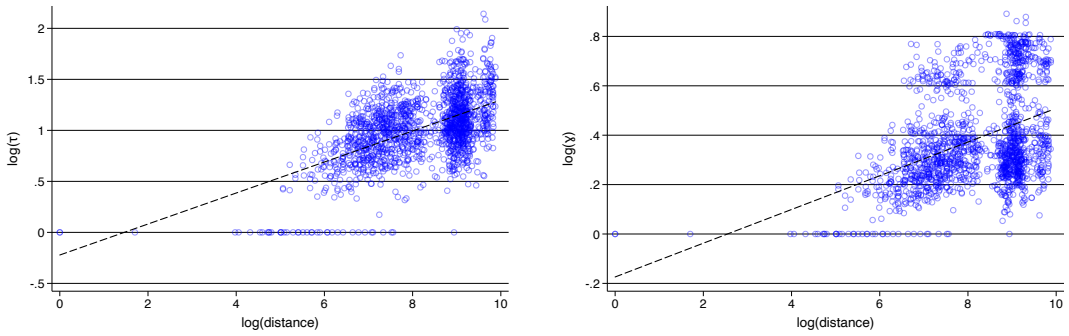
(c) Market potentials

Figure 4.F.1: Price indexes, market potentials, and trade costs

Asymmetric HQ frictions γ_{il} are also recovered using 4.23. Trade frictions τ_{ln} and HQ frictions γ_{il} are plotted against distance in figure 4.F.2.

Knowing w,Ξ and γ, we can back out country-level technology parameters A_{ll} (relative to a reference country that we take to be the U.S.) from equation 4.23. Intuitively, productivity differences are the residual explanatory factor for multinational activity once we control for differences in the cost of production, market potential, and gravity determinants of MP sourcing.

Last, equation 4.24 allows us to back-out profit shifting frictions. Intuitively, variations in profits shifted to different h from a given l given by 4.24 pin down the relative frictions $\alpha_{lh'}/\alpha_{lh}$. In turn, the comparison of the intensity of profit shifting from different l to the same h informs on the relative friction from other source countries after controlling for the "attractiveness" of source countries l, which depends on the market potential Ξ, wages w and technology A_{ll}.



(a) Trade costs (τ_{ln}) (b) Multinational activity costs (γ_{il})

Figure 4.F.2: Trade and MNE activity bilateral frictions

4.G . Exact hat algebra

4.G.1 . Computing counterfactual equilibria

Notations: we introduce the share of sales by firms from i, sourcing in l, booking their profits in h: $\beta_{ilh} = \frac{X_{ilh}}{\sum_{l,h} X_{ilh}}$. From equation (4.10), we obtain

$$\beta_{ilh} = \frac{\mathbb{P}_{ilh} / \left((1-t_{ilh})\iota_l\right)}{\sum \mathbb{P}_{ilh} / \left((1-t_{ilh})\iota_l\right)}.$$

We denote by μ_{ln} the share of sales to country n by firms producing in l. This share does not depend on firm's residence:

$$\mu_{ln} = \frac{\tau_{ln}^{1-\sigma} Y_n P_n^{\sigma-1}}{\sum_n \tau_{ln}^{1-\sigma} Y_n P_n^{\sigma-1}} \equiv \left(\frac{\Xi_{ln}}{\Xi_l}\right)^{1-\sigma}.$$

The sales of firms from i producing in l is denoted by $X_{il} = \sum_{h=l;h\in\mathcal{H}} X_{ilh}$ and their sales in market n by $X_{iln} = \mu_{ln} X_{il}$.

Endogenous variables z are denoted z and z' are respectively the initial and the new equilibrium so that $\hat{z} = z'/z$. Following Dekle, Eaton, and Kortum (2007), we look for a fixed point in changes $\hat{\mathbf{w}} = (\hat{w}_l)_{l\in[[1,N]]}, \hat{\mathbf{Y}} = (\hat{Y}_n)_{n\in[[1,N]]}, \hat{\mathbf{P}} = (\hat{P}_n)_{n\in[[1,N]]}, \hat{\mathbf{N}} = (\hat{N}_i)_{i\in[[1,N]]}$. Given $\hat{\mathbf{w}}, \hat{\mathbf{Y}}, \hat{\mathbf{N}}, \hat{\mathbf{P}}$ and the change in policy, we can compute the implied change in market potential $\hat{\Xi}_l$. This pins down the change in $\hat{\mathbb{P}}_{ilh}$ (see below) and thereby the changes $\hat{\beta}_{ilh}$ and $\hat{\mu}_{ln}$. The output in l produced by l firms is then obtained as

$$X'_{il} = \frac{N'_i}{T_i^{1-\sigma}} \left(\frac{\sigma}{\sigma-1}\right)^{-\sigma} \sum_h \left(\mathbb{P}'_{ilh} \iota_l^{-1} (1-t_{lh})^{-1}\right) \mathcal{D}_i'^{\frac{\sigma-1}{\upsilon_1}} \Gamma\left(1 - \frac{\sigma-1}{\upsilon_1}\right)$$

We thus get $X'_{iln} = \mu'_{ln} X'_{il}$ and $X'_{ilh} = \beta'_{ilh} \left(\sum_n X'_{iln}\right)$. A fixed point in changes is obtained when:

wages satisfy the labor-market clearing

$$w'_k = \frac{1}{\sigma L_k} \sum_{l,h,n} \beta'_{klh} \left(1 - t'_{klh}\right) \iota_l X'_{kln} + \frac{\sigma-1}{\sigma L_k} \sum_i X'_{ik};$$

total expenditures are equal to labor income, tax revenues, adjusted for the friction ι_l and imbalances

$$Y'_k = w'_k L_k + \frac{1}{\sigma}\left(\sum_{i,n} t'_k \beta'_{ikk} \iota_k X'_{ikn} + \sum_{i,l,n,l\neq k} t'_{ilk} \beta'_{ilk} \iota_l X'_{iln}\right) + \frac{1}{\sigma}\sum_{i,n}(1-\iota_k) X'_{ikn} + \Delta_k;$$

price indices for all countries but the numeraire verify

$$P_n'^{1-\sigma} = \sum_l \tau_{ln}^{1-\sigma} \Xi_l'^{\sigma-1} \sum_i X'_{il};$$

and the number of firms satisfies the free-entry condition

$$N'_i = \frac{\frac{1}{\sigma}\sum_{l,h,n} \beta'_{ilh} \left(1 - t'_{ilh}\right) \iota_l X'_{ilh}}{w'_i f_E}.$$

4.G.2 . Relative changes in probabilities $\hat{\mathbb{P}}_{ilh}$

Non-haven residence countries $i \notin \mathcal{H}$**.** The unconditional probabilities $\mathbb{P}_{ilh}$ for $h \neq l$ are given by

$$\mathbb{P}_{ilh} = \frac{A_{lh}^{\frac{\upsilon_2}{\upsilon_1}} \left(\gamma_{il}\theta_i\alpha_{lh}\tilde{t}_{ilh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2} \times \left(\sum_{l,h,h\neq l} A_{lh}^{\frac{\upsilon_2}{\upsilon_1}} \left(\gamma_{il}\theta_i\alpha_{lh}\tilde{t}_{ilh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}-1}}{\sum_l A_{ll}\left(\gamma_{il}\tilde{t}_{ll}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_1} + \left(\sum_{l,h,h\neq l} A_{lh}^{\frac{\upsilon_2}{\upsilon_1}} \left(\gamma_{il}\theta_i\alpha_{lh}\tilde{t}_{ilh}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}}}$$

while for $h = l$, we get

$$\mathbb{P}_{ill} = \frac{A_{ll}\left(\gamma_{il}\iota_l^{\frac{1}{1-\sigma}}\tilde{t}_{ll}w_l\Xi_l\right)^{-\upsilon_1}}{\theta_i\sum_l A_{ll}\left(\gamma_{il}\tilde{t}_{ill}\iota_l^{\frac{1}{1-\sigma}}w_l\Xi_l\right)^{-\upsilon_1} + \left(\sum_{l,h,h\neq l} A_{lh}^{\frac{\upsilon_2}{\upsilon_1}} \left(\gamma_{il}\theta_i\alpha_{lh}\iota_l^{\frac{1}{1-\sigma}}\tilde{t}_{ilh}w_l\Xi_l\right)^{-\upsilon_2}\right)^{\frac{\upsilon_1}{\upsilon_2}}}$$

Since tax havens do not shift to other tax havens, l is a haven implies that $A_{lh} = 0$ for $l \neq h$.

We introduce N_{ill} and N_{ilh} to denote the numerator of $\mathbb{P}_{ill}$ and $\mathbb{P}_{ilh}$ respectively and $\mathcal{D}_i$ their denominator so that for $h \neq l$

$$\mathbb{P}_{ilh} = \frac{N_{ilh}}{\sum_{l\notin\mathcal{H},h,h\neq l} N_{ilh}} \times \frac{\left(\sum_{l\notin\mathcal{H},h,h\neq l} N_{ilh}\right)^{\frac{\upsilon_1}{\upsilon_2}}}{\sum_l N_{illl} + \left(\sum_{l\notin\mathcal{H},h,h\neq l} N_{ilh}\right)^{\frac{\upsilon_1}{\upsilon_2}}} \equiv \frac{N_{ilh}\left(\sum_{l\notin\mathcal{H},h,h\neq l} N_{ilh}\right)^{\frac{\upsilon_1}{\upsilon_2}-1}}{\mathcal{D}_i}$$

$$h = l \Rightarrow \mathbb{P}_{ill} = \frac{N_{ill}}{\sum_l N_{ill} + \left(\sum_{l\notin\mathcal{H},h,h\neq l} N_{ilh}\right)^{\frac{\upsilon_1}{\upsilon_2}}}$$

Relative changes in $\mathbb{P}_{ill}$ and $\mathbb{P}_{ilh}$ are given by

$$\widehat{\mathbb{P}}_{ill} \equiv \frac{\hat{N}_{ill}}{\sum_l \hat{N}_{ill}\mathbb{P}_{ill} + \left(1-\sum_l \mathbb{P}_{ill}\right)^{1-\frac{\upsilon_1}{\upsilon_2}}\left(\sum_{l\notin\mathcal{H},h,h\neq l} \hat{N}_{ilh}\mathbb{P}_{ilh}\right)^{\frac{\upsilon_1}{\upsilon_2}}}$$

and

$$\widehat{\mathbb{P}}_{ilh} \equiv \frac{\hat{N}_{ilh}\left(1-\sum_l \mathbb{P}_{ill}\right)^{1-\frac{\upsilon_1}{\upsilon_2}}\left(\sum_{l\notin\mathcal{H},h,h\neq l} \hat{N}_{ilh}\mathbb{P}_{ilh}\right)^{\frac{\upsilon_1}{\upsilon_2}-1}}{\sum_l \hat{N}_{ill}\mathbb{P}_{ill} + \left(1-\sum_l \mathbb{P}_{ill}\right)^{1-\frac{\upsilon_1}{\upsilon_2}}\left(\sum_{l\notin\mathcal{H},h,h\neq l} \hat{N}_{ilh}\mathbb{P}_{ilh}\right)^{\frac{\upsilon_1}{\upsilon_2}}}$$

where

$$\hat{N}_{ill} = \widehat{w_l\Xi_l\tilde{t}_{ill}}^{-\upsilon_1} \qquad \hat{N}_{ilh} = \widehat{w_l\Xi_l\tilde{t}_{ill}}^{-\upsilon_2}$$

Haven-residence countries $i \in \mathcal{H}$ The probability to locate in l is simply given by

$$\mathbb{P}_{ill} = \frac{N_{ill}}{\sum_l N_{ill}}$$

and relative changes are given by

$$\widehat{\mathbb{P}}_{ill} = \frac{\hat{N}_{ill}}{\sum_l \mathbb{P}_{ill}\hat{N}_{ill}}$$

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ÉCOLE DOCTORALE
Droit, Économie, Management (DEM)

Titre: Essais sur les Paradis Fiscaux et l'Évasion Fiscale
Mots clés: Paradis fiscaux, Taxation internationale, Évasion fiscale, Évitement fiscal, Firmes multinationales

Résumé: Cette thèse étudie la taxation internationale et son évitement par les individus et les entreprises. Dans un contexte de coordination internationale imparfaite, individus et entreprises peuvent utiliser les différences légales entre plusieurs États afin d'éviter la taxation. Ce comportement est facilité par l'existence de juridictions agressives, les paradis fiscaux, qui proposent des faibles taux de taxation ainsi qu'une structure juridique facilitant l'évitement de l'impôt dans d'autres juridictions. Pourquoi des pays deviennent-ils des paradis fiscaux? Comment l'utilisation des paradis fiscaux affecte-t-elle les recettes fiscales des États? Quelles stratégies sont mises en place par les entreprises pour éviter l'impôt? Comment réformer la taxation internationale afin de limiter l'utilisation des paradis fiscaux? Cette thèse propose de répondre à ces questions en trois chapitres.
Le premier chapitre étudie la formation et le développement des paradis fiscaux à travers la création d'une nouvelle base de données qui retrace les moments où des juridictions sont devenues des paradis fiscaux. Les paradis fiscaux sont vus comme des offreurs dans le marché des services d'évasion et d'évitement fiscal. Cela permet d'analyser empiriquement et théoriquement le rôle des forces de marchés comme la demande et la compétition dans les décisions des pays à devenir des paradis fiscaux.

Le second chapitre étudie le comportement d'évasion fiscale des entreprises multinationales états-uniennes. Nous montrons que celles-ci enregistrent leurs ventes et leurs profits dans les paradis fiscaux alors que les biens et services qu'elles produisent sont physiquement vendus dans d'autres pays. Nous étudions les conséquences de ces pratiques sur l'organisation des firmes multinationales, sur les revenus fiscaux ainsi que sur les politiques à utiliser pour limiter le recours au paradis fiscaux.

Le troisième chapitre construit un modèle théorique de localisation des firmes multinationales lorsque celles-ci peuvent déplacer leurs profits dans des paradis fiscaux. Le cadre théorique identifie et met en avant les frictions bilatérales auxquelles les entreprises font face lorsqu'elles localisent leurs profits dans les paradis fiscaux. Afin de calibrer le modèle, nous proposons une méthodologie d'estimation des profits déplacés dans les paradis fiscaux. Le modèle est ensuite utilisé pour simuler les conséquences de réformes de la fiscalité internationale sur les revenus fiscaux, la localisation des entreprises et la consommation des ménages. Nous montrons que les effets réels de la taxation sont importants.

Title: Essays on Tax Havens and Tax Avoidance
Keywords: Tax havens, Tax evasion, Tax avoidance, International taxation, Multinational Firms

Abstract: This dissertation studies international taxation and its avoidance by individuals and firms. When international coordination is imperfect, individuals and firms can use legal differences between several jurisdictions to avoid being taxed. This behavior is facilitated by aggressive jurisdictions, tax havens, with low tax rates and legal architectures facilitating tax evasion and tax avoidance in other jurisdictions. Why do some countries become tax havens? How does tax haven use impact tax revenues? What kind of strategies are used by multinational firms to avoid taxes? How to reform international taxation to limit the use of tax havens? This dissertation proposes to answer these questions in three chapters.
The first chapter of this dissertation studies the formation and development of tax havens using a new database that traces the moment when jurisdictions have become tax havens. Tax havens are seen as suppliers in the market for tax evasion and avoidance services. This allows us to explore theoretically and empirically the role of market forces in countries' decisions to become tax havens.

The second chapter studies the tax avoidance behavior of U.S. multinational enterprises. We show that they record their sales and profits in tax havens while producing and physically selling goods and services in other countries. We study the impact of these practices on the organization of multinational firms, tax revenues, and the design of anti-tax avoidance policies.

The third chapter builds a theoretical model of multinational firms' location where they can shift their profits to tax havens. The theoretical framework underlines the role of frictions faced by multinational firms when they locate their profits in tax havens. To calibrate the model, we propose a methodology to estimate the profit shifted in tax havens. Using the model, we then simulate the consequences of some reforms of international taxation on tax revenues, firms' location, and consumption. We show the quantitative importance of real effects.