Credit market imperfections and business cycles

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La crise financière de 2009 a mis les économistes devant un nouveau dilemme qui met à son tour l'accent sur l'importance de la sphère financière dans l'analyse conjoncturelle. Tous les travaux de recherche, jusqu'à un certain moment, ont considéré le marché financier comme neutre et le système bancaire comme un voile qui sert à acheminer les fonds et les ressources des ménages en tant qu'épargnant principal, aux entrepreneurs en tant qu'investisseur principal. La crise de 2009 a ravivé le débat entre les classique et les keynésiens concernant le rôle de la finance dans le cycle d'affaire. L'intermédiation financière n'est plus considérée comme un voile. En mettant l'accent sur les frictions financières et leur amplification des chocs qu'elles impliquent, j'ai voulu montrer dans cette thèse les conséquences macroéconomiques de ces imperfections ainsi que quantifier leur impact sur le marché de travail spécialement.

Le premier chapitre est consacré à l'étude du « canal crédit » et de son intérêt pour l'analyse de l'impact de la politique monétaire. Une analyse fine des imperfections du marché du crédit a permis de repérer les différents sous- canaux du canal-crédit. Une modélisation des contrats de crédit est considérée en introduisant des imperfections basées sur des asymétries d'information. Ce modèle a permis d'identifier le sous-canal qui a la plus grande capacité de transmettre la politique monétaire à la sphère réelle. Cette proposition théorique est confirmée par une analyse empirique basée sur l'estimation de modèle VAR.

Le second chapitre fait le lien entre les imperfections financières et le marché du travail. La motivation de ce chapitre est l'observation de la persistance du chômage après la dernière crise financière. Ce travail s'inscrit donc la littérature contribuant à analyser la contribution des chocs financiers sur la persistance du chômage. J'étudie alors la relation empirique entre les caractéristiques des marchés financiers, la volatilité et le rendement, et celles du marché du travail. Pour ce faire, j'estime un modèle VAR structurel, où des statistiques de destructions, de créations d'emplois, de taux de chômage, de taux de défaut, de prime d'émission (indicateur des conditions de crédit) et l'indice de volatilité de VXO (indicateur de l'incertitude dans le marché financier) sont simultanément introduits. Je trouve que les deux chocs financiers et de crédit sont les principales sources de fluctuations du marché du travail.

Partant du constat empirique du second chapitre, le troisième chapitre est consacré à la construction d'un DGSE intégrant des frictions financières et du chômage. L'interaction entre chômage et frictions financière passe par hypothèse que les postes vacants sont financés par des fonds externes qui sont plus couteux qu'un financement interne, de par de l'impact de l'asymétrie d'information sur le marché du crédit. Il est alors montré, à l'aide de simulation du modèle calibré sur données US., qu'un choc financier négatif, i.e. un choc qui augmente la prime de risque sur le marché du crédit ou un choc qui détériore le bilan des entrepreneurs, réduit de manière significative les capacités d'emprunt, et, par conséquent, la création d'emplois diminue.

Chapitre 1. Credit channel, credit market frictions and monetary policy potency

Dans ce chapitre, je développe une analyse empirique du canal de crédit dans un premier temps en utilisant un modèle VAR, estimé par la méthode bayésienne. L'identification du canal de crédit est considérée comme une challenge vue la difficulté de l'enchevêtrement de la demande et l'offre de crédit. Dans les travaux précédents, les économistes prennent le stock de crédit comme un proxy pour l'offre de crédit mais l'évolution de cette variable ne reflète l'offre nette de crédit. Une augmentation du stock de crédit peut être interprétée comme une augmentation de la demande de crédit. Pour résoudre ce problème, je considère les résultats d'une enquête trimestrielle menée par la Banque Fédérale Américaine auprès des banques intitulée "The Senior Loan Officer Opinion Survey". Le modèle contient sept variables trimestrielles qui couvrent la période 1995 : 2 jusqu'au 2007 : 4. Cinq variables, issues de la littérature VAR-monétaire, sont: le taux de croissance du PIB, $_t$, le taux d'inflation, $_t$, le log du montant des réserves propres, NBR_t, le log de la masse monétaire $M1$ et le taux d'intérêt directeur nominal de la Banque Fédérale, FF_t. Les quatre nouvelles variables issues de l'enquête de la Banque Fédérale auprès d'un échantillon de banques domestiques sont: l'offre de crédit, LS_t, l'appétit pour le risque, AR_t, la qualité des emprunteurs, BS_t et la demande de crédit, LD_t. L'analyse couvre uniquement les crédits utilisés dans des activités commerciales et industrielles offerts par les banques locales aux grandes et moyennes entreprises.

Les réponses aux questionnaires sont quantifiées en utilisant la notion de "pourcentage net". L'offre de crédit pure est mesurée par le pourcentage net des banques qui reportent une variation des conditions de crédit due à une variation de leur capital. L'augmentation de l'offre de crédit est traduite par une valeur positive de la différence entre le pourcentage des banques qui reportent une augmentation des conditions d'octroi de crédit due à une amélioration du capital de la banque et le pourcentage des banques qui reportent une baisse des conditions d'octroi de crédit due à une détérioration du capital de la banque.

L'appétit pour le risque est mesurée aussi par la différence entre le pourcentage des banques qui reportent une augmentation des conditions d'octroi de crédit due à une plus grande tolérance au risque et le pourcentage des banques qui reportent une baisse des conditions d'octroi de crédit due à une baisse de la tolérance au risque. Une valeur positive de cette différence est interprétée comme une augmentation de l'appétit pour le risque des banques. De même, la qualité des emprunteurs et leur solvabilité est mesurée par la moyenne de deux variables: les perspectives économiques des emprunteurs et les problèmes spécifiques au secteur d'activité de l'emprunteur. Les perspectives économiques des emprunteurs est mesurée par la différence entre le pourcentage des banques qui reportent une amélioration des conditions d'octroi de crédit due à une amélioration des perspectives économiques des emprunteurs et la baisse de l'incertitude et le pourcentage des banques qui reportent une baisse des conditions d'octroi de crédit due à une détérioration des perspectives économiques des emprunteurs. D'une façon similaire, les problèmes spécifiques au secteur d'activité de l'emprunteur est mesurée par la différence entre le pourcentage des banques qui reportent une amélioration des conditions d'octroi de crédit due à une amélioration au niveau des problèmes spécifiques au secteur d'activité de l'emprunteur et le pourcentage des banques qui reportent une baisse des conditions d'octroi de crédit due à une aggravation des problèmes spécifiques au secteur d'activité. Une valeur positive de la moyenne des pourcentages nets des deux variables indique une amélioration de la solvabilité des emprunteurs. Finalement, la demande de crédit est mesurée par la différence entre le pourcentage des banques qui reportent une augmentation de la demande de crédit et le pourcentage des banques qui reportent une baisse de la demande de crédit.

Les chocs monétaires sont identifiés grâce à un ensemble de restrictions de court-terme. La première expérience constitue à examiner l'impact d'un choc positif sur les réserves propres et la deuxième expérience constitue à examiner l'impact d'un choc négatif sur le taux d'intérêt nominal. Dans les deux cas, le modèle est estimé en utilisant comme prior la distribution Wishart-Normale indépendante.

Les résultats des deux expériences convergent. Une politique monétaire expansionniste engendre une augmentation de l'offre de crédit, la tolérance au risque et un effet liquidité. Une augmentation des réserves propres stimule l'offre pure de crédit à la hausse et réduit le taux d'intérêt nominal engendrant un effet liquidité considérable. L'augmentation de l'offre de crédit stimule l'investissement et la croissance économique. Cependant, la baisse du du taux nominal ne se transmet pas dans sa totalité au coût de crédit à cause de l'augmentation de l'appétit au risque des banques. Cette dernière engendre à son tour une augmentation du taux de défaut des crédits et l'apparition d'une prime de risque. Ce phénomène annule partiellement l'impact positif de la baisse des taux d'intérêt sur l'investissement. Ces résultats sont confirmés par un modèle théorique d'équilibre général où l'appétit au risque et la prime de risque sont endogénéisés.

Le modèle théorique est une version monétaire du modèle de Carlstrom and Fuerst (1997a) où la monnaie est intégrée grâce à un contrainte de détention préalable de monnaie et en imposant une contrainte de "participation limitée". Cette hypothèse vise à bloquer la réponse instantanée des ménages suite à une injection monétaire. Si les ménages répondent instantanément à une politique monétaires expansionnistes, les fonds injectés seront consommés par les ménages et l'effet de liquidité n'existe plus. Ce modèle permet de modéliser l'effet liquidité et la prime de risque issue des frictions informationnelles qui caractérisent le contrat de crédit.

Il s'agit d'une économie fermée composée de cinq agents: les ménages, les entrepreneurs, les firmes, la banque et une banque centrale qui est censée conduire la politique monétaire. Les ménages détiennent en début de période de la monnaie transférée de la période précédente M_t^h. Ils répartissent ce montant entre la consommation C_t, une proportion φ de l'investissement et l'épargne D_t en respectant la contrainte suivante:

$$P_tC_t + \varphi Q_tI_t \leq M_t^h - D_t$$

Quant aux entrepreneurs, ils entrent la période t avec un montant M_t^e de monnaie transféré de la période antérieure, constituant une partie de son actif net N_t qui servira à obtenir un crédit. Les entrepreneurs reçoivent un choc idiosyncratique de productivité aléatoire ω_t après avoir obtenu le crédit, affectant la rentabilité de leur investissement. La résolution du contrat montre l'existence d'une valeur seuil $\bar{\omega}_t$, tel que tout entrepreneur recevant une valeur ω au dessous de $\bar{\omega}_t$ sera déclaré comme banqueroute. Dans ce cas, la banque récupère la totalité du projet, en dépensant un coût marginal de vérification μ. Dans le cas contraire, l'entrepreneur sera déclaré comme solvable. Le rendement de l'entrepreneur est donné par:

$$E^e(\bar{\omega}_t, I_t) = Q_t I_t f(\bar{\omega}_t)$$

où

$$f(\bar{\omega}_t) = \int_{\bar{\omega}_t}^{+\infty} \omega\phi(\omega)d\omega - \bar{\omega}_t \left[1 - \Phi(\bar{\omega}_t)\right].$$

Le profit réalisé par la banque après avoir octroyé un crédit à l'entrepreneur est

$$E^l(\bar{\omega}_t, I_t) = Q_t I_t g(\bar{\omega}_t)$$

où

$$g(\bar{\omega}_t) = (1-\mu)\Gamma(\bar{\omega}_t) + \bar{\omega}_t \left[1 - \Phi(\bar{\omega}_t)\right].$$

and

$$\Gamma(\bar{\omega}_t) = \int_0^{\bar{\omega}_t} \omega\phi(\omega)d\omega.$$

A l'équilibre, tous les agents maximisent leurs fonctions d'utilité et de profit. Le modèle d'équilibre général est linéarisé autour de son état stationnaire. Il est simulé après avoir calibré ses paramètres pour correspondre aux faits stylisés de l'économie américaine. Avant de procéder à l'analyse numérique, une analyse théorique a été réalisée. Deux résultats principaux sont obtenus. Le premier stipule qu'une politique monétaire expansionniste réduit le coût de crédit. Je démontre analytiquement que l'impact de l'injection monétaire dans l'économie contribue à la baisse du coût de crédit à travers de canal de crédit. La transmission du choc monétaire se fait principalement via deux canaux de transmission distincts. Le premier est le canal de crédit classique où la liquidité injectée dans l'économie est acheminée vers le système bancaire grâce à l'hypothèse de la participation limitée qui garantie une rigidité dans la réponse des ménages au choc. Cette rigidité retarde la réaction des ménages après le choc monétaire et toute la liquidité injectée sera transférée aux entrepreneurs à travers l'augmentation de l'offre de crédit. Afin d'inciter les entrepreneurs à emprunter l'excès de liquidité, le coût de crédit doit baisser. En même temps, le résultat mentionne que le taux de défaut augmente aussi, ce qui engendre une augmentation de la prime de risque. Cette dernière annule partiellement la baisse initiale du taux d'intérêt nominal. Cette baisse du coût de crédit est valable pour tout niveau de productivité idiosyncratique seuil tel que l'élasticité du rendement de la banque est inférieure à 0.5.

Le deuxième résultat stipule que l'effet liquidité est une fonction décroissante du coût marginal de vérification. Une augmentation exogène de μ va engendrer une augmentation des pertes anticipées, à cause de la faillite de l'entrepreneur. Dans ce cas là, les prêteurs vont être plus vigilants par rapport à la qualité des prêteurs et vont améliorer le processus de screening des emprunteurs. On peut voir une sorte de "flight to quality". Par conséquent, une augmentation du coût marginal de vérification a un impact négatif sur la transmission de la politique monétaire. De plus, L'élasticité-prix de la demande des fonds prêtables diminue quand le cou^t de vérification augmente, ce qui signifie que la demande de crédit devient plus inélastique et l'investissement devient mois sensible à la politique monétaire. En effet, la puissance de la politique monétaire dépend significativement des caractéristiques du marché de crédit et son environnement institutionnel. L'efficacité de la politique monétaire est plus importante quand le coût marginal de vérification est petit.

L'analyse numérique est basée sur l'analyse des fonctions de réponse des différentes variables économiques à un choc monétaire. Le choc consiste à une augmentation de l'offre de monnaie, qui est une injection exogène de liquidité par la banque centrale dans le système bancaire. J'ai étudié les fonctions de réponses en considérant deux cas distincts: une économie avec frictions financières et une économie sans frictions financières. Les frictions financières sont supprimées en supposant que le coût marginal de vérification μ est nul et $\bar{\omega}_t = 0$. Les fonctions de réponses obtenues montrent que les frictions financières améliorent considérablement la propagation du choc monétaire et amplifient la réponse des variables à un tel choc. L'effet liquidité est amplifié quand l'aléa moral est pris en considération. Bernanke and Gertler (1995a) and Bernanke et al. (1999a) ont trouvé le même résultat, stipulant que les imperfections du marché de crédit amplifient la réponse des variables économiques aux chocs et aide à répliquer la persistance de l'effet de la politique monétaire, qui dure plusieurs trimestres.

Une politique monétaire expansionniste provoque une baisse du taux d'intérêt nominal dans les deux modèles mais cette baisse est plus importante quand les frictions financières sont présentes. Ce constat montre l'existence d'un effet liquidité amplifié qui est transmis à l'économie réelle via le canal de crédit; principalement à travers l'augmentation de la sensibilité de la demande des fonds prêtables au taux d'intérêt de crédit. La procyclicalité de la prime de risque est due à l'augmentation du taux de défaut qui suit une augmentation imprévue de l'offre de monnaie. L'augmentation de la productivité idiosyncratique seuil $\bar{\omega}_t$ se rallie parfaitement avec les résultats du modèle VAR.

Le montant total de la monnaie injectée dans l'économie est absorbé par les entrepreneurs à cause de l'incapacité des ménages de réviser leur décision consommation-épargne. Par conséquent, la quantité de capital produite par les entrepreneurs augmente, ce qui stimule l'investissement et le prix de capital. L'augmentation du capital engendre une augmentation du stock de capital accumulé par les ménages et disponible pour les firmes à l'état stationnaire, ce qui incite les firmes à augmenter leur production. Suite à l'expansion de la production, la demande de travail augmente engendrant une augmentation des revenues des ménages à l'état stationnaire. Bien que la consommation des ménages durant la première période soit fixée par la contrainte de détention préalable de monnaie, les ménages augmentent leur consommation durant les trimestres suivants. En outre, l'injection de la liquidité dans le système bancaire a généré un effet Fisher traduit par une augmentation de l'inflation. L'augmentation des prix entraine deux effets opposés: un effet revenue et un effet substitution. D'après les résultats de la simulation, l'effet revenue domine l'effet substitution: une augmentation du revenue des ménages incite les ménages à consommer davantage et surmonter l'effet substitution grâce à l'augmentation du prix de bien de consommation. Normalement, l'effet inflation stipule que la persistance d'un choc monétaire force les ménages à prendre en considération l'inflation anticipée quand ils décident de leurs dépenses en terme de consommation et d'investissement. Par conséquent, les ménages se trouvent obligés de substituer le bien de consommation par un bien d'investissement et réduire potentiellement leur offre de Travail.

Bien que les imperfections du marché de crédit amplifient la réponse de l'économie au choc de politique monétaire, une limite majeure est reliée à la persistance de l'effet liquidité observé dans les données. L'hypothèse de la participation limitée s'avère inappropriée pour répliquer un effet liquidité persistent car les ménages sont incapables de réviser leur décision consommation-épargne. Qu'il y ait une asymétrie d'information dans le marché de crédit ou pas, cette limite existe, comme le montrent les fonctions de réponse: l'effet liquidité ne dure pas plus que 4 trimestres. Dans l'ensemble, le modèle avec des imperfections dans le marché de crédit montre une robustesse en terme de résultats qualitatifs.

Une analyse des moments de variables ainsi que leurs corrélations avec le produit montrent que le produit et l'investissement ont le même niveau de volatilité, qui est considérablement élevée dans le modèle, comparé à la volatilité observée dans les données. En outre, la consommation et l'emploi sont moins volatiles dans le modèle comparant aux données. Le modèle avec asymétrie d'information dans le marché de crédit montre une volatilité plus élevée de l'investissement comparant au modèle où l'information est symétrique. Cette différence est due principalement à la sensibilité croissante de la demande des fonds prêtables au coût de crédit. D'un autre côté, le produit réel et l'emploi ont quasiment la même volatilité. Dans les deux modèles, la volatilité du produit réel est considérablement plus élevée que celle de l'emploi. Globalement, le modèle avec asymétrie d'information reproduit un niveau de volatilité plus élevée.

Chapitre 2. Credit shocks, uncertainty shocks and labor market

Dans le deuxième chapitre, J'ai fait le lien entre les imperfections financières et le marché du travail. La motivation de ce chapitre est l'observation de la persistance du chômage après la dernière crise financière. Ce travail s'inscrit donc la littérature contribuant à analyser la contribution des chocs financiers sur la persistance du chômage. J'étudie alors la relation empirique entre les caractéristiques des marchés financiers, la volatilité et le rendement, et celles du marché du travail. Pour ce faire, J'estime un modèle VAR structurel, où des statistiques de destructions, de créations d'emplois, de taux de chômage, de taux de défaut, de prime d'émission (indicateur des conditions de crédit) et l'indice de volatilité de VXO (indicateur de l'incertitude dans le marché financier) sont simultanément introduits. Je trouve que les deux chocs financiers et de crédit sont les principales sources de fluctuations du marché du travail.

Une augmentation imprévue de la prime de risque ou de l'incertitude a un impact considérable sur la création et la destruction des emplois. Bloom (2009) et Bloom et al. (2012) ont trouvé un résultat , mais dans un contexte plus général où toute l'économie est considérée. Le résultat central est l'incertitude est contracyclique, amplifie les chocs négatifs et atteint ses niveaux les plus élevés durant les périodes de récessions. Bien que l'impact des chocs sur le coût de crédit soit bien connu, il est difficile de les identifier empiriquement. Généralement, une augmentation de la volatilité au sein du marché financier, prise comme proxy de l'incertitude, est associée avec une augmentation de la prime de risque. Le ralentissement économique observé après ces développements est généralement considéré comme une conséquence de la combinaison des deux chocs. Plusieurs essaie dans la littérature visant l'identification des deux chocs dans le contexte d'un modèle VAR. La difficulté majeure était la haute réactivité de l'incertitude et la prime de risque. Quelques économistes soutiennent la thèse de l'impossibilité d'imposer des restrictions de court-terme afin d'identifier les deux chocs. De plus, il est difficile d'utiliser une stratégie d'identification basée sur les restrictions par les signes, imposées sur les fonctions de réponses afin d'obtenir une interprétation économique raisonnable. La raison principale est qu'un choc négatif engendrant une augmentation de l'incertitude ou la prime de risque a le même impact sur les variables économiques principales. Par exemple, Meeks (2012) a utilisé l'accélérateur financier développé par Bernanke et al. (1999b) pour justifier les restrictions par les signes afin d'identifier les chocs financiers. Les chocs financiers sont interprétés dans ce contexte comme chocs de crédit où un choc négatif entrainant une baisse de l'offre de crédit engendre une baisse des fonds transférés aux entrepreneurs. Afin de mettre en ouvre cette stratégie d'identification, un contrôle de la maturité et le timing s'avère crucial. Le résultat de cette méthode est que les chocs financiers contribuent considérablement au cycle d'affaire durant les périodes de récessions.

Afin de répondre aux questions soulevés au-dessus, je considère une modèle VAR structurel monétaire standard, au quel je rajoute le taux de créations et le taux de destructions d'emplois, le taux de chômage, le taux de défaut, l'excédent de prime associé aux obligations comme indicateur des conditions de crédit et l'indice VXO comme indicateur de l'incertitude dans le marché financier. Afin d'améliorer l'efficacité des estimateurs et remédier au problème du nombre élevé de paramètres, un VAR structurel est estimé en utilisant l'estimation bayésienne. J'utilise la distribution Wishart-Normale comme prior. L'identification des chocs est basée sur l'hypothèse que uniquement la prime de risque et la volatilité dans le marché financier répondent immédiatement aux chocs. Tous les autres variables réagissent après un délai d'un période.

Les variables choisies couvrent une période de $1986Q1$ au $2005Q1$. L'approche bayésienne stipule que les paramètres sont traités comme des variables aléatoires où des priors leur sont affectés. En effet, l'espace de paramètres augmentent géométriquement avec le nombre de variables endogènes et proportionnellement avec le nombre de retards. Étant donné le nombre important de variables incluses dans le modèle et la taille modeste de l'échantillon, l'estimation bayésienne permet de surmonter le problème de surestimation caractérisant les modèles VAR standards. L'intégration de l'information à travers les priors permet une meilleure précision au niveau des prévisions et renforce le lien entre la théorie économique et les modèles VAR. Dans le cas de ce chapitre, comme le nombre d'observation est acceptable, l'inférence peut être instable et affectée par le bruit plutôt que par les signaux émis par les données. La méthode bayésienne permet de réduire le nombre de paramètres sans leur imposer des valeurs nulles. L'idée est d'ajouter une certaines incertitude aux paramètres de telle façon que le vecteur des paramètres ait une distribution à la place de valeurs exactes. Cette distribution constitue le prior, qui sera mis à jour par la quantité d'informations incluses dans les données. La difficulté est d'imposer des priors réalistes qui respectent les caractéristiques statistiques des séries macroéconomiques, y compris les tendances et l'auto-corrélation élevé. Concrètement, ça revient à imposer une distribution de probabilité, où la moyenne et la variance sont contrôlées. En d'autres termes, la moyenne des paramètres associés à tous les délais, hormis le premier délai, est égale à zéro. Ensuite, la variance des paramètres doit être une fonction inverse du nombre de délais. Enfin, out coefficient associé à une variable X_{-i} a une variance inférieure à celle de l'équation de la variable X_i. Ces hypothèses sont équivalents à introduire un vecteur d'hyper-paramètres qui contrôlent pour les valeurs de la moyenne et de la variance de tous les paramètres pour les différents délais.

Un VAR structurel est un modèle à p-équations et q-variables où chaque variable est expliquée par ses propres retards, les valeurs actuelles et passées des autres variables. Par conséquent le modèle vise à capter les interdépendances linéaires au sein d'un ensemble de variables. Le VAR structurel considéré ici est donné par:

$$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + ... + A_L X_{t-L} + \epsilon_t, \quad t = 1, ..., T \tag{1}$$

où X_t est un vecteur de variables de dimension $p \times 1$ à la date t, A_0 est un vecteur de constantes de dimensions $p \times 1$ et A_i est une matrice de coefficients pour chaque délai de vecteur de variables de dimension $p \times p$. ϵ_t est un vecteur des erreurs i.i.d de dimension $p \times 1$ avec une matrice variance-covariance, Σ. Alors $E(\epsilon_t \epsilon_t^{'}) = \Sigma$, $E(\epsilon_t) = 0$ et $E(\epsilon_t \epsilon_t^{'}) = 0$, $\forall t \neq s$. L'ensemble des paramètres inconnus à estimer est résumé par le vecteur β où $\beta = vec(A_0, A_1, A_2, ..., A_L)$ et la matrice Σ.

L'estimation de 1 en utilisant la méthode bayésienne est équivalente à trouver la distribution posterior jointe des paramètres conditionnellement à l'ensemble d'information incluse dans les données, $p(\beta, \Sigma \mid X)$. La distribution du posterior est donnée par:

$$p(\beta, \Sigma \mid X) \propto p(\beta, \Sigma)\mathcal{L}(X \mid \beta, \Sigma)$$

où $p(\beta, \Sigma)$ est la distribution du prior et $\mathcal{L}(X \mid \beta, \Sigma)$ est la fonction de vraisemblance qui résume toute l'information incluse dans les données. Elle est donnée par:

$$\mathcal{L}(X \mid \beta, \Sigma) \propto \mid \Sigma \mid^{-T/2} \exp\Big\{ -\frac{1}{2} \sum_t (X_t - Z_t\beta)'\Sigma^{-1}(X_t - Z_t\beta)\Big\}$$

où $Z_t = I_p \otimes (I_p, X'_{t-1}, X'_{t-2}, ..., X'_{t-L})$.

Du moment que $p(\beta, \Sigma \mid X)$ est calculé, on peut déduire la distribution marginale du posterior de β et Σ conditionnellement aux données, qui sont données par $p(\beta \mid X)$ et $p(\Sigma \mid X)$, respectivement. Le calcul de la distribution marginale du posterior est basé sur l'intégration de $p(\beta, \Sigma \mid X)$, qui difficile à calculer. Par conséquent, j'utilise la méthode de simulation Monte Carlo pour l'integration numérique. Une méthode spéciale utilisée dans la littérature est "Gibbs Sampler".

L'estimation est basée sur le choix de la distribution du prior $p(\beta, \Sigma)$. J'utilise la distribution Wishart-Normale. Cette distribution est une extension de la distribution de Minnesota, où l'hypothèse d'une matrice variance-covariance des erreurs Σ diagonale constante est relaxée. En outre, la propriété de "conjugacy" est appliquée de telle façon la distribution posterior a la même forme paramétrique que la distribution prior. Les priors sont donnés par:

$$p(\beta \mid \Sigma) = N(\bar{\beta}, \Sigma \otimes \bar{\Omega}) \quad (2)$$

$$p(\Sigma) = iW(\bar{\Sigma}, \alpha) \quad (3)$$

où $E(\beta) = \bar{\beta}$ et $V(\beta) = (\alpha - p - 1)^{-1}\bar{\Sigma} \otimes \bar{\omega}$, avec α désigne le nombre de degrés de liberté de la distribution inverse-Wishart, vérifiant $\alpha > n + 1$ et $\bar{\Omega}$ est la matrice variance-covariance de β.

Étant donné la spécification des priors au-dessus, la distribution du posterior de β et Σ ont les expressions suivantes :

$$\begin{aligned} p(\beta \mid \Sigma, Y) &= N(\tilde{\beta}, \Sigma \otimes \tilde{\Omega}) \quad (4) \\ p(\Sigma \mid Y) &= iW(\tilde{\Sigma}, T + \alpha) \quad (5) \end{aligned}$$

où,

$$\begin{aligned} \tilde{\Omega} &= (\bar{\Omega}^{-1} + X'X)^{-1} \quad (6) \\ \tilde{\beta} &= \tilde{\Omega}(\bar{\Omega}^{-1}\bar{A} + X'X\hat{A}_{ols}) \quad (7) \end{aligned}$$

$$\begin{aligned} \tilde{\Sigma} = \hat{A}'_{ols}X'X\hat{A}_{ols} + \bar{A}'\bar{\Omega}^{-1}\bar{A} + \bar{\Sigma} \\ + (Y - X\hat{A}_{ols})'(Y - X\hat{A}_{ols}) \\ - \tilde{A}'(\bar{\Omega}^{-1} + X'X)\tilde{A} \end{aligned} \quad (8)$$

avec $A = [A'_0, ..., A'_L]$ and $iW(R, r)$ est l'inverse de la distribution Wishart avec une matrice de balance R et r degrés de liberté. Cette distribution est le conjugué de la distribution prior d'une matrice covariance à distribution normale multivariée.

Afin d'obtenir la distribution marginale du posterior de A, Σ doit être intégrée à partir de la distribution jointe du posterior données par (7). Cette distribution marginale suit une distribution de Student multivariée. A ce niveau, $\bar{\beta}$, $\bar{\Omega}$ et Σ sont fixes. En pratique, j'ai considéré la distribution Minnesota pour une raison de simplicité. α, Le nombre de degrés de liberté de la distribution Wishard est choisi tel que les variances de différents paramètres existent. En outre, les valeurs respective des éléments de la diagonale de $\bar{\Sigma}$ désigné par $\bar{\sigma}_{ii}$, sont proportionnels aux variances des mêmes éléments obtenus d'un modèle AR(L) univarié σ^2_{ii}, avec $\bar{\sigma}^2_{ii} = (\alpha - p - 1)\sigma^2_{ii}$.

Toutes les variables considérées dans le modèle sont exprimées en log sauf le taux d'intérêt nominal, le taux de chômage, le taux de défaut et la prime de risque. Le nombre optimal de délais est déterminé pour chaque choc en utilisant Schwarz-Bayes (SB), Hannan-Quinn (HQ) and Akaike's Final Prediction Error (FPE) criteria. Le nombre optimal de nombre de lags est égal à $L = 1$.

Je considère des données américaines couvrant la période de 1986$Q1$ à 2005$Q1$. L'échantillon s'arrête avant la Grande Récession; on a voulu éviter d'inclure cette période car elle était marquée par la mise en oeuvre des politiques monétaires inconventionnelles. La stratégie d'identification adoptée n'est pas capable de capter ce types de politiques. En outre, les données concernant le taux de destructions et le taux de créations d'emplois n'est disponible qu'à partir de 2005$Q1$. Le VAR structurel est destiné à étudier l'impact d'un choc monétaire et un choc de crédit sur les marchés de travail et de crédit. Les deux chocs sont identifiés en se basant sur des restrictions de court terme comme chez Christiano et al. (2005) et Popescu and Smets (2010).

Les fonctions de réponses à un choc monétaire sont obtenues en prenant le spread Baa-Aaa comme mesure de la prime de risque. La distribution du prior est une Wishard-Normale. Un choc positif sur le taux d'intérêt nominal engendre une baisse considérable du PIB réel. La baisse maximale est de 2%, atteinte après 8 trimestres. Les entreprises réduisent leur demande de travail, suite à une baisse de la production. Par conséquent, le taux de chômage augmente, pour atteindre une augmentation maximale de 3.5%, 8 trimestres après l'augmentation du taux d'intérêt nominal. L'augmentation du chômage est due surtout à une augmentation importante du taux de destruction de postes et une baisse rapide du taux de création des postes. En effet, la destruction des postes augmente de 1% après 5 trimestres et la créations des postes baisse de 0.8% après 3 trimestres. Ce résultat est consistent avec les résultats de Ravn and Simonelli (2007) et Hansen (1985) qui ont particulièrement montré que 55% de la variabilité des heures travaillées est due à la variation du nombre des employés et seulement 20% de cette variation est due à la variation des nombre d'heures travaillées. D'autres travaux ont montré que les deux marges, intensive et extensive, répondent à un choc monétaire. Le niveau de l'emploi ainsi que le nombre d'heures travaillées baissent. Les salaires réels augmentent marginalement mais ils commencent à baisser après 5 trimestres. Le niveau maximal de l'augmentation des salaires réels est de 1.7%. De plus, l'inflation augmente aussi, réalisant une augmentation maximale après 2 trimestres. Le spread Baa-Aaa, pris comme proxy de la prime de risque, et le taux de défaut suivent la même tendance.

Ils atteignent une augmentation maximale après 5 trimestres. L'augmentation de la prime de risque et le taux de défaut atteignent un maximum de 0.8% et 3%, respectivement. Une politique monétaire restrictive engendre une récession persistante. Le PIB, le nombre d'heures travaillées par employé baissent et le taux de chômage, la prime de risque et le taux de défaut augmentent. Il y a deux points importants à signaler. Premièrement, le salaire réel augmente suite à un choc positif sur le taux d'intérêt nominal, témoignant de la rigidité des salaires observée dans les données. Deuxièmement, la réponse de l'indice d'incertitude n'est pas significative. Ce résultat peut être expliqué par deux raisons: le nombre limité d'observations et la capacité informative limité de cet indice.

Les fonctions de réponse à un choc de crédit sont obtenues en utilisant la prime excédentaires des obligations construite par Gilchrist et al. (2009a), connu sous le nom de GZ-spread. J'utilise la distribution Wishard-Normale comme prior. En outre, le taux de défaut est exclu de l'estimation du modèle pour éviter tout problème d'endogéneité car le GZ spread est un indice composite de quelques variables, y compris le taux de défaut. Un choc de crédit correspond à une augmentation de la prime de risque. Suite à ce choc, le PIB réel baisse considérablement, accompagné par une augmentation marginale de l'inflation. Les réponses de l'inflation et du PIB sont consistantes avec les résultats dans la littérature. La baisse du PIB est autour de 0.8% atteinte après 5 trimestres. L'inflation augmentent de 0.1% après 6 trimestre. Le taux d'intérêt nominal baisse de 0.2% après 5 trimestres.

Suite à une augmentation imprévue de la prime de risque, le taux de chômage augmente considérablement, par 0.5% après 6 trimestres. Cette baisse peut être interprétée comme le résultat d'une augmentation du taux de destruction des emplois et une baisse du taux de création des emplois. Un choc positif de la prime de risque augmente le coût de financement externe pour les firmes, entrainant une baisse de leur production, leur investissement et par conséquent la création de l'emploi. La création de l'emploi a baissé de 0.4% après 4 trimestres et le taux de destruction de l'emploi augmente de 0.4% après 4 trimestres. L'impact de ce choc sur le PIB réel est plus important que son impact sur le chômage. Le nombre d'heure par employé baisse de 0.5% au sixième trimestre. La marge extensive de l'emploi est plus sensible aux chocs de crédit que la marge intensive. La réponse de chômage à un choc défavorable est plus importante et plus persistante que la réponse des nombres d'heures. Le salaire réel baisse considérablement. La contraction des conditions de crédit entraine une augmentation du taux de chômage et une détérioration du marché de l'emploi.

Je considère finalement, l'impact d'un choc exogène positif à l'indice VXO. Cet indice est pris comme une proxy pour l'incertitude sur le marché financier. Un tel choc engendre une augmentation du PIB réel 4 trimestres après le choc. Bien que ce résultat soit imprévu, mais il reste consistent avec la baisse du taux d'intérêt nominal et l'inflation. Une augmentation de la volatilité dans le marché financier a un impact retardé sur l'économie réelle. Le taux d'intérêt nominal et l'inflation baissent initialement pour 6 trimestres, mais ils augmentent de nouveau pour atteindre une augmentation de 0.005% et de 2%, respectivement. L'impact sur le marché de travail est plus consistent avec la conjecture économique. Le taux de destruction des emplois augmente de plus de 0.015% dans 2 trimestres, le taux de création d'emplois baisse de plus de 8% durant le premier trimestre. Malgré la baisse importante du taux de création d'emploi, le taux de chômage est conduit principalement par le taux de destruction des postes. Le taux de chômage commence à baisser à partir du quatrième trimestre, quand le taux de destruction de l'emploi a commencé à baisser. Globalement, une augmentation de l'incertitude dans le marché financier engendre une augmentation de la prime de risque. L'augmentation de la prime de risque était annulé e partiellement par la baisse du taux d'intérêt nominal. L'impact final sur le chômage est une combinaison de deux effets opposés. Le premier est due à l'augmentation de la production qui stimule l'emploi. Le second est due à une destruction de postes intensive suite à l'augmentation de l'incertitude dans les marchés financiers.

Chapitre 3. Uncertainty shock, risk shock and interplay of intensive and extensive margins in the labor market

Le troisième chapitre est consacré à la construction d'un DSGE intégrant des frictions financières et du chômage. L'interaction entre chômage et frictions financière passe par l'hypothèse que les postes vacants sont financés par des fonds externes qui sont plus coûteux qu'un financement interne, de par de l'impact de l'asymétrie d'information sur le marché du crédit. Il est alors montré, à l'aide de simulation du modèle calibré sur données US., qu'un choc financier négatif, i.e. un choc qui augmente la prime de risque sur le marché du crédit ou un choc qui détériore le bilan des entrepreneurs, réduit de manière significative les capacités d'emprunt, et, par conséquent, la création d'emplois diminue.

Il s'agit d'un modèle New-Keynésien monétaire avec asymétrie d'information dans le marché de crédit et un modèle de matching à la Mortensen and Pissarides. Le modèle permet de comprendre les fluctuations cycliques qui caractérisent les variables principales du marché de travail telles que le chômage, les postes vacants, les heures travaillées par employé et les salaires et les variables principales du marché de crédit telles que la prime de risque et le taux de défaut. En effet, et comme les salaires et le coût de création des nouveaux postes sont financés partiellement par le crédit, l'interaction entre les frictions dans le marché de crédit et le marché de travail constitue un élément clé pour mieux comprendre et analyser la propagation et l'amplification des chocs dans les deux marchés.

D'après le modèle théorique, on trouve que la procyclicalité de la prime de risque a un impact sur la création de postes, la masse salariale et le chômage dans l'économie. Durant les périodes de récession, la prime de risque augmente et le "net worth" des firmes baisse. Ce qui augmente leur dépendance au fonds externes, ce qui rend à son tour la création des postes couteuse. Par conséquent, il y aura mois de postes vacants et un niveau de chômage plus élevé. L'asymétrie d'information dans le marché de crédit augmente le coût marginal ainsi que les prix, et le coût de recrutement à cause d'un mark-up financier, qui dépend positivement du coût de vérification et du niveau de choc idiosyncratique seuil. Ce mark-up financier est censé couvrir les coûts d'agence qui naissent durant la relation entre les banques et les firmes produisant les biens de consommation. Par contre, ce mark-up va être transféré aux prix fixés par les firmes et par conséquent ça va affecter les décisions de recrutement des firmes, les salaires ainsi que le niveau de l'emploi.

Comme le montre l'évolution du taux de chômage, le Baa-Aaa spread et le taux de défaut entre $1970Q1$ et $2007Q4$ pour l'économie américaine, la corrélation entre ces variables est égale à 0.76. Par conséquent, une valeur élevée du taux de chômage est accompagnée par une valeur élevée du Baa-Aaa spread. Concernant le taux de défaut, la corrélation est moins claire, à cause des réformes structurelles entre 1971 et 1980. Cependant, il y a des corrélations importantes caractérisant des périodes spécifiques. Ces résultats sont répliqués par le modèle théorique où on montre que le taux de chômage est déterminé par l'évolution de la prime de risque et le taux de défaut. Étant donnés tous ces motivations empiriques, on a élaboré une analyse numérique du modèle que nous simulons pour établir le lien entre la sphère financière et le marché de l'emploi. On calibre le modèle sur l'économie américaine. On trouve que l'emploi et les postes vacants augmentent suite à choc de crédit positif ou un choc de "net-worth", tandis qu'un choc d'incertitude engendre une augmentation persistante du chômage. Un choc positif de net-worth est interprété comme un choc positif de richesse. On a trouvé que l'impact de ce choc sur l'emploi est très élevé et plus persistant que l'impact de la baisse du coût de vérification. En outre, les deux chocs entrainent un effet substitution entre la marge intensive et la marge extensive de l'emploi. Une amélioration des conditions du marché de crédit encourage des entrepreneurs à ouvrir des postes, les firmes à augmenter leur production et les employés à travailler un nombre d'heures moindre. Ce résultat est consistent avec les travaux empiriques. Le modèle a permis de mettre l'accent sur les canaux de transmission des principaux chocs qui appariassent pour la première fois dans le marché de crédit vers le marché de travail et les résultats sont consistent avec les faits stylisés et la conjecture théorique.

Le modèle décrit une économie fermée où il y a sept agents: les ménages, les firmes-grossistes gérées par les entrepreneurs, les firmes-détaillantes, les firmes vendant le produit final, une banque et le gouvernement qui conduit les politiques monétaire et fiscale. Le secteur des ménages est représenté par un continuum de ménages identiques. Chaque ménage est constitué de membres qui soit travaillent ou en chômage. Tous les membres sont supposés être averses au risque. Ils offrent le travail, louent le capital et épargnent en transférant la monnaie d'une période à l'autre à travers les dépôts dans les intermédiaires financiers. On suppose qu'il y a un partage parfait de risque tel que la consommation est assurée pour tous les membres de chaque ménage quelque soit le membre travaille ou en chômage. Le revenues des ménages sont composés du salaire réel des membres qui travaillent $W_t H_t n_t$, les primes de chômage, b, gagnées par les membres en chômage et les profits transférés des autres firmes Π_t. Le ménage reçoit aussi des banques le principales de ses dépôts ainsi que le montant des intérêts gagnés, $R_{t-1}D_{t-1}$. Le ménage possède le capital dans cette économie et le loue à un taux r_t^K. Finalement, ces revenues sont utilisés dans la consommation du bien final , C_t, dans l'investissement I_t, en épargnant un montant D_t et le reste est accumulé sous forme de détentions monétaires. Les conditions d'optimalité issues de la résolution du problèmes des ménages sont données par:

$$
\begin{array}{llcl}
(C_t) & \lambda_t & = & \frac{\epsilon_t^C}{C_t - hC_{t-1}} - \beta h E_t \frac{\epsilon_{t+1}^C}{C_{t+1} - hC_t} \\
(D_t) & 1 & = & \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{R_t}{\pi_{t+1}} \right] \\
(\nu_t) & r_t^K & = & (\epsilon_t^I)^{-1} \Upsilon'(\nu_t) \\
(I_t) & \epsilon_t^I Q_t \left[1 - \Lambda \left(\frac{I_t}{I_{t-1}} \right) \right] & = & 1 + \epsilon_t^I Q_t \frac{I_t}{I_{t-1}} \Lambda' \left(\frac{I_t}{I_{t-1}} \right) - \beta E_t \epsilon_{t+1}^I \frac{\lambda_{t+1}}{\lambda_t} Q_{t+1} \left(\frac{I_{t+1}}{I_t} \right)^2 \Lambda' \left(\frac{I_{t+1}}{I_t} \right) \\
(K_t^p) & Q_t & = & \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left((1 - \delta_K) Q_{t+1} + r_{t+1}^K \nu_{t+1} - (\epsilon_{t+1}^I)^{-1} \Upsilon(\nu_{t+1}) \right) \right] \\
(M_t) & \frac{M_t}{P_t} & = & \xi \left[\lambda_t - \beta E_t \left(\frac{\lambda_{t+1}}{\pi_{t+1}} \right) \right]^{-1}
\end{array}
$$

Les entrepreneurs possèdent les firmes-grossistes et ils sont des managers. Au début de chaque période, ils empruntent de l'argent de la banque pour couvrir les frais d'ouverture de postes et la masse salariale. Après avoir reçu le montant de la banque, ils louent et paye immédiatement le capital dont ils ont besoin dans un marché de capitaux compétitif. En même temps, les postes vacants sont postés et le processus de recrutement commence. Les entrepreneurs alors payent immédiatement le coût de recrutement, le salaire des nouveaux recrutés et les salaires des anciens employés. Vers la fin de la période, l'entrepreneur soit rembourse le crédit et garde le reste de son rendement sous firme de net-worth pour la période prochaine ou il déclare la faillite et à ce moment là la banque conduit une vérification couteuse et confisque tout le projet. Par conséquent la fonction d'accumulation du net-worth est donnée par:

$$X_{t+1} = W^e + \varsigma_t \frac{P_t^{ws}}{P_t} Y_t^{ws} f(\bar{\omega}_t)$$

Le montant de la consommation des entrepreneurs est donnée par

$$C_t^e = (1 - \varsigma_t) \frac{P_t^{ws}}{P_t} Y_t^{ws} f(\bar{\omega}_t)$$

$f(\bar{\omega}_t)$ est la proportion des rendements restituée par 'entrepreneur suite au contrat financier. Chaque entrepreneur i doit résoudre le problème suivant:

$$\begin{aligned}
\underset{K_{it},H_{it},V_{it},\bar{\omega}_{it}}{max} \quad & [P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it}] f(\bar{\omega}_{it}, \sigma_{\omega,t}) \\
\text{S/C} \quad & [P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it}] g(\bar{\omega}_{it}, \sigma_{\omega,t}) \geq R_t P_t (W_{it} N_{it} + \gamma V_{it} + r_t^K K_{it} - X_{it}) \\
& \psi_{it} = p_t V_{it} \\
& N_{it} = n_{it} H_{it}
\end{aligned}$$

Les conditions d'optimalité sont:

$$\begin{aligned}
Y_K^{ws}(K_{it}, H_{it} \mid n_{it}) &= \frac{P_t}{P_t^{ws}} r_t^K R_t S_{it} \\
Y_H^{ws}(K_{it}, H_{it} \mid n_{it}) &= \frac{P_t}{P_t^{ws}} n_{it} W_{it} R_t S_{it} \\
\frac{Z_t}{P_t} &= \frac{\gamma}{p_t} R_t S_{it}
\end{aligned}$$

où $S_{it} = \{1 - \mu_t[\Gamma(\bar{\omega}_{it}, \sigma_{\omega,t}) + \bar{\omega}_{it} h(\bar{\omega}_{it}, \sigma_{\omega,t}) f(\bar{\omega}_{it}, \sigma_{\omega,t})]\}^{-1}$, avec $h(\bar{\omega}_{it}, \sigma_{\omega,t})$ le taux de hasard défini par défini par $h(\bar{\omega}_{it}, \sigma_{\omega,t}) = \dfrac{\phi(\bar{\omega}_{it}, \sigma_{\omega,t})}{1 - \Phi(\bar{\omega}_{it}, \sigma_{\omega,t})}$.

L'asymétrie d'information dans le marché de crédit a généré des frictions dans les deux marchés, le marché des biens et le marché de travail. Ainsi, la productivité marginale de travail est plus élevée est plus élevée que son coût marginal. Le prix final de biens en gros est augmenté par la mark-up S_t, utilisé pour surmonter les problèmes d'agence entre entrepreneurs et banques. Par conséquent, les conditions du marché de crédit sont importants car ils affectent le coût marginal des firmes et il est transmis au reste de l'économie à travers les prix. Ce contexte annonce la rupture avec le théorème de Modigliani-Miller et rend le coût de l'endettement externe plus élevé que le coût d'opportunité des fonds internes.

La négociation salariale se fait entre les entrepreneurs et les membres du ménage cherchant un emploi, à travers un processus de négociation salarial de Nash. Ce processus consiste à maximiser le surplus net de la relation d'emploi pour une firme représentative, $(J_t^n - J_t^V)$, et une firme représentative $(W_t^n - W_t^U)$, en dépendant du pouvoir de négociation du ménage. Par conséquent le salaire réel ets celui qui maximise :

$$\underset{W_t}{max} \quad (\mathcal{W}_t^n - \mathcal{W}_t^U)^{\eta}(J_t^n - J_t^V)^{(1-\eta)}$$

Comme il y a une entrée libre des firmes sur le marché, à l'équilibre, $J_t^V = 0$ est vérifié. En effet, si $J_t^V > 0$, une firme a la motivation de publier des postes vacants du moment que la valeur d'un poste vacant est positive. Plus le nombre de postes vacants augmente relativement au nombre d'employés en chômage, la probabilité de remplir un poste vacant, p_t, baisse. En effet, la variable de contraction du marché de travail, θ_t, augmente et p_t baisse comme $\partial p_t / \partial \theta_t < 0$. Ce qui réduit la motivation de publier des postes vacants et diminue la valeur de J_t^V, jusqu'à ce qu'elle atteigne zero. Par conséquent, la condition du premier ordre pour le processus de négociation de Nash est données par:

$$\eta J_t^n = (1 - \eta)(\mathcal{W}_t^n - \mathcal{W}_t^U)$$

L'équation de salaire est donnée par:

$$W_tH_t = \eta\left[\frac{P_t^{ws}}{P_t}\frac{(1-\alpha)Y_t^{ws}}{n_t} + (1-\delta_t)\frac{Z_t}{P_t}E_t(\theta_{t+1})\right] + (1-\eta)\left[b + \frac{\epsilon_t^H H_t^{1+\tau}}{(1+\tau)\lambda_t}\right]$$

Le salaire partage les coûts et les bénéfices issues du matching entre employés et entrepreneurs suivant le paramètre η. Les employés sont compensés d'une fraction $(1-\eta)$ pour la désutilité liée à l'offre du travail et pour la prime de chôme non encaissée. Ils obtiennent une fraction η des revenues des firmes et une fraction η des économies réalisées sur l'opération de recrutement, en fonction de la probabilité que le match va être détruit jusqu'à la fin de la période.

Les produits finis sont produits en utilisant une fonction de production standard avec rendements d'échelle constants. Elle est donnée par:

$$Y_t = \left[\int_0^1 Y_{j,t}^{\frac{\epsilon_t-1}{\epsilon_t}} dj\right]^{\frac{\epsilon_t}{\epsilon_t-1}}$$

Ces firmes sont face au problème suivant:

$$\underset{P_{j,t}}{max} \quad E_t\sum_{s=0}^{\infty}(\varrho\beta)^s\frac{\lambda_{t+s}}{\lambda_t}\left[\left(\frac{P_{j,t}}{P_{t+s}}\right)^{1-\epsilon_t}Y_{t+s} - \left(\frac{P_{j,t}}{P_{t+s}}\right)^{-\epsilon_t}\left(\frac{P_{t+s}^{ws}}{P_{t+s}}\right)Y_{t+s}\right]$$

ϱ est intégré dans le paramètre d'actualisation car il y a une probabilité ϱ^s que le prix choisi continue à être appliqué durant s périodes.

La condition optimale est donnée par:

$$E_t\sum_{s=0}^{\infty}(\varrho\beta)^s\frac{\lambda_{t+s}}{\lambda_t}P_{t+s}^{(\epsilon_t-1)}Y_{t+s}\left(\epsilon_t P_{t+s}^{ws}P^{*(-\epsilon_t-1)} + (1-\epsilon_t)P_t^{*(-\epsilon_t)}\right) = 0$$

Le prix optimal, P_t^* , fixé par les firmes qui sont capables de ré-optimiser leurs prix:

$$P_t^* = \frac{\epsilon_t}{\epsilon_t - 1}\frac{E_t\sum_{s=0}^{\infty}(\varrho\beta)^s\frac{\lambda_{t+s}}{\lambda_t}P_{t+s}^{ws}P_{t+s}^{\epsilon_t}Y_{t+s}}{E_t\sum_{s=0}^{\infty}(\varrho\beta)^s\frac{\lambda_{t+s}}{\lambda_t}P_{t+s}^{\epsilon_t-1}Y_{t+s}} \tag{9}$$

Le mark-up dépend négativement de l'élasticité de substitution, ϵ_t.

Les firmes qui optent pour un prix flexible fixe un rpix qui est égal à la somme actualisée des coûts marginaux. Le prix optimal est un mark-up issue de la moyenne pondérée des coûts marginaux futurs. La taille du mark-up dépend de l'élasticité prix de la demande. S'il n' y a pas une rigidité des prix, $\varrho = 0$, le mark-up standard du monopole:

$$P_t^* = \frac{\epsilon_t}{\epsilon_t - 1} P_{t+s}^{ws}, \qquad \text{where } \frac{\epsilon_t}{\epsilon_t - 1} > 1$$

La contrainte des ressources agrégées est donnée par:

$$Y_t = C_t + C_t^e + I_t + G_t + \Upsilon(\nu_t) K_{t-1}^p$$

Le modèle est simulé et les fonctions de réponses sont examinées. **La première expérience** est un choc positif sur le net-worth des entrepreneurs. Ce choc est interprété comme un choc positif de richesse des entrepreneurs, ce qui améliore leur capacité d'autofinancement. En se basant sur le montant de net-worth, les entrepreneurs vont négocier le contrat et s'endetter. Les fonctions de réponses liées à ce choc montrent un augmentation du montant de net-worth agrégé, accompagné par une baisse du mark-up financier, mettant en exergue l'accélérateur financier. Par conséquent, on observe une baisse du taux de défaut. La baisse du coût de crédit engendre une augmentation de la proportion du profit réalisé par l'entrepreneur. Ces développements dans la sphère financière ont un impact sur l'économie réelle surtout le marché de l'emploi. En effet, une augmentation de la richesse propre des entrepreneurs engendre une baisse du chômage. Les entrepreneurs sont capables de financer une partie plus importante des coûts de recrutement par leurs propres capacités et ils sont prêts à élargir leur activité, comme le coût de financement externe a baissé. Par conséquent, le coût marginal réel des entreprises gérées par les entrepreneurs a baissé à son tour. Cette baisse encourage les entrepreneurs à ouvrir davantage de postes et recruter plus d'employés, ce qui pousse le chômage à la baisse. La probabilité de trouver un emploi et finir par réussir le matching sur le marché de l'emploi a augmenté et le degré de rétrécissement du marché de l'emploi a baissé. Il s'avère important de mentionner l'existence d'un effet de substitution entre la marge intensive te la marge extensive. Ce résultat est trouvé aussi par d'autres économistes. Ce phénomène met l'accent la dynamique du marché de l'emploi et l'interaction la marge intensive et la marge extensive dans le marché de travail. Suite à une amélioration des conditions de crédit due à l'augmentation de la capacité d'autofinancement des entrepreneurs, ces derniers ont tendance à recruter plus d'employés. Ce phénomène est observé aussi dans les données. La marge extensive est plus sensible que la marge intensive suite à un choc financier. En outre, les salaires constituent aussi un autre canal de transmission des chocs aux marchés de travail. Une amélioration des conditions de crédit engendre une baisse du cout marginal et entrainant une baisse de l'inflation. Par conséquent, on observe une augmentation du salaire réel. De plus, une augmentation de la richesse des entrepreneurs engendre une augmentation de la consommation globale, accompagné d'une baisse de chômage et augmentation de l'investissement. L'augmentation de l'investissement peut être expliquée par le nombre plus important des employés et un niveau de salaire plus élevé, ce qui permet aux ménages d'accumuler davantage de capital. La combinaison de l'augmentation de consommation et l'augmentation de l'investissement entraine une augmentation du produit, après une baisse initiale, qui peut être due à l'existence du cout d'ajustement de l'investissement et les niveau élevé des salaires. Par conséquent, le choc positif sur le net-worth des entrepreneurs a un impact positif sur l'économie.

La deuxième expérience consistait à étudier l'impact d'un baisse du cout marginal de vérification μ. Dans ce cas, le taux de recouvrement des crédits augmente et le cout de défaut agrégé baisse. Les fonctions de réponse à un tel choc montrent que le taux de défaut baisse considérablement. Comme la vérification de la production engagée par la banque est synonyme de défaut, une baisse de ce cout signifie automatiquement une baisse de défauts dans l'économie. Par conséquent, un choc de crédit positif entraine une baisse de la prime de risque imposée par les banques sur les crédits. Ce constat est issu directement de la structure du contrat optimal dans le modèle qui stipule que la prime de risque est une fonction décroissante du taux de recouvrement. De plus, le problème d'agence entre les entrepreneurs varie le cout réel de recrutement et le cout marginal de production pour les firmes-grossistes. La simulation montre qu'un choc de crédit positif entraine une augmentation des postes vacants et une baisse du chômage. Dans la littérature, on trouve qu'un choc de crédit négatif engendre une augmentation instantanée du chômage qui atteint son niveau maximal un an après le choc. Par conséquent, un cout marginal bas engendre une baise du mark-up financier, ce qui encourage les firmes à recruter davantage et ouvrir des postes. Le rétrécissement du marché de l'emploi du point de view de la firme augmente, indiquant une augmentation de la probabilité de trouver un emploi par les membres du ménage en chômage. un autre résultat qui mérite d'être mentionné est la pente du cout réel de recrutement qui augmente avec le cout de vérification. Le cout réel de nouveaux recrutements augmente avec le cout de vérification, tout chose étant égale par ailleurs. La substitution observée entre la marge extensive et la marge intensive n'apparait pas dans le cas d'un choc de crédit. Comme le cout de vérification est nominal et il n'est pas dépensé sous forme de produit réel, le défaut des entrepreneurs n'a pas un impact direct sur le "Total Output". Cependant, les résultat de la simulation montrent un impact indirect sur le produit réel total. La réduction du cout de vérification et par conséquent la réduction du taux de défaut a un impact positif indirecte sur le bien-être à travers leurs implications sur la prime de risque. La simulation montre ce phénomène: une baisse des couts de vérification entraine une baisse le cout marginal réel et par conséquent le prix des biens produits et le taux d'intérêt nominal. Ce qui génère à son tour une augmentation de la consommation et l'investissement qui augmente le niveau de l'output. Finalement, la consommation des entrepreneurs et le net-worth agrégé augmentent comme conséquence de la réduction du cout de vérification et du cout marginal. Les entrepreneurs solvables, quelque soit ils vont quitter l'économie en fin de période ou non, ils ont une part de profit plus importante à consommer et à épargner. Ainsi, un choc de crédit positif réduit le cout marginal et les prix ainsi que le cout de recrutement à travers un mark-up financier plus bas. Une baisse du cout de vérification a un impact important sur l'économie, surtout sur le marché de l'emploi: création de nouveau emploi et le taux de chômage.

La troisième expérience consistait à examiner l'impact un choc d'incertitude positif sur l'économie et sur le marché de l'emploi. Un choc positif sur l'incertitude est équivalent à une augmentation de l'écart-type de la productivité idiosyncratique de l'entrepreneur. Cette variable est vue comme un proxy reflétant le niveau de risque des entrepreneurs. Une augmentation de la valeur de cette variable est interprétée par les banques comme une augmentation de risque qui doit être intégrée dans le cout de crédit. Les fonctions de réponse à un tel choc montrent une augmentation immédiate de la prime de risque imposée par les banques pour se protéger contre une augmentation du taux de défaut. En effet, la réponse du taux de défaut est consistante avec la conjecture économique. Il augmente considérablement en réponse à une plus grande incertitude concernant le rendement des projets gérés par les entrepreneurs. Cette incertitude entraine aussi une baisse de l'emploi à l'équilibre, accompagné par une baisse de la production, la consommation et l'investissement. Par conséquent, le rétrécissement du marché de travail du point de vue des employés baisse. Ainsi, les firmes ouvrent moins de postes et recrutent moins. Ce résultat est due principalement à une augmentation du mark-up financier. Suite à une augmentation de l'incertitude, d'après le modèle théorique, l'augmentation de la prime de risque est transférée à l'économie réelle à travers le cout marginal réel et les prix. Les firmes sont amenées à ouvrir moins de postes et recruter moins d'employés à cause de la hausse du cout de financement. En outre, l'inflation augmente ainsi que le taux d'intérêt nominal. Les marges intensive et extensive varient dans la même direction donc il n'y a aucun effet de substitution. Les nombre d'heures par employé baisse et le nombre d'employés recrutés baisse aussi. Ceci peut être du, d'après le modèle, à la baisse de la consommation et de l'investissement. Les ménages voient leurs ressources baisser donc ils investissent moins et la demande de capital baisse. En effet, une augmentation de l'incertitude par rapport à la réussite des projets financés par la banque a un impact négatif sur 'économie das son ensemble. En augmentant le niveau de risque, les banques ont besoin, pour surmonter les problèmes liés à l'asymétrie d'information, d'augmenter la prime de risque et par conséquent le cout de crédit. Le cout marginal réel de financement augmente, ce qui entraine une baisse la valeur escomptée d'un nouveau recruté et engendre une baisse de recrutement. Le chômage augmente.

Introduction

The recent financial crisis $(2007 - 2009)$ has showed to economists, either practitioners or academia, new facts regarding the interconnectedness between the real and the financial spheres. Before the crisis, most of the research focused on the main drivers of output fluctuations in the short-run without taking into consideration the financial spillovers originating in the credit and financial markets. After the crisis, the interest to financial shocks such that risk and uncertainty shocks has grown. The output decline and the persistence of a high unemployment rate in USA and the Euro Area were subject to many studies. Hence, the financial frictions are considered as an important driver of the business cycle fluctuations. The accumulation of distortions and imbalances due to these frictions amplifies the negative impact of adverse shocks to the economy. The macroeconomic implications of these imperfections on the financial system were not the center of interest of classic economic thinkers. The financial crisis was a turning point in this regard, so that the source of these frictions as well as their propagation mechanism and the magnitude of their impact on the real economy become subject to deep investigations.

There is a growing literature focusing on the typology of shocks originating in the financial market and their transmission channels to the real economy. Although, the subject was approached from different angles and using different techniques, most of the economists share a common issue regarding the identification of these shocks. It is quite difficult to disentangle the uncertainty shocks for example from the risk shocks and to identify properly their respective impacts on the output and employment. An increase of the uncertainty in the financial market can be a interpreted as a symptom of the increase of investors' riskiness. On the other hand, the uncertainty can be solely considered as cause of the widening of credit spreads and hence, the investors likelihood to default. Only taking into consideration the frictions in the credit market and in the financial market allows to model these issues and investigate the impact of such shocks. Therefore, the representative agent paradigm does not hold anymore. In a frictionless economy, the wealth distribution does not matter and risk perception does not affect the equilibrium outcome. However, when there are financial frictions, the individual characteristics matter and micro-behavior determines final allocations. In this thesis, I tried to approach the subject using different tools and techniques. The first chapter was dedicated to the credit channel of monetary policy and the importance of credit market imperfections to identify different sub-channels. Using a tractable contractual device in the credit market assuming asymmetric information among contractors, I show that the balance-sheet sub-channel is the largest in terms of monetary policy transmission capacity. This finding was confirmed by an empirical evidence based on the outcome of the Senior Loan Officer Opinion Survey. In the second chapter, I tried to make the link with the labor market. The persistence of unemployment after the financial crisis raised many questions regarding the contribution of the adverse financial shock to this high persistent level. I study the impact of uncertainty and risk shocks on the unemployment via the job creation and the job destruction dynamics. The third chapter is dedicated to the impact of asymmetric information on the job creation, mainly. Vacancies were supposed to be financed by external funds which is, by definition, more expensive than the internal funding. An adverse shock that increases the risk premium in the credit market or deteriorates the entrepreneurs balance-sheet reduces significantly levered investors risk-bearing capacity. Hence, their borrowing capacity is reduced and consequently, job creation decreases.

Chapter 1. Credit channel, credit market frictions and monetary policy potency

In this chapter, I use the broad credit channel to investigate the impact of credit market imperfections on liquidity effect and on monetary policy potency. I use a micro founded model where there an asymmetric information in the credit market via a lending contract established between heterogeneous agents. The model satisfies two necessary conditions of lending view. First, all funds in the model's economy are supposed to be intermediated by the bank so that there is no possibility for borrowers to substitute bank loans with another source of funding. Second, borrowers are bank-dependent since their self-financing capacity is supposed to be sufficiently weak so that external financing is unavoidable. In this model, I assume that there is asymmetric information between the borrower and the lender so that a wedge between the cost of borrowed funds and the opportunity cost of internally raised funds arises. This approach is motivated by the results from a structural vector autoregression model (SVAR). The balance-sheet and bank-lending channels are fully identified because I am using U.S data on supply and demand of loans collected from the U.S. Senior Loan Officer (SLO) Survey as well as data on banks' appetite to risk. The SVAR results document that a positive money supply shock generates a liquidity effect as well as an increase of loans demand, loans supply and tolerance to risk by banks. Both channels, the balance-sheet channel and the bank-lending channel are found to be significantly active.

On the other side, I find that the model was able to replicate quite well the Bayesian VAR evidence. An unanticipated positive money supply shock generates an increase of the default rate and the risk premium. The introduction of informational frictions amplified the liquidity effect and generated more volatility of real output. More specifically, when credit market imperfections are taken into consideration, Both sub-channels of the broad credit channel are activated, which shapes the economy's response to a positive money supply shock and helps to explain the monetary policy potency observed in the data. Although it weakens the bank-lending channel, The procyclical movement of the risk premium increases the price-elasticity of the loanable funds's demand, activating a new transmission channel that amplifies the initial "pure" liquidity effect. Thus, the initial drop of the short-run nominal interest rate is not transmitted to the real economy by an important decrease of the lending rate but through a positive impact of loanable funds' demand price-elasticity. The increase of banks' appetite to risk after a positive money supply shock observed in the data is mirrored in the behavior of the external finance premium in the model economy. Moreover, The liquidity effect is weaker when there is an exogenous increase of the marginal cost of verification. When bankruptcy costs are very high, there is a kind of *flight to quality* so that the risk premium does not increase as it is expected, consequently, a decrease of the lending rate does not need an important initial drop of the short-run nominal interest rate.

Chapter 2. Credit shocks, uncertainty shocks and labor market

In this chapter, I study the empirical relationship between financial market characteristics , volatility and return, and the extensive margin of the labor market. To this end, I consider a standard monetary structural VAR, augmented with job destruction and job creation indicators, unemployment rate, the default rate, the excess bond premium as an indicator of credit conditions and the volatility VXO index as an indicator of uncertainty in the financial market. The model is estimated using the Bayesian techniques. I find that both credit and financial shocks drive the labor market fluctuations. The first experience was studying the impact of an exogenous increase of the nominal interest rate. Such restrictive monetary policy shock induces a significant increase of the job destruction rate and a decrease of the job creation rate. In addition, the unemployment rate increases significantly. The results of an adverse credit shock is consistent with the conjecture that an increase of the credit spread induces a slowdown of the economic activity. An increase of the excess bond premium induces a decrease of the job creation rate and increase of job destruction rate and unemployment. This result is in line with the growing literature saying that the cyclicality of the extensive margin of the labor market in influenced by credit market conditions. In addition, the uncertainty increases significantly in the financial market after an exogenous adverse credit shock. This finding is also in line with the conjecture that the uncertainty increase in the financial market is a symptom of the credit market deterioration.

Chapter 3. Uncertainty shock, risk shock and interplay of intensive and extensive margins in the labor market

This chapter revisits the labor market and the financial market interactions in a general equilibrium context. Assuming that job creation and production costs are covered partially by external funding, I capture the response of the extensive margin of labor market to adverse financial shock through the job creation solely. to this end, I use a medium-size dynamic stochastic general equilibrium model, calibrated to the USA. I find that employment rates and vacancies posting increase following positive credit and net worth shocks. A positive credit shock corresponds to a decrease of the marginal monitoring cost applied by lenders. While a positive uncertainty shock induces a persistent increase of unemployment. A positive shock to the net worth is interpreted as a positive wealth shock. I found that the impact of such a shock on the employment is quite important and more persistent than the impact of a reduction of monitoring costs. Moreover, both shocks induce a substitution effect between the intensive and the extensive margins of employment. Improved credit market conditions encourages entrepreneurs to post more vacancies, firms to expand production and employees to work a lesser number of hours. This finding is consistent with empirical figures. The model allowed to highlight the main transmission channels of shocks originating in the credit market to the labor market and results appear to be consistent with stylized facts and theoretical conjectures.

Chapter 1

Inside the black box : Bank lending channel, Risk-taking channel and potency of monetary policy

1.1 Introduction

> "The quantitative importance of the lending channel is likely to be sensitive to a number of institutional characteristics of the financial market ...Thus understanding the lending channel is a prerequisite to understanding how innovation in financial institutions might influence the potency of monetary policy."

Kashyap and Stein (1994), Monetary policy, p. 221-261.

> "... insufficient attention appears to have been paid so far in the transmission mechanism to the link between monetary policy and the perception and pricing of risk by economic agents - what might be termed the risk-taking channel."

Borio and Zhu (2012), p. 2

The recent financial crisis has revived the debate about the monetary policy transmission mechanism and its potency. The sharp downturn that followed this financial disruption has encouraged major central banks to adopt a set of measures termed loosely as "unconventional monetary policies". Nevertheless, these measures are not unconventional in their essence. Most of them would have been seen as "canonical" in the scientific literature of the monetary policy transmission mechanism. The novel part was a greater attention paid to financial and credit frictions in particular- by emphasizing the role of private sector and banking sector balance-sheets, as well as the role of credit channel as a main mechanism of credit provision to the private sector. Therefore, the transmission channels of these canonical monetary policies are revisited in a new context where financial frictions are taken into consideration.

Although the banking sector affects the real economy through many channels[1], the credit channel remains the most important one. According to this credit view, monetary policy, besides its impact on the level of interest rates, affects the external finance premium. Bernanke and Gertler (1995b) and Bernanke (2007) break down the credit channel into two channels through which the link between monetary policy actions and the external finance premium is established: the balance-sheet channel and the bank-lending channel. The first one meets the central idea of the financial accelerator theory; a tightening of monetary policy deteriorates borrowers' creditworthiness through affecting their potential cash-flows and the value of assets, which in turn affects the effective cost of credit and external finance premium that borrowers face. The second one holds that a tightening of monetary policy affects the loanable funds and the amount of intermediated credit. In this case, the monetary policy actions may reduce the supply of loans offered by depository institutions. Although the existence of the balance-sheet channel is well established in the literature, the bank-lending channel is still controversial when there is a money easing. The response to the question about the bank-lending potency when there is a positive money supply shock remains ambiguous. The response to this question encounters a problem related to the difficulty of a complete identification of both channels in the data. Figure 1. shows a positive correlation between real investment and the amount of real commercial and industrial loans. However, this fact does not confirm the existence of a causality relation between loans supply and investment in the economy because an increase of real loans can also arise from an increase of loans demand. Moreover, when the disentanglement of credit

[1] See Bernanke and Gertler (1995b) for the typology of monetary policy transmission channels.

supply and demand becomes possible, as shown by figure 2. an increase of credit supply is associated with an increase of banks ' appetite to risk measured by banks' tolerance to risk. This increase of bank's appetite to risk may generate a "lemons" premium related to a higher expected verification cost and a higher rate of default. This risk premium may offset a part of the initial positive impact of a positive money supply shock, transmitted through the bank-lending channel. The level of this premium depends on the loanable funds demand's elasticity as it will be shown below. In this case, informational frictions raise the loans demand sensitivity to the lending. This increase is sufficiently important to overcome the adverse impact of the risk premium increase, leading to an amplified liquidity effect as a response of the economy to an expansionary monetary policy.

To this end, I am using the broad credit channel to investigate the impact of credit market imperfections on liquidity effect. The model used here is the monetary counterpart of Carlstrom and Fuerst (1997a) with perfectly flexible prices. It is a very convenient framework to study the lending channel of monetary policy when credit market is imperfect. The model satisfies two necessary conditions of lending view described in Kashyap and Stein (1994). First note that all funds in the model's economy are assumed to be intermediated by the bank so that there is no possibility for borrowers to substitute bank loans with another source of funding. In other words, the Modigliani-Miller capital structure invariance breaks down since the a decrease in intermediated funds supply would impact directly borrowers financial capacities. Second, borrowers are bank-dependent since their self-financing capacity is supposed to be sufficiently weak so that external financing is unavoidable. This is condition 2. However, in order to study the non-neutrality of money and its real effects, imperfect prices adjustment is needed. The limited participation assumption allows to integrate prices imperfect adjustment without substantive modifications of the model. Introduced for the first time by Grossman and Weiss (1983) and Rotemberg (1984), the limited participation model stipulates that only borrowers can transact with the financial intermediary without any time lag, while households and other agents cannot revise their saving's decision after a money injection into the banking sector. This timing assumption generates the prices' response sluggishness required by the third necessary condition of the credit

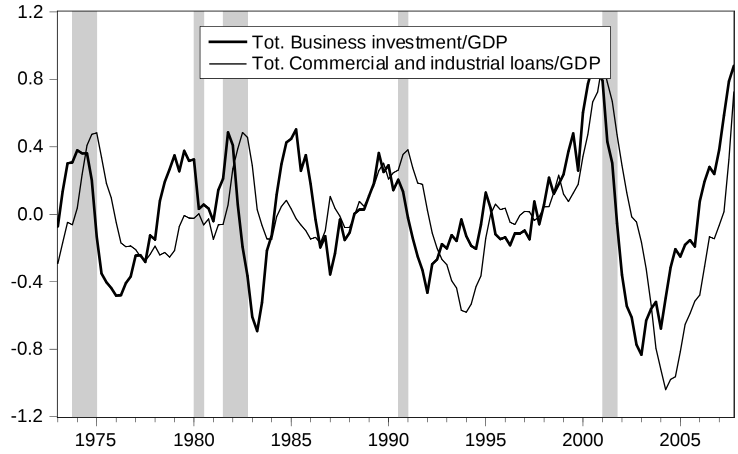

Figure 1.1: Ratio of Total U.S. Business Investment to GDP vs Ratio of Total U.S. Commercial and Industrial Loans to GDP

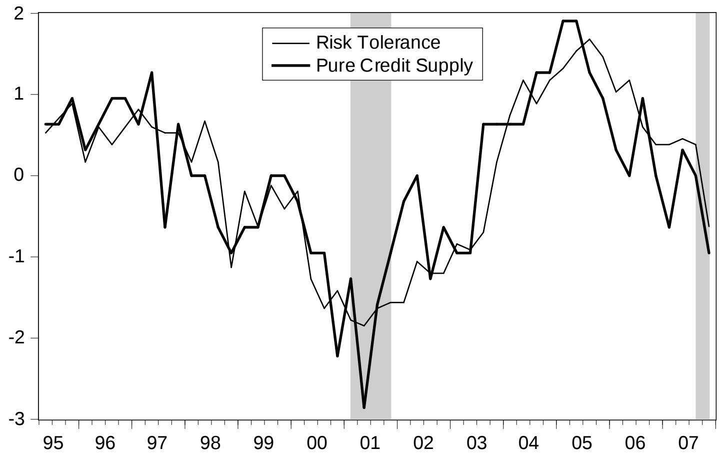

Figure 1.2: Banks Pure Credit Supply vs Banks Risk Tolerance Level

NOTE : The total US business investment and total US commercial and industrial loans as a percentage of GDP data are filtered using a HP filter with a smoothing parameter λ=1600. Pure credit supply and risk tolerance data are collected from the U.S. Senior Loan Officer (SLO) Survey (see Appendix A for more details). In order to show the full variation of the risk tolerance and credit supply, the graph of figure 2 is scaled and data are normalized.

channel. In this model, I assume that there is asymmetric information between the borrower and the lender so that a wedge between the cost of borrowed funds and the opportunity cost of internally raised funds arises. This approach is motivated by the results from a structural vector autoregression model (SVAR). The balance-sheet and bank-lending channels are fully identified because I am using U.S data on supply and demand of loans collected from the U.S. Senior Loan Officer (SLO) Survey as well as data on banks' appetite for risk. The SVAR results document that a positive money supply shock generates a liquidity effect as well as an increase of loans demand, loans supply and tolerance to risk by banks. Both channels, the balance-sheet channel and the bank-lending channel are found to be significantly active.

I find that the model economy replicates the Bayesian VAR evidence quite well. An unanticipated positive money supply shock generates an increase of the default rate and the risk premium. The introduction of informational frictions amplified the liquidity effect and generated more volatility of real output. More specifically, when credit market imperfections are taken into consideration, Both sub-channels of the broad credit channel are activated, which shapes the economy's response to a positive money supply shock and helps to explain the monetary policy potency observed in the data. Although it weakens the bank-lending channel, The procyclical movement of the risk premium increases the price-elasticity of the loanable funds's demand, activating a new transmission channel that amplifies the initial "pure" liquidity effect. Thus, the initial drop of the short-run nominal interest rate is not transmitted to the real economy by an important decrease of the lending rate but through a positive impact of loanable funds' demand price-elasticity. The increase of banks' appetite to risk after a positive money supply shock observed in the data is mirrored in the behavior of the external finance premium in the model economy. Moreover, The liquidity effect is weaker when there is an exogenous increase of the marginal cost of verification. When bankruptcy costs are very high, there is a kind of *flight to quality* so that the risk premium does not increase as it is expected, consequently, a decrease of the lending rate does not need an important initial drop of the short-run nominal interest rate.

The remainder of the paper is organized as follows: the next section describes the empirical evidence and explains the data, the identification strategy and the bayesian estimation technique of the structural VAR. Section 3 presents the economy models and develops the optimal financial contract between the financial intermediary and entrepreneurs as well as the agents optimal decision rules. Section 4 discusses the theoretical properties of the model. Sections 5 is dedicated to the numerical analysis of the model, it presents the parameters' calibration and simulation results regarding the model' s response to a positive money supply shock. I conclude in section 6.

1.2 Empirical evidence

This section presents empirical evidence on the impact of a positive money supply shock on the real economy and credit market variables in the United States. Previous studies on the credit channel of the monetary policy faced an important challenge regarding the identification of the sources of credit fluctuations after a monetary shock. Bernanke and Gertler (1995b) argued that the response of the amount of loans channeled to the economy after a monetary shock is shaped jointly by credit demand and credit supply, as well as by credit market imperfections. For example, an increase of the amount of commercial and industrial loans or the amount of total private credit, observed after an increase of money supply, does not give enough information to conclude about credit supply and/or demand changes. Initially a positive money supply shock induces a decrease of the nominal interest rate, generating a liquidity effect in the economy. An the same time, it induces an increase of the available funds for banks, who are willing to increase their credit provision and make loans at a lower price. This is what is called the bank-lending channel. On the other hand, in order to take advantage of the decline of the cost of external financing, non-financial borrowers increase their demand for loans, expand investment and consumption and improve their balance-sheet conditions. This is what is called the balance-sheet channel. In this case, the cost of external financing drops further and amplifies the initial impact, giving rise to a financial accelerator effect. However, this effect lingers if we assume that borrowers and lenders' appetite for risk remains unchangeable. In fact, the willingness of banks to lend all the available money may stimulate their appetite for risk and reduces the efficiency of borrowers' screening mechanism. This behavior has a dramatic impact on the external finance premium, offsetting a part of the initial positive impact on the cost of credit generated by the liquidity effect and dampening consequently the initial economic expansion.

Unfortunately, it is very difficult to assess empirically using the observable credit aggregates, the banks' appetite for risk and to fully identify the credit channel. A complete identification of the credit channel of the monetary policy needs a complete identification of its two sub-channels. This identification scheme aims at disentangling changes in loans' demand and loans' supply, which is impossible as long as they are unobservable. Available macro-data do not offer such information neither a measure of banks' appetite for risk. For this reason, I use the detailed answers to U.S. Senior Loan Officer Survey (SLOS). In the following subsections, I present the data used and the empirical identification strategy as well as estimation results.

1.2.1 Data

The U.S. Senior Loan Officer Survey (SLOS) publishes quarterly a set of detailed information about changes in credit demand and credit supply in the U.S Banking system as well as information about the factors affecting these changes. The Federal Reserve (Fed) asks large domestic banks and U.S. branches and agencies of foreign banks to give details about changes in credit standards (tightening and easing), credit terms and loans demand by firms and households[2]. Most of the questions concern past developments and do not tackle bankers expectations. The Fed gets around 60 complete responses on average each quarter and publishes a report covering the main features and statistics[3]. For the business (C&I) loans part, the survey contains many important information about the reasons of lending standards changes in the case of small and large firms. These reasons are summarized by banks capital positions, firms balance-sheet conditions (borrowers risk and outlook), banking competition and banks appetite to risk.

For the purpose of this study, I use only responses to four questions to get measures of four variables loan supply, LS_t, appetite to risk, AR_t, borrowers' quality, BS_t, and loan demand, LD_t. Moreover, I limit the scope of the analysis to cover only commercial and industrial loans supplied by domestic banks to large and middle-market firms[4]. Answers to the questions are quantified using net percentages[5]. Changes of credit standards are interpreted as changes in broad credit availability. However, in order to

[2]Since the survey is conducted by the Fed as a supervisory authority, the survey results are supposed to be credible and reliable. I follow Ciccarelli et al. (2014) by keeping *trusting the bankers.*

[3]See Lown and Morgan (2006) for more details about the survey's construction and design.

[4]Ciccarelli et al. (2014) found that, for lending standards, the correlation of large firms and small firms series is around 96%. For the demand side, they found that the correlation between large firms and small firms series are 93%. Therefore, their analysis was limited to large firms since it does not affect the qualitative results.

[5]See Appendix A for more details.

measure the "pure" credit supply, I compute the net percentage of banks reporting a change of credit standards due to changes in their capital position. A net easing of the "pure" credit supply is reflected by a positive value of the difference between the percentage of banks reporting an easing of credit standards due to an easing of bank's capital position and the percentage of banks reporting a tightening of credit standards due to a tightening of bank's capital position.

The appetite to risk is measured by the difference between the percentage of banks easing credit standards due to an increased tolerance for risk and the percentage of banks reducing credit standards due to a decreased tolerance for risk. A positive value of this net percentage is a net increase of banks' appetite to risk. The borrowers quality and creditworthiness is measured as an average of net percentages of two variables: the borrowers' economic outlook and industry-specific problems. The net change of the borrowers' economic outlook is defined as the difference between the percentage of banks reporting credit standard easing due to a more favorable and less uncertain borrowers' economic outlook and the percentage of banks reporting credit standard tightening due to a less favorable and more uncertain borrowers' economic outlook. Similarly, the net change of industry-specific problems is the difference between the percentage of banks reporting credit standard easing due to improvement in industry-specific problems and the percentage of banks reporting credit standard tightening due to worsening of industry-specific problems. A positive value of the average of the two variables' net percentages shows an improvement of the borrowers creditworthiness. Changes in credit demand are measured by the difference between the percentage of banks reporting an increase and the percentage of banks reporting a decrease of the loan demand. A positive value is interpreted as an net increase of the demand of loans by firms for a given quarter.

I embed the obtained variables into an otherwise structural VAR model containing five other macroeconomic variables: GDP growth rate (ΔY_t), inflation (ΔP_t), log of nonborrowed reserves (NBR_t), log of the money base M1 (M_t) and the Federal funds rate (FF_t), where Y_t and P_t denote the time t values of the log of real GDP and the log of the implicit GDP deflator, respectively. All series are measured quarterly and cover a sample period from 1995:2 to 2007:4[6]. The model is regressed using bayesian estimation techniques, assuming Independent Normal-Wishart priors and a one lag.

1.2.2 Identification strategy

I follow a standard approach for the identification of the monetary policy shock by adopting the recursiveness assumption discussed by Christiano et al. (1999a) where estimation results are conditioned by the variables' ordering. This assumption is widely used for studying the effects of a monetary policy shock and it stipulates that a shock to the policy variable is orthogonal to the information set of the monetary authority when implementing its policy. This identification scheme divides the set of variables into three subsets X_{1t}, S_t and X_{2t}. X_{1t} is the set of variables that appear contemporaneously in the policymaker's set of information, typically the real GDP growth rate, the inflation rate and credit market variables. Those variables are ranked first, without any special order withinX_{1t}[7].. S_t is the monetary policy variable and it is ranked the second. X_{2t} is the set of variables that is ranked the last. The structural VAR is presented by:

$$A_0 Y_t = A_1 Y_{t-1} + \epsilon_t$$

where $Y_t' = (X_{1t}\, S_t\, X_{2t})$, $X_{1t} = (\Delta Y_t, \Delta P_t, LD_t, LS_t, AR_t, BS_t)$ and $X_{2t} = (FF_t, M_t)$ when shocks to money supply are identified to be shocks to nonborrowed reserves, $S_t = NBR_t$ and $X_{2t} = (NBR_t, M_t)$ when the short-term nominal interest rate, $S_t = FF_t$, is the monetary policy instrument. A_0 is a lower triangular matrix with non-negative diagonal terms. ϵ_t is the vector of structural economic shocks, satisfying the following standard assumptions:

$$E(\epsilon_t) = 0 \tag{1.1}$$

and

$$E(\epsilon_t \epsilon_s^{'}) = \begin{cases} 0 & \text{if } t \neq s \\ \Sigma & \text{if } t = s \end{cases} \tag{1.2}$$

[6]The sample starts at 1995:2 because the question related to banks risk tolerance is introduced in the survey in this quarter. In addition, it ends at 2007:4 because the non-borrowed reserves values were negative after this date.

[7]Christiano et al. (1999a) showed that the impact on economic variables, of a shock to monetary policy instrument in insensitive to the ordering of the variables in X_{1t} and X_{2t}

Σ is the co-variance matrix of structural shocks. ϵ_t are serially uncorrelated and their respective variances constitute the principal diagonal of Σ.

Intuitively, the recursive identification assumes that the Fed observes the current values of the GDP, the GDP deflator, the credit supply and demand, the borrowers' quality and the banks' appetite to risk when deciding on its monetary policy. In other words, the monetary policy rule is a linear combination of the current values of all these variables, so that the monetary policy instrument responds contemporaneously to variables in X_{1t}. Moreover, the variables in X_{2t} respond contemporaneously to the monetary policy shock, while the variables in X_{1t} respond with a lag. Although this assumption is questionable in the literature, many economists argue for its plausibility because of the important amount of economic information that the Fed disposes at each quarter, thanks to monthly releases of many economic and financial indicators.

Technically, the identification of the monetary shock requires recovering the parameters of A_0 and Σ by imposing many restrictions on the elements of both matrices. A recursive scheme is equivalent to a Wold causal ordering of the variables with an orthogonality condition among structural shocks. This is achieved by assuming that A_0 and Σ are a lower triangular matrix and the identity matrix, respectively. The identification strategy using the recursiveness assumption and the bayesian estimation of a VAR model as well as the choice of the priors' distribution are discussed extensively in chapter 2.

1.2.3 Estimation results

Figures below report the impact of an expansionary monetary shocks on real economy indicators and credit variables. Figure 3 displays the estimated impulse responses to a one standard deviation positive shock to nonborrowed reserves, whereas Figure 4 depicts the estimated impulse responses to a one standard deviation negative shock to the Federal Funds rate.

An exogenous negative shock to the Federal funds rate induces a persistent and important increase of the nonborrowed reserves that lasts for more than 8 quarters. This

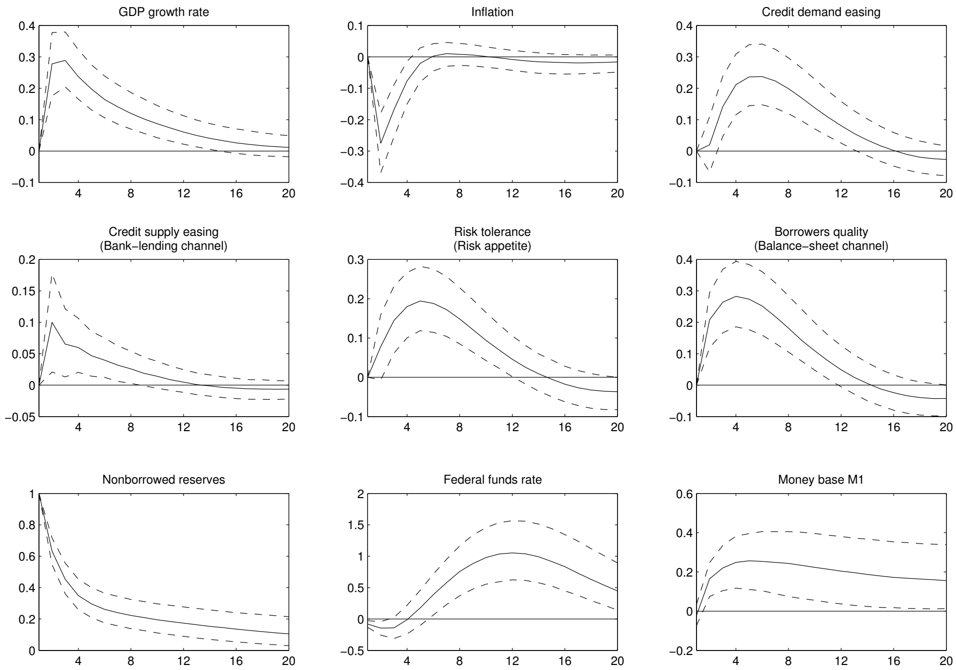

Figure 1.3: The median response to a one standard deviation positive shock to nonborrowed reserves. The dashed lines are the 68% upper and lower bands of the credibility interval for each variable.

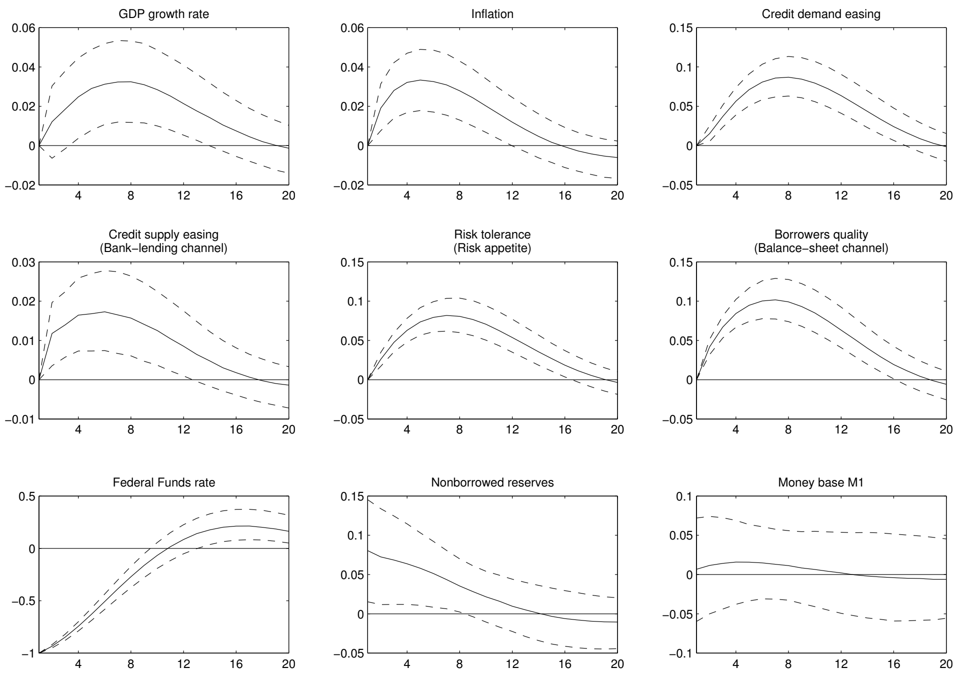

Figure 1.4: The median response to a one standard deviation negative shock to the Federal Funds rate. The dashed lines are the 68% upper and lower bands of the credibility interval for each variable.

result proves the existence of a substantial liquidity effect. The increase of the money base M1 is negligible and statistically non significant along the whole period. This result is consistent with the wide-ranging statement that the short-run elasticity of money demand to nominal interest rate is very low. Christiano et al. (1999a) found that the short-run elasticity of M1 to the Federal funds rate is roughly -0.1. On the other side of the economy, three quarters after the shock, the GDP growth increases and reaches a maximal peak of more than 3% after two years. The increase of he GDP growth is very persistent and lasts for more than four years. The response of inflation is quantitatively similar to the response of the GDP growth. However, the increase of the inflation rate occurs at the beginning of the first quarter after the shock and lasts for more than ten quarters.

The impact of an expansionary interest rate policy shock on credit variables is quite consistent with the economic conjecture. Credit demand and credit supply increase simultaneously at the beginning of the first quarter after the shock. The increase of the credit demand is more important and more persistent than the credit supply. It lasts for more than four years and reaches a maximal level in the second year. A decrease of the nominal interest rate reduces the cost of credit, it stimulates the loan demand and activates the bank-lending channel of the monetary policy. On the other hand, the improvement of credit conditions generates an improvement of the borrowers' quality that activates the balance-sheet channel and may amplify the initial impact.

The second experience is to examine the effect of an exogenous positive shock to the nonborrowed reserves. The consequences of such shock are qualitatively robust with two exceptions regarding the inflation rate. and M1. A positive shock to the amount of nonborrowed reserves induces a decrease of the Federal funds rate and an important increase of the money base M1. Although the decline of the Federal funds rate is contemporaneous, it is not quantitatively important and lasts for only three quarters. This finding confirms previous results regarding the presence of a transitory liquidity effect after a positive shock to money supply. An increase of the nonborrowed reserves generates an increase of the GDP growth and a decrease of the growth rate of the GDP deflator, giving rise to what is called the "price puzzle". It is noteworthy to mention the hump-shaped response of the real GDP growth that starts its decline one year after the policy shock. The findings regarding the impact of a positive shock to nonborrowed reserves on the credit variables are also consistent with the economic conjecture, with one exception. This exception has to do with the credit demand, whose response is delayed and occurs with two lags.

Both experiences offer empirical evidence on the presence and the importance of three monetary policy transmission channels. The "classical" interest rate channel is well established since there is a clear evidence on the presence of a liquidity effect for both cases. Moreover, the balance-sheet channel is also highly significant since an expansionary monetary policy in both cases induces an increase of the borrowers' quality reflecting an improvement of their self-financing capacity and consequently, an improvement of their creditworthiness. The bank-lending channel is also significant and is well established, since the "pure credit supply" variable increases when there is an unexpected ease of nonborrowed reserves or a cut in the federal funds rate. Whether the Fed uses the Federal funds rate or the nonborrowed reserves as a policy instrument, the expansion of credit supply goes along with an increase of the credit demand and banks' appetite to risk. This finding raises some concerns regarding the efficiency of the bank-lending channel. An increase of the banks' appetite, associated with an increase of the credit demand, induces an increase of the default rate. Moreover, the external finance premium will rise, dampening the positive initial effect of an expansionary monetary policy. The final impact will depend importantly on the elasticity of loans demand to the nominal interest rate. Indeed, this kind of distortions needs to be taken into consideration when implementing the monetary policy. More explanation of this issue will be discussed in a theoretical framework below.

1.3 The Model

In the previous section I investigated empirically the existence and the importance of the credit channel and its sub-channels, namely the bank-lending channel and the balance-sheet channel. In addition, I discussed the risk-taking channel. An increase of banks' appetite to risk after a positive monetary shock raises questions about the role of credit market imperfections and their impact on the potency of the monetary policy. According to the conventional economic wisdom, a decrease of the nominal interest rate induces, ceteris paribus, a one-to-one decrease of the lending rate, inducing an expansion of investment, output and employment. This development will improve the investors' balance-sheet, reduces the risk premium, lowers the lending rate further and amplify the impact of the initial shock. This is what is called the financial accelerator. However, this theory did not take into consideration the increase of banks' appetite to risk after a positive money supply shock. An increase of risk tolerance by banks provokes an increase of the risk premium, offsetting partially the initial positive impact and weakens the credit channel. The aim of this section is to built a general equilibrium model that is able to replicate the credit channel as well as the risk-taking channel observed in the data.

For this reason, I consider the monetary counterpart of the investment model proposed by Carlstrom and Fuerst (1997a), with asymmetric information in the credit market and perfectly flexible prices and wages. I extend the original model by introducing money via a cash in advance constraint on household's consumption and investment purchases, with a sluggish saving's decision à la Fuerst (1992). This limited participation assumption allows to replicate the liquidity effect observed in the data after a money supply shock. Moreover, asymmetric information in the lender-borrower relationship enables the existence of a risk premium and activates the risk-taking and the balance-sheet channels.The model allows also for a habit persistence in households' consumption in order to add some persistence to the initial liquidity effect.

It is closed economy, formulated in discrete time with an infinite horizon, populated by five types of agents: households, entrepreneurs who are capital-good producers, firms who are consumption-good producers, a financial intermediary used interchangeably with bank and the central bank as a monetary authority.

There is a representative household who consumes, supplies labor to firms, accumulates physical capital, saves and holds money balances. There is also a continuum of entrepreneurs, indexed by $i \in (0, 1)$ who consume, work and produce the investment good by transforming consumption goods into capital. The entrepreneurs also hold money balances, carried out from one period to another as a part of their net worth. Firms produce the consumption good using the labor supplied by households and entrepreneurs and the capital rent from households as inputs. The central bank conducts the monetary policy through injecting or withdrawing money from the economy[8]. The financial intermediary adds the collected funds from households to the injected money and grants loans to entrepreneurs. In this context, the role of the bank is well defined. They gather funds and pool loans in order to mitigate risks and avoid monitoring duplication. They guarantee a riskless interest rate R_t to households, remunerating their deposits and charge borrowers a higher interest rate of loan. The spread is supposed to compensate for the default risk and agency costs.

Using the Lucas-Fuerst framework, the introduction of the “sluggish saving decision" assumption assumes that the asset market opens first and households decide on the amount of their savings. This decision is not reversible so that households cannot adjust their consumption/saving decision after an unanticipated money supply shock. This timing assumption is intended to capture a set of institutional and financial constraints[9] that prevent households from reviewing their saving decisions. Consequently, an increase in the money supply will increase the money stock available for financial intermediaries. Entrepreneurs are willing to absorb a disproportionate share of the extra cash through borrowing, only at a lower interest rate of loan. This lending channel of monetary policy is supposed to spur investment, output and employment. However, with the presence of asymmetric information in the credit market, the extent to which the interest rate of loan declines will depend on the response of the risk premium to a positive money supply shock. The importance of the timing in this limited participation model suggests to highlight the sequence of events.

Timing. At the beginning of the period t, the household enters the period with its nominal money holding M_t^h and its accumulated capital stock K_t. It takes the saving decision so that it deposits an amount D_t into the bank remunerated at a risk-free rate

[8]The process through which the money supply is altered is not modeled explicitly here. However, one can see Cooley and Nam (1998) where the central bank intervenes through changing the reserve requirement ratio.

[9]See Akerlof (1979) and Christiano and Eichenbaum (1992, 1995).

of R_t. The rest of the cash is split between consumption expenditures and investment purchases. Entrepreneurs enter the period with their money holdings M_t^e.

The technology shock is realized. Firms decide on their production so that they decide on their demand for labor and capital. The household supplies labor L_t and accumulated capital K_t to a competitive factors' market in order to meet the firms needs. Entrepreneurs are supposed to supply inelastically one unit of labor to firms at each period in order to guarantee a minimum positive income. This small amount of revenue, whenever they receive it at the end of the period, is carried over by entrepreneurs as a part of their net worth for the next period. A part of the produced consumption good is purchased by the household and the remaining amount is split between the capital production and the consumption of solvent entrepreneurs as explained below.

Then, the money supply shock is realized. The money supply M_t^s, is supposed to grow at a rate τ_t so that an amount of $(\tau_t - 1)M_t^s$ of new money is injected in the banking sector. Entrepreneurs are involved in the production of the investment good using a stochastic, constant returns-to-scale technology that contemporaneously transforms consumption goods into capital. This production is subject to an idiosyncratic shock privately observed by them. In order to acquire the needed amount of consumption goods, entrepreneurs use their net worth carried over from the previous period, N_t and the borrowed funds from the financial intermediary. Prior to the realization of the entrepreneurial idiosyncratic productivity shock, entrepreneurs and the bank negotiate and establish the loan contract. The entrepreneurial net worth is made of two components: entrepreneurs' cash-holdings at the beginning of the period, M_t^e and their labor income gained at the end of the previous period, W_{t-1}^e. Using all these funds, entrepreneurs buy the needed amount of consumption goods from firms and transform it to capital. Whenever the production process is finished, the financial contract parties are asymmetrically informed about the entrepreneurs real return: while it is fully known by entrepreneurs, the financial intermediary can observe it only at a marginal cost, μ. At this point, each entrepreneur will decide either to reimburse the loan, purchases his own consumption and carries the remaining resources to the next period; or to default and declare bankruptcy. In the latter case, the financial intermediary will monitor the entrepreneurial production by incurring a verification cost and confiscates the project's income. In this case, the entrepreneur does not consume and has no money holding to carry to the next period[10].

Firms pays for the household's labor and capital as well as for the entrepreneurs' labor. They rebate their profit as a lump-sum to the household. The household buys the produced capital at a price Q_t and receives its savings' return from the bank (principal+interest). Solvent entrepreneurs and households carry over their residual incomes to the next period as cash-holdings.

The limited participation assumption raises a technical issue. The household takes its optimal saving decision before observing any shock in the economy. In order to take this timing constraint into account, I assume that there are two nested information sets : the first one, denoted by $\mathcal{I}_{0t}$, includes all the information carried from the previous period so that it contains the capital stock K_t, the money holding of the household M_t^h, the money holding of entrepreneurs M_t^e and all realizations of other variables in the past. The second one, $\mathcal{I}_{1t}$ includes $\mathcal{I}_{0t}$, all information regarding the current realizations of all variables including technology and monetary shocks.

I start the analysis by resolving for the optimal loan contract in a partial equilibrium framework, where all prices and nominal interest rate are taken as given. Then, the optimal financial contract is embedded in a general equilibrium environment.

1.3.1 Optimal financial contract and investment supply

The contractual arrangement in this economic environment is designed to overcome the information asymmetry between entrepreneurs and the bank using a state verification cost. It is a typical principal-agent problem where the principal (the bank) is willing to incur a cost of verification in order to obtain a perfect or imperfect knowledge of the agent's (the entrepreneur) private information, ex-post. This contracting approach has been developed by Townsend (1979a) for the first time and extended by

[10] Unlike Bernanke et al. (1999a), entry and exit of entrepreneurs are not allowed. Indeed, insolvent entrepreneurs do not exit the economy. They keep their labor income, W_t^e to guarantee a positive net worth for the next period, where they can start new projects.

Gale and Hellwig (1985) to cover debt contracts. This mechanism, among others that are providing incentives[11], allows to account for asymmetric information that characterizes debt contracts in loan relationships and offers *"a clear and articulated basis to understand the role of both debt and intermediaries in financial contracting"* as it has been outlined by Attar and Campioni (2003). In this framework, the role of the financial intermediary is well defined, and the banking activity emerges and becomes essential since it mitigates monitoring costs by performing *a delegated monitoring activity*[12] on behalf of funds' owners.

Financial contract

I consider the optimal contract under a pre-committed, deterministic monitoring paradigm. The financial contract is not stochastic and is negotiated at the beginning of the period t and resolved by the end of the same period (quarter). Following Carlstrom and Fuerst (1997a) and Bernanke et al. (1999a), I assume that there is enough inter-period anonymity in the financial market so that one-period contracts can be considered by ignoring the past borrowing's history of the entrepreneur. Hence the contract characteristics depend only on the entrepreneur's current level of net worth. The entrepreneur i with a real net worth N_{it}[13], can transform an amount I_{it} of consumption goods, expressed in the same terms as his net worth, into a random amount $\omega_{it} I_{it}$ of capital. Hence the capital is produced using a stochastic, constant returns-to-scale technology, where $\omega_{it} \in \Omega_t$ is the stochastic idiosyncratic disturbance to the entrepreneurs' production, satisfying the following assumptions :

Assumption (A1): ω_{it} is a random variable, i.i.d across entrepreneurs and time, with a continuously differentiable cumulative distribution function $\Phi(.)$ over a nonnegative support Ω_t, a density function $\phi(.)$, and a mean of unity and a standard deviation σ_ω.

Assumption (A2): The function $\bar{\omega}_{it} h(\bar{\omega}_{it})$ is increasing in $\bar{\omega}_{it}$, with $h(\bar{\omega}_{it}) = \dfrac{\phi(\bar{\omega}_{it})}{(1 - \Phi(\bar{\omega}_{it}))}$

[11] Asymmetric information is introduced in the lender-borrower relationship in many ways starting from the pure adverse selection case with Stiglitz and Weiss (1981) to the classic hidden action moral hazard with Innes (1990).

[12] See Diamond (1984).

[13] The net worth N_{it} is supposed to be sufficiently small so that each entrepreneur needs external funds in order to start his production.

is the hazard function of the distribution Φ.

The assumption (A2) is made to guarantee that the lender's expected return reaches its maximum at an interior unique value of $\bar{\omega}_{it}$. It a a regularity condition satisfied by most of the continuous distributions[14]. In addition, the financial intermediary and entrepreneurs are supposed to be risk neutral Both and have the same probability beliefs about the distribution of ω_{it}.

In order to run his project, each entrepreneur needs to rely on the bank for external finance by borrowing an amount $P_t(I_{it} - N_{it})$. As mentioned earlier, the entrepreneur's net worth is accumulated at the end of the previous period; it is the sum of his labor income after supplying one unit of work to the firms at a nominal wage $W^e_{i,t-1}$ in the previous period, and his nominal money holdings carried over from the previous period, M^e_{it}, then it is given by :

$$P_t N_{it} = M^e_{it} + W^e_{i,t-1} \tag{1.3}$$

Each entrepreneur supplies inelastically one unit of labor in order to guarantee a positive net worth amount at the beginning of each period. Under this assumption, bankrupt entrepreneurs in the previous period are not obliged to exit the economy and can implement again their new projects during the current period using their labor income. Then, the following assumption needs to be satisfied :

Assumption (A3) : The contract is defined and exists only for non-autarkic allocations and positive amounts of net worth so that :

$$\forall I_{it} \in (0, +\infty), \quad 0 < N_{it} < I_{it}.$$

The underlying contract stipulates that the entrepreneur reimburses an amount of $R^l_t P_t(I_{it} - N_{it})$ to the financial intermediary at the end of the same period and after the realization of the idiosyncratic productivity shock ω_{it}, where R^l_t is the gross interest rate of loan. If an entrepreneur defaults, the financial intermediary expends a nominal amount of $\zeta(\omega_{it}, I_{it})$ in order to monitor the project returns, assuming that the entrepreneur may misreport the true value of his production. Therefore, the optimal

[14]See (Bernanke et al., 1999a) for the proof.

contract is designed in such a way that entrepreneurs have no incentive to deviate, and they truthfully report their realizations. The costly verification, if it occurs, is "commonly" interpreted as a default of the entrepreneur and all his returns from the project are confiscated by the financial intermediary. In the opposite case, the borrower pays back his loan. The monitoring cost function $\zeta(\omega_{it}, I_{it})$ must satisfy the following assumption :

Assumption (A4) : The monitoring cost $\zeta : \mathbb{R}_+ \times \mathbb{R}_+ \to \mathbb{R}_+$ is a $\mathcal{C}^2$ function in the interior of its domain and continuous at the boundaries. In addition, it verifies

$$\frac{\partial}{\partial I}\zeta(\omega_{it}, I_{it}) \geq 0, \qquad \frac{\partial^2}{\partial I^2}\zeta(\omega_{it}, I_{it}) \geq 0, \qquad \frac{\partial}{\partial \omega}\zeta(\omega_{it}, I_{it}) \geq 0.$$

Formally, the entrepreneur defaults if and only if his income from selling the capital produced $Q_t\omega_{it}I_{it}$ is less than the loan's repayment $R_t^l P_t(I_{it} - N_{it})$, or equivalently, when the realization of ω_t is not high enough to reach the threshold value $\bar{\omega}_{it} = R_t^l P_t(I_{it} - N_{it})/(Q_t I_{it})$[15]. Consequently, the entrepreneur's decision rule is given by

- If $\omega_{it} \in (0, \bar{\omega}_{it})$, the entrepreneur cannot honor his contractual commitments and thus declares bankruptcy. In this situation, the lending intermediary pays the auditing cost $\zeta(\omega_{it}, I_{it})$ and then confiscates all the returns from the project. That is, the intermediary net receipts are $Q_t\omega_{it}I_{it} - \zeta(\omega_{it}, I_{it})$ and the entrepreneur receives nothing.

- If $\omega_{it} \in [\bar{\omega}_{it}, \infty)$, the entrepreneur's revenue from selling his produced capital exceeds the repayment, he reimburses the promised amount $R_t^l p_t(I_{it} - N_{it})$ and keep the difference that equals to $Q_t\omega_{it}I_{it} - R_t^l P_t(I_{it} - N_{it})$. He decides on his current consumption and carries the remainder into the next period as a part of his net worth.

[15]Let $L_{it} = I_{it}/N_{it}$ be the leverage ratio. Then $\bar{\omega}_{it} = R_t^l P_t/Q_t(1 - 1/L_{it}) \underset{L\to+\infty}{\longrightarrow} R_t^l(P_t/Q_t)$. It is straightforward to notice that the entrepreneurial productivity cutoff value $\bar{\omega}_{it}$ is an increasing function of the project's leverage ratio. The entrepreneurs who are running highly leveraged projects are likely to default more than the others and their rate of bankruptcy $\Phi(\bar{\omega}_{it})$ is higher. $\bar{\omega}_{it}$ is bounded from above such that, for given values of R_t^l and (Q_t/P_t), $\forall L_{it} \in (1, \infty)$, $L_{it} \leq (R_t^l P_t)/Q_t$. For an infinitely high-leveraged project, the default probability is a function of the ratio of loan's cost to the relative price of capital. Indeed, an increase of the relative price of capital, for a fixed loan cost, reduces the default probability of the entrepreneur.

Using the definition and the distribution of $\bar{\omega}_{it}$ and the entrepreneur's decision rule, one can derive both entrepreneur's and bank's expected payoffs. The entrepreneurial expected return is

$$E^e(\bar{\omega}_{it}, I_{it}) = Q_t I_{it} f(\bar{\omega}_{it})$$

where

$$f(\bar{\omega}_{it}) = \int_{\bar{\omega}_{it}}^{+\infty} \omega\phi(\omega)d\omega - \bar{\omega}_{it}\left[1 - \Phi(\bar{\omega}_{it})\right].$$

Following Bernanke et al. (1999a) and others, in order to facilitate aggregation over entrepreneurs below, I will assume that the monitoring cost $\zeta(\omega_{it}, I_{it})$ is linear and proportional to the expected gross income $Q_t I_{it}$[16]. This specification satisfies assumption (A4) and adds more tractability to the model. Moreover, the marginal cost, denoted by μ is supposed to be exogenous [17], so that the total monitoring cost that a bank incurs whenever an entrepreneur declares bankruptcy is

$$\zeta(\omega_{it}, I_{it}) = \mu Q_t \omega_{it} I_{it}$$

Using this functional form of $\zeta(\omega_{it}, I_{it})$, the bank's expected return is

$$E^l(\bar{\omega}_{it}, I_{it}) = Q_t I_{it} g(\bar{\omega}_{it})$$

where

$$g(\bar{\omega}_{it}) = (1-\mu)\Gamma(\bar{\omega}_{it}) + \bar{\omega}_{it}\left[1 - \Phi(\bar{\omega}_{it})\right].$$

[16]In order to grapple with the heterogeneity among entrepreneurs, the linearity assumption is needed. Bernanke et al. (1999a) argue that this assumption does not seem to be "unreasonable".

[17]Aysun (2011) suggests alternative specifications of $\zeta(\omega_{it}, I_{it})$. He assumes that the marginal monitoring cost is endogenous. Particularly, he assumes that the loans recovery in case of bankruptcy is not immediate and there is a variable cost that depends on the loan's recovery duration D. The variable cost is null when the recovery is immediate, however, its is positive whenever the debt recovery is delayed. The bank incurs the cost mainly due to the uncertainty that characterizes the unexpected nominal interest rate change and the expected inflation volatility. The bank needs to take into consideration this delay when computing its expected return and the loan cost (the risk premium). He tested also for other credit payment schedules.

and

$$\Gamma(\bar{\omega}_{it}) = \int_0^{\bar{\omega}_{it}} \omega\phi(\omega)d\omega.$$

$f(\bar{\omega}_{it})$ and $g(\bar{\omega}_{it})$ are interpreted as the fractions of the expected capital revenue received by the entrepreneur and the bank, respectively. Note that the sharing of the expected gross income $Q_t I_{it}$ between the entrepreneur and the bank is fully determined by the cutoff value $\bar{\omega}_{it}$, since

$$f(\bar{\omega}_{it}) + g(\bar{\omega}_{it}) = 1 - \mu\Gamma(\bar{\omega}_{it})$$

which implies that on average, an amount of $\mu\Gamma(\bar{\omega}_{it})Q_t I_{it}$ of the capital revenue is lost due to auditing.

Credit demand and entrepreneurs efficiency conditions

Under assumptions $(A1 - A4)$, the optimal financial contract is given by the pair $(\bar{\omega}_{it}, I_{it})$, which is an interior solution to the following principal-agent problem:

$$\max_{(\bar{\omega}_{it}, I_{it})} E^e(\bar{\omega}_{it}, I_{it})$$

subject to

$$E^l(\bar{\omega}_{it}, I_{it}) \geq R_t P_t (I_{it} - N_{it}) \tag{i}$$

$$E^e(\bar{\omega}_{it}, I_{it}) \geq R_t P_t N_{it} \tag{ii}$$

The optimal contract pays the maximum non-negative amount of expected payoff $E^e(\bar{\omega}_{it}, I_{it})$ to the entrepreneur, taking into account the constraints (i) and (ii). The constraint (i) is the lender's individual rationality constraint that is binding at the optimum ensuring to the financial intermediary a fixed return R_t (zero-profit condition). (ii) is the entrepreneur's participation constraint that will always be satisfied[18].

[18]The entrepreneur is willing to invest all his net worth since with asymmetric information, the expected return on internal funds is higher than the expected return of the external funds, as it will be showed below.

The first-order-conditions subject to the variables ω_{it} and I_{it} are, respectively

$$\frac{P_t R_t}{Q_t} = 1 - \mu\Big\{\Gamma(\bar{\omega}_{it}) + \bar{\omega}_{it} h(\bar{\omega}_{it}) f(\bar{\omega}_{it})\Big\} \tag{1.4}$$

$$I_{it} = \frac{P_t R_t}{P_t R_t - Q_t g\left(\bar{\omega}_{it}\right)} N_{it} \tag{1.5}$$

Equation (1.4) defines an implicit function of ω_{it} which is the same for all entrepreneurs. This result is due to the linearity assumptions on monitoring and capital production technologies. All the entrepreneurs have the same threshold of the idiosyncratic productivity shock $\bar{\omega}_t$, above which they are solvent. Then, we can drop the subscript i from $\bar{\omega}_{it}$ and aggregate equation (1.5) over all entrepreneurs to get the economy-wide investment supply function . Let $I_t = \int_0^1 I_{it} di$ and $N_t = \int_0^1 N_{it} di$, then the investment supply is given by

$$I_t = \frac{P_t R_t}{P_t R_t - Q_t g\left(\bar{\omega}_t\right)} N_t \tag{1.6}$$

The entrepreneur's investment is a linear function of the aggregate net worth N_t with a proportionality factor, $P_t R_t / P_t R_t - Q_t g\left(\bar{\omega}_t\right)$, that exceeds 1. Other things being equal, an increase of the net worth by a one unit induces an increase of the investment level by more than one unit. Moreover, at the optimum, the financial external premium is equal the wedge between the effective cost of loan R_t^l and the opportunity cost of internal fund measured by the riskless interest rate R_t. This wedge, denoted by Δ_t, depends positively on the amount of monitoring costs and is given by

$$\Delta_t = \frac{\bar{\omega}_t}{g(\bar{\omega}_t)} \tag{1.7}$$

with $\Delta_{\bar{\omega}} > 0$. An increase of the default rate induces more monitoring costs, consequently a higher risk premium. Equation (1.6) can be also considered as the aggregate credit demand, $I_t - N_t$:

$$I_t - N_t = \frac{Q_t g\left(\bar{\omega}_t\right)}{P_t R_t - Q_t g\left(\bar{\omega}_t\right)} N_t \tag{1.8}$$

Solvent entrepreneurs need to decide on their consumption level C_t^e, and on their net worth accumulation for the next period. Equivalently, they decide on the amount of cash holdings M^e_{t+1}, to carry into the next period. The cash holding is equal to 0 for faulty entrepreneurs since all their production is confiscated by the financial intermediary whereas solvent entrepreneurs maximize their utility by splitting their investment return between consumption and cash holdings. Formally, an entrepreneur maximizes his inter-temporal utility

$$E_0 \sum_{t=0}^{\infty} \gamma^t C^e_t$$

subject to the following budget constraint

$$M^e_{t+1} = \begin{cases} Q_t I_t f(\bar{\omega}_t) - P_t C^e_t & \text{if } \omega_t \geq \bar{\omega}_t \\ 0 \quad \text{and} \quad C^e_t = 0 & \text{if } \omega_t < \bar{\omega}_t. \end{cases}$$

where $\gamma \in (0,1)$ is the discount factor. Solving for the entrepreneurs' problem implies the following Euler equation,

$$E\left\{\frac{P_{t+1}}{P_t} - \gamma \frac{Q_{t+1} R_{t+1} f(\bar{\omega}_{t+1})}{P_{t+1} R_{t+1} - Q_{t+1} g(\bar{\omega}_{t+1})} \mid \mathcal{I}_{1t}\right\} = 0. \tag{1.9}$$

1.3.2 Households

The representative household chooses the consumption C_t, the investment I_t and the deposits amount D_t. In addition, he decides on the number of working hours L_t, to be supplied to firms. These decisions maximize the following discounted stream of his utility

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t - hC_{t-1}, L_t)$$

where E_0 denotes the expectation operator conditional on time-0 information. The leisure endowment is normalized to unity, so that $L_t \in (0,1)$. $0 < \beta < 1$ is a constant discount factor such that $\beta < \gamma$; so that households discount the future less heavily than do entrepreneurs. This impatience is intended to prevent entrepreneurial sector from accumulating wealth and being fully self-financed[19]. The utility function $U(.)$

[19]Bernanke et al (1999) used the assumption of finite horizons for entrepreneurs (exponential death) to preclude the possibility of being fully self-financed.

is increasing, strictly concave in each of its arguments and verifies Inada conditions. Households allow for some persistence of their consumption habits: they take into consideration their previous consumption when deciding the current one. The parameter $h \geq 0$ is intended to capture this consumption adjustment behavior. A positive value of h reflects the complementarity of past and present consumption amounts, thus households adjust gradually their consumption path in response to some unanticipated shocks, giving rise to a habit formation phenomenon. Throughout, the following utility function will be used in the quantitative analysis below:

$$U(C_t - hC_{t-1}, L_t) = \ln(C_t - hC_{t-1}) + \nu(1 - L_t)$$

As mentioned above, the household enters period t with a nominal money balance equals to M_t^h, carried over from the previous period. After deciding on the amount of deposits D_t, the household split the remaining cash, $M_t^h - D_t$ between consumption's purchasing P_tC_t and investment's spending φQ_tI_t, taking all prices as given. We assume that only a share $\varphi \in (0,1)$ of the investment is purchased using cash. Therefore, the household faces the following cash-in-advance constraint,

$$P_tC_t + \varphi Q_tI_t \leq M_t^h - D_t \tag{1.10}$$

where $\delta \in (0,1)$ is the depreciation rate of capital. At the end of the period t, the household receives his labor income W_tL_t, the nominal capital income $P_tr_tK_t$ and his intra-period deposits' repayment, including the earned interest, R_tD_t. The household receives also the profit Π_t^F, realized by the firms. All the money flows accumulated are used to buy the remaining share of investment $(1-\varphi)Q_tI_t$ and carried into the next period as, M_{t+1}^h. Hence, the representative household's inter-temporal budget constraint is represented by

$$M_{t+1}^h + (1-\varphi)Q_tI_t = W_tL_t + P_tr_tK_t + R_tD_t + \Pi_t^F + \Big(M_t^h - P_tC_t - \varphi Q_tI_t - D_t\Big) \tag{1.11}$$

where r_t is the real rental rate of capital. The household uses its purchased investment to accumulate capital following the law of motion :

$$K_{t+1} = (1-\delta)K_t + I_t \tag{1.12}$$

Let $V(s_t)$ be the households value function, where S_t represents the initial state of the economy that includes household's beginning-of-period money stock M_t^h, entrepreneur's beginning-of-period money stock, M_t^e and beginning-of-period capital stock K_t such that $S_t = (K_t, M_t^h, M_t^e)$. The household's optimal decision plan is the solution to the following dynamic programming problem :

$$V(K_t, M_t^h; S_t) = \max_{D_t} E\Big\{\max_{C_t, L_t, K_{t+1}} U(C_t - hC_{t-1}, L_t) + \beta E\Big[V(K_{t+1}, M_{t+1}^h; S_{t+1}) \mid \mathcal{I}_{1t}\Big] \mid \mathcal{I}_{0t}\Big\}$$

subject to the cash-in-advance constraint (1.10) and the budget constraint (1.11).

Combining the first-order-conditions with the envelop conditions, we get the following optimality conditions :

$$E\Big\{\beta W_t \frac{A_{t+1}}{P_{t+1}} + U_{L,t} \mid \mathcal{I}_{1t}\Big\} = 0 \tag{1.13}$$

$$E\Big\{\beta R_t \frac{A_{t+1}}{P_{t+1}} - \frac{A_t}{P_t} \mid \mathcal{I}_{0t} = 0 \tag{1.14}$$

$$E\Big\{Q_t\Big(\beta(1-\varphi)\frac{A_{t+1}}{P_{t+1}} + \varphi\frac{A_t}{P_t}\Big) - \beta(1-\delta)Q_{t+1}\Big(\beta(1-\varphi)\frac{A_{t+2}}{P_{t+2}} + \varphi\frac{A_{t+1}}{P_{t+1}}\Big) - \beta^2\frac{A_{t+2}}{P_{t+2}}P_{t+1}r_{t+1} \mid \mathcal{I}_{1t}\Big\} = 0 \tag{1.15}$$

where where $A_t = U_{C,t} + \beta U_{C,t+1}$ and $U_{x_i,t} = \partial U_t/\partial x_i$. For ease of notation, let $E_t = E\{. \mid \mathcal{I}_{1t}\}$ and $E_{t-1} = E\{. \mid \mathcal{I}_{0t}\}$. The interpretation of the efficiency conditions is straightforward. According to equation (3.3.29), the representative household equalizes the current cost of increasing labor supply by one unit, $-U_{L,t}$ with the discounted wage that will be spent next period, $W_tE_t\{\beta U_{C,t+1}/P_{t+1}\}$. The equation shows that the monetary policy distorts labor supply decision through the expected inflation effect. In fact, the benefit of working an extra hour can be expressed as, $(W_t/P_t)E_t\{\beta U_{C,t+1}/\pi_{t+1}\}$, where $\pi_{t+1} = P_{t+1}/P_t$ is the expected inflation rate. In short, an increase of the expected inflation brings down the value of a given real wage in the next period and consequently, the household's consumption spending decreases. Equation (3.3.30) governs the household's saving decision which is, in accordance with the limited participation assumption, conditioned by the information set that excludes monetary and technology shocks. Given $\mathcal{I}_{0t}$, the household equalizes the discounted benefit of increasing his deposits by one unit, $E_{t-1}\{R_t \beta U_{C,t+1}/P_{t+1}\}$ to this current utility cost, $E_{t-1}\{U_{C,t}/P_t\}$ of reducing his current consumption. This relation is the source of the liquidity effect in the model, that will be more detailed below. Equation (3.3.31) describes the capital accumulation process by households. If the entire investment was a credit good i.e. $\varphi = 0$, equation (3.3.31) collapses to the standard capital accumulation equation when capital production is subject to asymmetric information in the credit market.

1.3.3 Consumption-good production

The firms are engaged in the production of the homogeneous consumption good in a competitive market, using a constant-returns-to-scale production technology. In order to facilitate aggregation, I assume that all firms in the economy are represented by one price-taker firm, maximizing its profit Π_t^F given by

$$\Pi_t^F = P_t Y_t - W_t H_t - P_t r_t K_t - W_t^e H_t^e$$

Where Y_t is the aggregate output, realized using the following Cobb-Douglas technology:

$$Y_t = A_t K_t^{\alpha_1} H_t^{\alpha_2} H_t^{e(1-\alpha_1-\alpha_2)} \tag{1.16}$$

K_t and H_t are households' capital and labor, H_t^e is entrepreneurs' labor supply and it is normalized to one and A_t is the aggregate productivity shock. A_t evolves according to the following law of motion

$$\ln A_t = (1-\rho)\ln \bar{A} + \rho \ln A_{t-1} + \varepsilon_t, \tag{1.17}$$

where $\varepsilon_t \sim i.i.d.(0, \sigma_A^2)$, $\rho \in (0,1)$ is the auto-correlation coefficient and $\bar{A}$ is the non stochastic steady state value of A_t.

Under perfect competition, optimal conditions for the representative firm are such that real marginal costs of inputs equalize their corresponding marginal productivities,

$$r_t = \alpha_1 \frac{Y_t}{K_t} \tag{1.18}$$

$$\frac{W_t}{P_t} = \alpha_2 \frac{Y_t}{H_t} \tag{1.19}$$

$$\frac{W_t^e}{P_t} = (1 - \alpha_1 - \alpha_2) \frac{Y_t}{H_t^e}. \tag{1.20}$$

1.3.4 Financial intermediary

The financial intermediary deals with financial operations, controlling all borrowing-lending activities in the economy. At the beginning of each period, its balance is augmented with a new money, injected by the monetary authority. In addition, the bank receives deposits D_t from households. The accumulated cash is loaned to entrepreneurs using the optimal debt contract derived earlier. The financial intermediary has a well defined role: it coordinates lending from risk-averse households to risk-neutral entrepreneurs[20] and mitigates the total verification cost by eliminating the duplication of monitoring activity which would emerge in case of direct lending[21].

1.3.5 Monetary policy

Monetary policy is conducted by the central bank according to a money supply rule. The money supply M_t^s at a rate τ_t such that an amount $(\tau_t - 1)M_t^s$ is injected in the economy each period. τ_t obeys to a stationary first-order auto-regressive process given by:

$$\ln \tau_t = (1 - \gamma) \ln \bar{\tau} + \gamma \ln \tau_{t-1} + u_t, \tag{1.21}$$

where u_t is an i.i.d random variable with $u_t \rightsquigarrow N(0, \sigma_u^2)$ and $\gamma \in (0, 1)$ is the autocorrelation coefficient. $\bar{\tau}$ is the steady-state gross money growth rate.

[20]Since they are risk neutral, entrepreneurs will care only about expected returns and bear all the risk. Loans are insured by the financial intermediary which is supposed to be risk-neutral (because of its diversified loan portfolio), then without loss of generality, households can be considered effectively in this context as risk-neutral.

[21]Diamond (1984) and Williamson (1987) showed that an equilibrium allocation where financial intermediation activity is performed Pareto dominates the direct lending allocation, under the assumption of "large scale investment project".

1.3.6 Market clearing conditions

The goods market clearing condition is given by

$$Y_t = C_t + C_t^e + I_t \tag{1.22}$$

The Labor market clearing conditions are :

$$H_t = L_t \tag{1.23}$$

$$H_t^e = 1. \tag{1.24}$$

The financial market clears when accumulated funds are fully borrowed by entrepreneurs:

$$P_t(I_t - N_t) = (\tau_t - 1)M_t^s + D_t \tag{1.25}$$

The money market clearing condition is such that money supply equalizes the money demanded by households and entrepreneurs:

$$M_t^h + M_t^e = M_t^s \tag{1.26}$$

1.3.7 General equilibrium

Since the money supply is growing over time and the scope of the analysis is limited to stationary rational equilibria, so I rescale all nominal variables and express them in terms of economy-wide beginning-of-the-period money stock M_t^s. In addition, I am dividing all rescaled variables by the price level $p_t = P_t/M_t^s$ in order to deal only with real aggregates and prices and inflation rate π_t. All transformed quantities and prices are denoted by lower cases letters.

The stationary competitive general equilibrium consists of an admissible allocation $(Y_t, C_t, C_t^e, I_t, L_t, K_{t+1}, \bar{\omega}_t, m_{t+1}^e, m_{t+1}^h, D_t)_{t\geq 0}$ and a system of prices $(w_t, w_t^e, r_t, q_t, p_t, R_t)_{t\geq 0}$ satisfying the following conditions for each agents in the economy :

- Households

$$E\Big\{\beta w_t \frac{A_{t+1}}{\tau_t p_{t+1}} + U_{L,t} \mid \mathcal{I}_{1t}\Big\} = 0 \tag{1.27}$$

$$E\Big\{q_t\Big(\beta(1-\varphi)\frac{A_{t+1}}{\tau_t p_{t+1}} + \varphi\frac{A_t}{p_t}\Big) - \beta(1-\delta)q_{t+1}\Big(\beta(1-\varphi)\frac{A_{t+2}}{\tau_{t+1}p_{t+2}} + \varphi\frac{A_{t+1}}{p_{t+1}}\Big) - \beta^2\frac{A_{t+2}}{\tau_{t+1}p_{t+2}}p_{t+1}r_{t+1} \mid \mathcal{I}_{1t}\Big\} = 0 \tag{1.28}$$

$$E\Big\{\beta R_t \frac{A_{t+1}}{\tau_t p_{t+1}} - \frac{A_t}{p_t} \mid \mathcal{I}_{0t}\Big\} = 0 \tag{1.29}$$

$$K_{t+1} = (1-\delta)K_t + I_t \tag{1.30}$$

- Entrepreneurs

$$E_t\Big\{\frac{p_{t+1}}{p_t}\tau_t - \gamma\frac{q_{t+1}R_{t+1}f(\bar{\omega}_{t+1})}{p_{t+1}R_{t+1} - q_{t+1}g(\bar{\omega}_{t+1})} \mid \mathcal{I}_{1t}\Big\} = 0 \tag{1.31}$$

$$I_t = \frac{p_t R_t}{p_t R_t - q_t g\left(\bar{\omega}_t\right)} N_t \tag{1.32}$$

$$1 - \mu\Big\{\Gamma(\bar{\omega}_t) + \bar{\omega}_t h(\bar{\omega}_t) f(\bar{\omega}_t)\Big\} = \frac{R_t p_t}{q_t} \tag{1.33}$$

$$m^e_{t+1}\tau_t = q_t I_t f(\bar{\omega}_t) + p_t C^e_t \tag{1.34}$$

$$p_t N_t = m^e_t + \frac{w^e_{t-1}}{\tau_{t-1}} \tag{1.35}$$

- Firms

$$r_t = \alpha_1 A_t K_t^{\alpha_1 - 1} H_t^{\alpha_2} \tag{1.36}$$

$$\frac{w_t}{p_t} = \alpha_2 A_t K_t^{\alpha_1} H_t^{\alpha_2 - 1} \tag{1.37}$$

$$\frac{w^e_t}{p_t} = (1 - \alpha_1 - \alpha_2) A_t K_t^{\alpha_1} H_t^{\alpha_2} \tag{1.38}$$

- Markets clearing conditions

$$Y_t = C_t + C^e_t + I_t \tag{1.39}$$

$$p_t(I_t - N_t) = (\tau_t - 1) + d_t \tag{1.40}$$

$$m_t^h - d_t = p_t C_t + \varphi q_t I_t \tag{1.41}$$

$$m_t^h + m_t^e = 1 \tag{1.42}$$

- Exogenous shocks processes

$$\ln A_t = (1 - \rho_A) \ln \bar{A} + \rho_A \ln A_{t-1} + \varepsilon_t \tag{1.43}$$

$$\ln \tau_t = (1 - \gamma) \ln \bar{\tau} + \gamma \ln \tau_{t-1} + u_t \tag{1.44}$$

1.4 Theoretical analysis

In this section, I analyze theoretically the broad credit transmission channel as well as the risk-taking channel of an expansionary monetary policy. First, I investigate the existence of the liquidity effect when there is asymmetric information in the credit market. Second I examine the response of credit market variables to a positive money supply shock and to which extent banks' risk tolerance affects the bank lending channel and monetary policy potency.

The limited participation assumption is supposed to enable generating the liquidity effect after a positive money supply shock. This is the most traditional transmission channel of the monetary policy, namely the interest rate channel. This result was analytically proved by Christiano and Eichenbaum (1995) in a production model with a frictionless credit market. Naturally, the first question to ask is whether such liquidity effect still exists in an investment model when asymmetric information in the credit market is introduced. The second question is whether and to which extent the frictions' intensity affects the liquidity effect if it exists. The following propositions stipulate that in a limited participation model with asymmetric information in the credit market, where capital is produced using external funding, a positive money supply shock generates a drop in the short-run nominal interest rate, an increase of investment and a rise of the relative price of capital. This drop is more important than the one observed when the credit market is frictionless because informational frictions alter the sensitivity of the demand for loanable funds to the cost of credit. In addition, the observed decline in the nominal interest is a decreasing function of the marginal cost of verification in the credit market.

Proposition 1

In equilibrium, in an endogenous net-worth model and for a given level of net worth $N_t > 0$, the following holds:

$$\frac{dR_t}{d\tau_t} > 0, \qquad \frac{dI_t}{d\tau_t} > 0, \qquad \frac{dq_t}{d\tau_t} > 0, \qquad \frac{d\bar{\omega}_t}{d\tau_t} > 0, \qquad \frac{d\Delta_t}{d\tau_t} > 0.$$

Proof: See appendix B. ■

When the central bank increases its money supply, given the sluggish response of households, entrepreneurs wind up holding all the extra money, funneled to them through the banking sector. Entrepreneurs are willing to absorb the monetary injections only at a lower cost of credit R^l_t. This new lending rate clears the credit market and entrepreneurs voluntary invest more to achieve a higher accumulated capital in equilibrium.

In the first step, in response to a positive monetary shock, the lending rate decreases to reach an amount ${R^{l}}'_t$ (see figure 5.). This decrease is due to an instantaneous decrease of the short-run nominal interest rate R_t, which corresponds to the "pure" liquidity effect. Fuerst (1992) argues that this liquidity effect is generated by a negative liquidity premium Λ_t, defined as the difference between liquidity valuation in the credit sector and a "shadow" liquidity valuation in the households' sector. The basic idea is that an injection of extra money in the credit market devaluates the liquidity and pushes down its price. Given that households are not allowed to participate, they are willing to offer a higher price for money than R_t if they were able to do. Following Fuerst (1992), I define the liquidity premium, Λ_t, by

$$\Lambda_t = R_t \beta E_t \Big\{ \frac{A_{t+1}}{\pi_{t+1}} \Big\} - A_t$$

where $\pi_{t+1} = \tau_t \frac{p_{t+1}}{p_t}$. Using the law of iterated mathematical expectations, the households' optimal saving condition (3.3.30) states that $E_{t-1}\Lambda_t = 0$. Solving this equation for R_t, one gets:

$$R_t = \frac{\Lambda_t + A_t}{\beta E_t(A_{t+1}/\pi_{t+1})}$$

Since the risk premium Δ_t is defined by $\Delta_t = R^l_t/R_t$, then the lending rate R^l_t can be expressed by:

$$R^l_t = \frac{\Lambda_t + A_t}{\beta E_t(A_{t+1}/\pi_{t+1})}\Delta_t \tag{1.45}$$

The final impact of a positive money supply shock on the cost of credit depends on the respective responses of both liquidity and risk premia, Λ_t and Δ_t. Unlike the case of a frictionless credit market, the feedback from the short-term nominal interest rate to the lending rate is not one-to-one anymore so that the decrease of R^l_t due to a negative value of the liquidity premium in the first step is not a stable equilibrium because the optimal lending rate that will clear the credit market depends also on the the response of the risk premium Δ_t. Moreover, the risk premium Δ_t is an increasing function of the entrepreneurial productivity threshold $\bar{\omega}_t$, then its response depends on how $\bar{\omega}_t$ reacts to a positive money supply shock. This new effect added by asymmetric information in the credit market pushes the cost of credit toward a stable equilibrium level of lending rate $R^{l''}_t$ (see figure 5.) higher than $R^{l'}_t$.

Since the credit contract is a one-period contract and the real net worth is predetermined, then equation (1.8) can be considered as a static demand function for loanable funds in real loans, nominal lending rate space. Using the definition of the risk premium Δ_t above, the credit demand function can be expressed as

$$I_t - N_t = \frac{q_t\bar{\omega}_t}{p_t R^l_t - q_t\bar{\omega}_t}N_t \tag{1.46}$$

It is straightforward to show that the demand of loans is a decreasing function of the credit cost R^l_t and an increasing function of the net worth N_t. Money injection increases

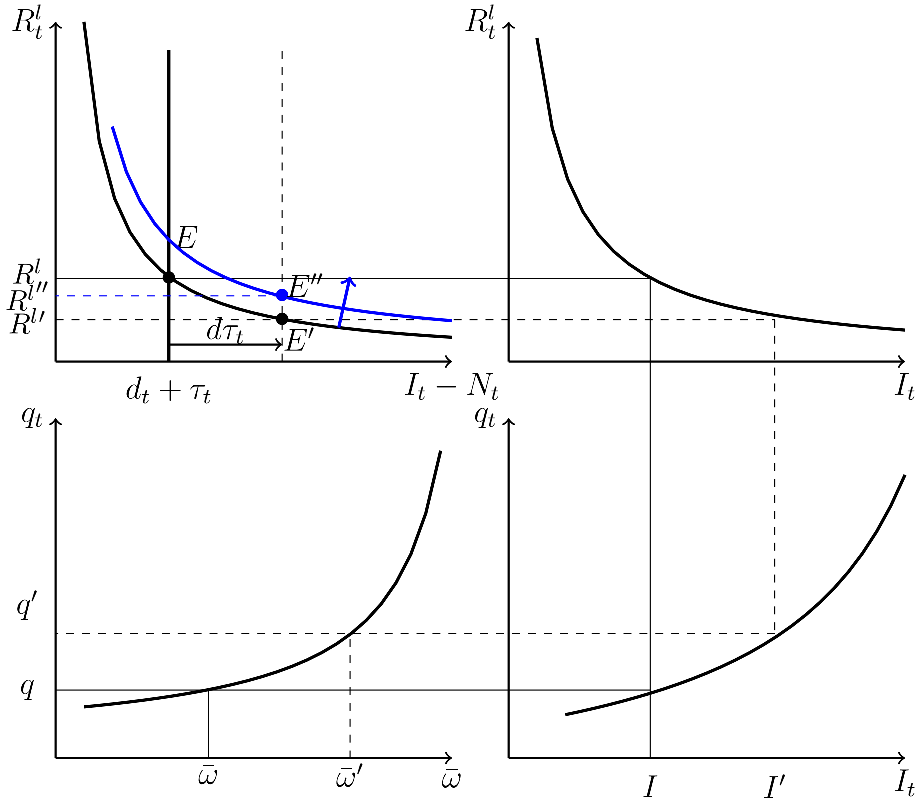

Figure 1.5: Impact of an unanticipated positive money supply shock on the equilibrium in the short-run

loanable funds and spurs investment spending. Since the net worth is pre-determined, the increase of investment spending leads to more moral hazard and adverse selection problems in the credit market. As a consequence, the default rate and the amount of monitoring costs increase, which leads to an increase of the external finance premium. Therefore, the marginal cost of investment increases, driving up the relative price of the existing capital, q_t. Due to this increase of the risk premium, the lending rate shifts from the initial low level ${R^{l}}'_t$ induced by the initial decrease of R_t to a higher level ${R^{l}}''_t$. Despite its negative impact on the cost of loans, the presence of informational frictions in the credit market amplifies the liquidity effect and the reason is the following: in order to induce the desired decrease of the lending rate, the drop of the risk-free rate R_t needs to be more important than the drop observed when the credit market is frictionless in order to overcome the adverse impact of the risk premium's increase. On the other hand, the potency of this adverse effect depends on the sensitivity of the lender's expected return to the borrower's productivity threshold $\bar{\omega}_t$. This finding is summarized by the following proposition.

Proposition 2

When there is asymmetric information in the credit market, an unanticipated positive money supply shock reduces the borrowing cost if and only if the impact of the liquidity premium on the interest rate of loan dominates the impact of the risk premium.

Equivalently, If $\bar{\omega}_t h(\bar{\omega}_t)$ is increasing in $\bar{\omega}_t$ and $\tau_t > 0$, then:

$$\frac{dR_t^l}{d\tau_t} < 0 \quad \Longleftrightarrow \quad \frac{1}{2} < E_{g/\bar{\omega}} < 1.$$

where $E_{g/\bar{\omega}}$ is the elasticity of the lender's expected return with respect to $\bar{\omega}_t$.

Proof: See appendix B. ■

The lender's expected return elasticity cannot exceed 1, otherwise the lender can continue generating profits by infinitely increasing risk, through bad loans, and credit market ends up collapsing. Informational frictions in the credit market activate both sub-channels of the broad credit view of the monetary policy, namely the balance-sheet channel and the bank-lending channel, so that the monetary policy potency depends on the strength of each sub-channel. Obviously, the increase of the default rate among entrepreneurs after a positive money supply shock will weaken the bank-lending channel significantly. However, credit market frictions will raise the price-elasticity of loanable funds' demand. In order to show these facts, one needs to investigate the demand side of the credit market and especially the sensitivity of the demand for loanable funds, $I_t - N_t$, to movements in lending rate. Using equation (1.46) again and after some algebra, the price-elasticity of loanable funds demand function is found to be

$$E_{I-N/R^l} = \frac{E_{I-N/R}}{1 + E_{\bar{\omega}/R}(1 - E_{g/\bar{\omega}})}$$

Given the results of propositions 1 and 2, information frictions in the credit market induce an increase of the elasticity of the demand for loanable funds. This is the channel through which the amplification of the liquidity effect is transmitted to investment and to the real economy. After a positive money supply shock, the lending rate does not decrease as much as the short-term nominal interest rate does, because of the increase of the risk premium Δ_t. On the other hand, the sensitivity of loanable funds demand increases significantly, which leads to a greater response of real investment and an amplified response of the economy to a such shock. Proposition 1 stipulates that $\partial\bar{\omega}_t/\partial R_t < 0$, so that $E_{\bar{\omega}/R} < 0$. Moreover, proposition 2 stipulates that $1 - E_{g/\bar{\omega}} > 0$. Thus, $E_{I-N/R^l} > E_{I-N/R}$, which means that the price elasticity of loanable funds' demand function is higher when there is asymmetric information in the credit market than the price elasticity of loanable funds' demand function in the case of a frictionless credit market. Although credit market informational frictions are shown to amplify the impact of a positive money supply shock, the potency of the monetary policy decreases with the degree of credit market conditions' deterioration. Indeed, when the marginal cost of verification μ increases, two adverse effects dampen the monetary policy efficiency: the "pure" liquidity effect decreases and the demand for loanable funds becomes less sensitive to the lending rate. Proposition 3 summarizes this finding.

Proposition 3

If all conditions in proposition 1 hold, then the "pure" liquidity effect and the price elasticity of the loanable funds' demand are decreasing functions of the monitoring cost, $\mu > 0$:

$$\frac{\partial}{\partial\mu}\Big(\frac{dR_t}{d\tau_t}\Big) < 0, \qquad \frac{\partial E_{I-N/R^l}}{\partial\mu} < 0.$$

Proof: See appendix B. ■

In the model above, the marginal agency cost μ is exogenous and constant. Everything else equal, an exogenous increase of μ will raise the expected losses related to entrepreneurs' default. Lenders will be more selective in granting loans and a *flight to quality* is likely to happen. Thus, the increase of $\bar{\omega}_t$ will be smaller than the increase of default rate observed in the case of a smaller marginal agency cost μ. As a consequence, the risk-free rate does not need to drop sharply in order to reach a low lending rate. Therefore, the pure liquidity effect is a decreasing function of the marginal cost of monitoring. On the other hand, raising μ has an adverse impact on the transmission of the monetary policy. The price elasticity of the loanable funds's demand decreases when the marginal cost of verification increase, which means that the demand for credit tends to be more inelastic and investment will be less sensitive to monetary policy. The essence of this proposition is that the potency of the monetary policy depends significantly on the credit market characteristics and its institutional environment. The efficiency of the monetary policy is higher when the marginal monitoring cost is smaller. An exogenous increase of agency costs raises the economywide deadweight losses.

1.5 Numerical analysis

This section is dedicated to the numerical analysis of the model developed above. The solution is obtained using a perturbation technique, based on the algorithms presented by Klein (2000) and Sims (2002). In short, dynamic nonlinear rational expectations equilibrium conditions given by agents' optimal conditions, are log-linearized around the non-stochastic steady state and the decision rules, as a first order approximated solution, are computed using the method of undetermined coefficients. The basic idea is to compare the impulse response functions of an asymmetric information model with a benchmark model where the credit market is frictionless. To this end, I calibrate the models parameters and I compute the responses of both models to a positive money supply shock.

1.5.1 Calibration

The model is parametrized to match empirical counterparts of U.S. data. The calibration exercise is standard and based on empirical estimates used in the existing literature on business cycle fluctuations. Following Carlstrom and Fuerst (1997a), the constant ν is chosen such that the ratio $L/(1-L)$, matches its empirical value 0.3, so that ν is set equal to 2.957. The habit formation parameter h is taken to be 0.65 and the share of investment good φ purchased with cash is equal to 0.6. The annual real interest rate is 4%, implying a quarterly discount rate, β, of 0.99. The quarterly depreciation rate of capital δ is supposed to be equal 0.0212.

The production of the consumption good is supposed to be Cobb-Douglas, with a capital share of 0.36 and household labor share of 0.6399. Thus the entrepreneurial labor share is 0.0001. It is selected arbitrary small so that the labor income plays a minor role in determining the entrepreneurial net worth. Being in line with Prescott (1986), the persistence of the productivity shock ρ_A is assumed to be 0.95 and its standard deviation, σ_A, is equal to 0.0075. The value of $\bar{A}$ is normalized to unity.

Turning to the monetary policy, following Christiano and Eichenbaum (1995), the steady-state monetary growth rate is fixed at 1.0119. Concerning the autocorrelation coefficients γ, it is set to be equal to 0.32.

On the other hand, some non standard parameters appear in the financial sector. The distribution of the entrepreneurial productivity, $\Phi(.)$ is assumed to be lognormal with a mean of unity and time-varying standard deviation, σ_ω. The value of σ_ω is calibrated to its expected value in Carlstrom and Fuerst (1997a) which is 0.207. I take the annual business failure rate, $\Phi(\bar{\omega})$, to be 2.8%, the approximate value in the U.S data. The entrepreneurs' rate of discount γ, is selected to imply an annualized external finance premium of 300 basis points, the average spread between the Moody's seasoned Baa corporate bond yield and the 3-month treasury bill for the period between 1934 and 2008. Matching these values, γ is set equal to 0.94. The bankruptcy rate μ is calibrated to 0.15 corresponding to a reasonable average value in the literature. Carlstrom and Fuerst (1997a) take μ equal to 0.25 and Bernanke et al. (1999a) assume a lower value, μ equal to 0.12.

1.5.2 Impulse responses to a monetary shock

The first experiment consists of generating an expansionary monetary policy corresponding to a unanticipated shock of 1 standard deviation to money supply growth rate. Responses of both models are displayed in figures 6 and 7. It is straightforward to notice that the introduction of asymmetric information in the model improves the propagation of a monetary policy shock and amplifies its impact. One can remark easily that the liquidity effect is amplified when the lender-borrower relationship is characterized by a moral hazard problem. This finding joins Bernanke and Gertler (1995a) and Bernanke et al. (1999a) who argue that credit market imperfections amplify the economy's response to monetary policy shocks and help to replicate the persistence of the monetary policy effect that lasts for many quarters after the shock. An expansionary monetary policy shock induces a drop of the short-run nominal interest rate in both cases, but this drop is more important when asymmetric information in the credit market is taken into consideration. This numerical result confirms the theoretical analysis conducted above.

In figures 6 and 7, the solid line designates the impulse responses when there is asymmetric information in the credit market. The dashed line indicates the impulse responses when the credit market is frictionless. This second model is considered as the benchmark model where credit market imperfections are turned-off by setting the marginal cost of verification μ equal to 0 and $\bar{\omega}_t$ equal to 1, keeping all other aspects unaltered. An unanticipated increase of the money supply generates an increase of real output that is around 100% greater when credit market imperfections are added. Similarly, the response of investment is 60% greater. The drop of the riskless interest rate is more than 50% greater than the drop observed in the benchmark model. This amplified *liquidity effect* is transmitted to the economy through the increase of the loanable funds demand's sensitivity to lending rate and not through the decrease of the lending rate itself. The cost of loans decreases only by 0.8%.

The procyclical movement in the risk premium is due to the increase of the default rate that follows an unanticipated increase of money supply. It is worth noting that the increase of the entrepreneurial productivity threshold $\bar{\omega}_t$ matches reasonably very well the Bayesian VAR evidence established in section 1.

The total amount of newly injected money is totally absorbed by entrepreneurs because of the incapacity of households to review their portfolio decision. The quantity of capital produced by entrepreneurs increases which raises in turn investment and the price of capital. This capital expansion spurs the level of aggregate capital accumulated by households and available for firms at the steady-state, inciting firms to produce more. Thus the labor demand increases at the steady-state giving rise to an increase of households' income. Even though the level of consumption in the first period is fixed by the CIA constraint, households increase their consumption during the subsequent

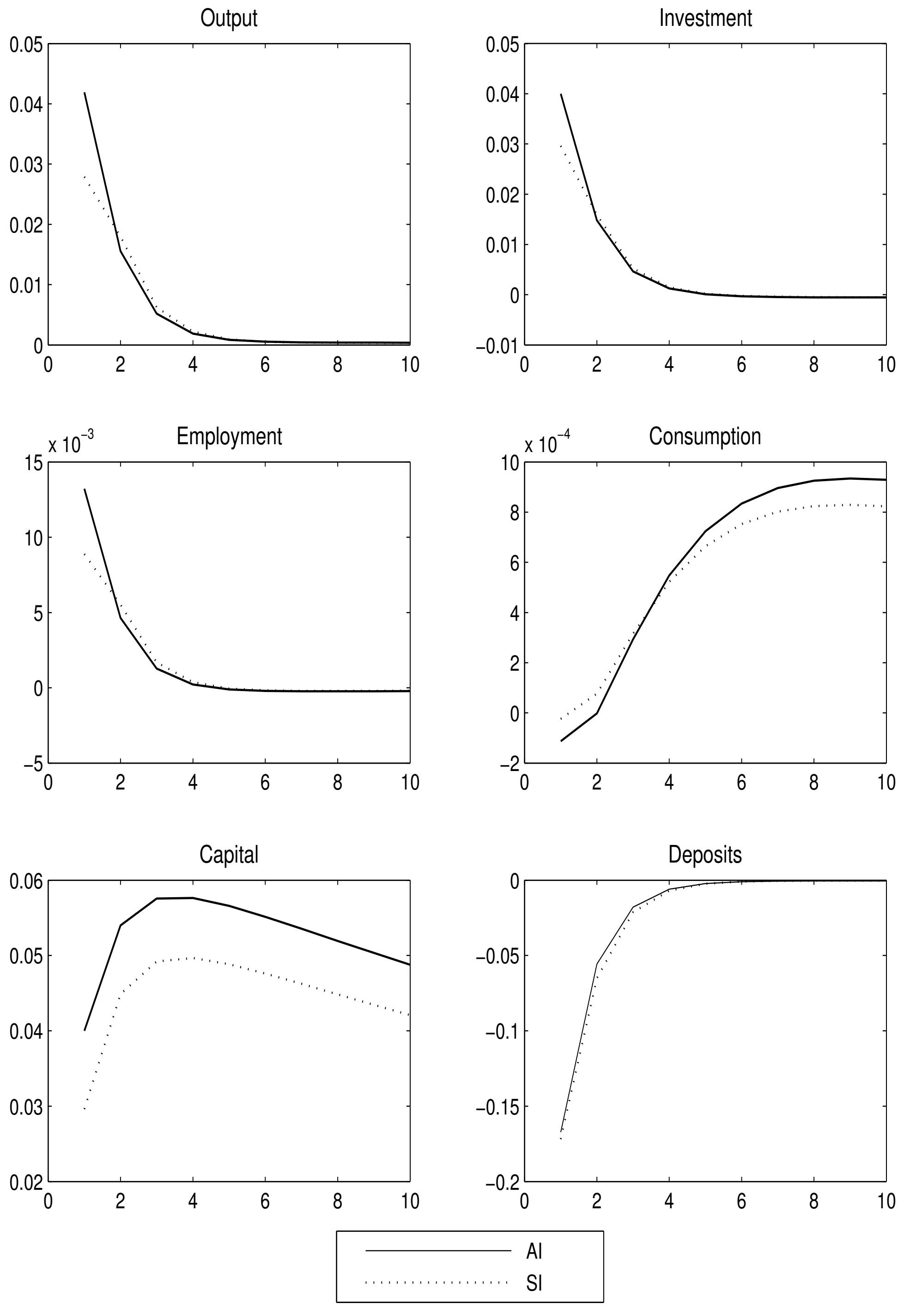

Figure 1.6: Impulse responses to a positive money supply shock (1): the solid line presents the response of asymmetric information model and the dashed line presents the symmetric information model.

periods. Moreover, money injections generate a *Fisher effect* mirrored in the increase of the inflation rate. All these prices fluctuations induce two opposite effects: a revenue effect and a substitution effect. According to the simulation results, the revenue effect

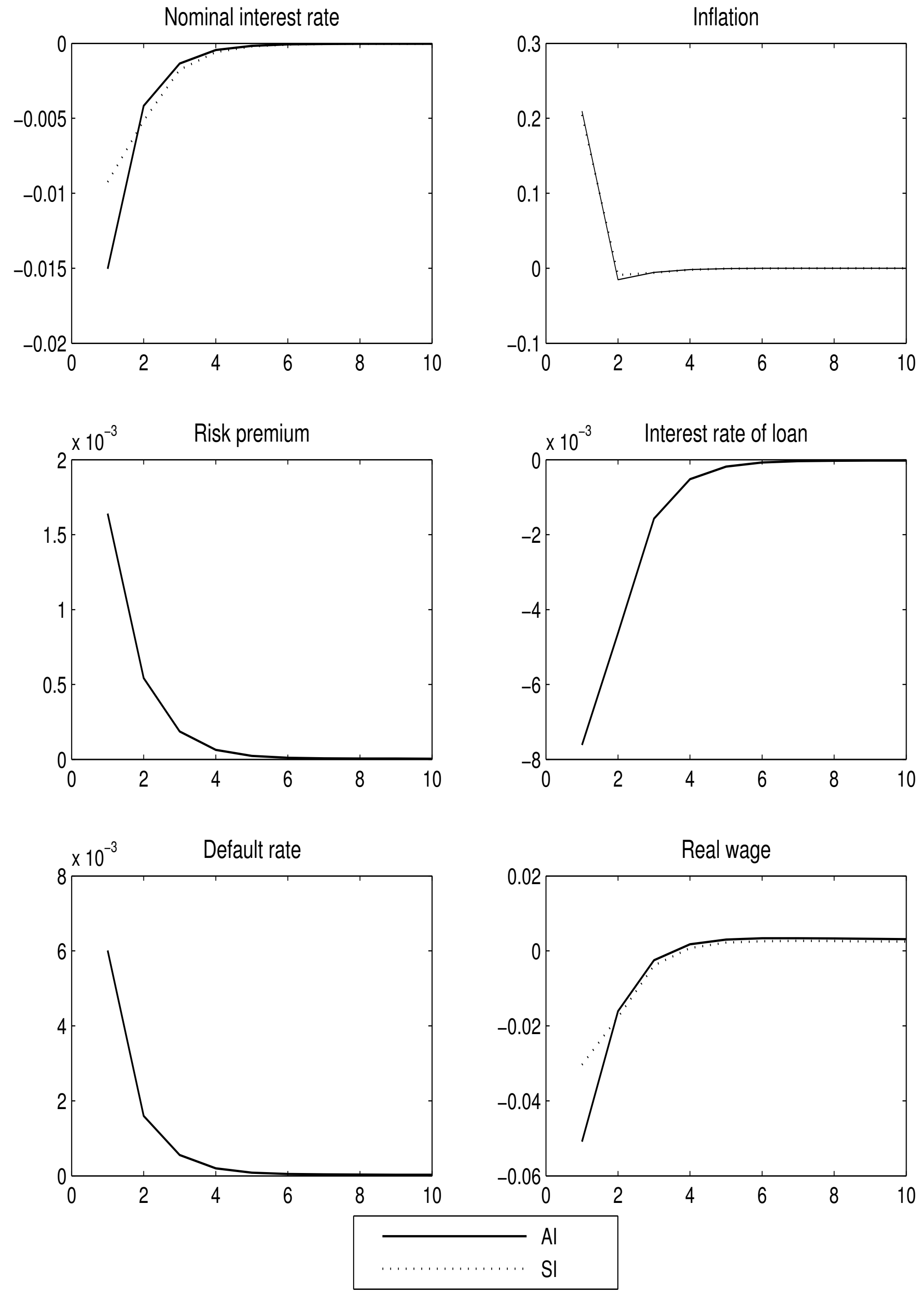

Figure 1.7: Impulse responses to a positive money supply shock (2): the solid line presents the response of asymmetric information model and the dashed line presents the symmetric information model.

dominates the substitution effect : an increase of the household's revenue stimulates the households' consumption and overcomes the substitution effect due to the increase of consumption-good price. Normally, the inflation effect stipulates that, the persis-

Variables	U.S. data (1960 : 1 − 2007 : 4)		A.I. model ($\mu = 0.15$)		S.I.model ($\mu = 0$, $\bar{\omega} = 1$)	
X	σ_X	ρ_{YX}	σ_X	ρ_{YX}	σ_X	ρ_{YX}
Real output, Y	0.017	1.00	0.05	1.00	0.04	1.00
Employment, h	0.019	0.88	0.015	0.9300	0.01	0.9251
Consumption, C	0.009	0.76	0.004	0.3962	0.0038	0.4219
Investment, I	0.04	0.79	0.05	0.9845	0.04	0.9794
Nominal interest rate, R	0.006	-	0.01	-0.6724	0.009	-0.6419
Inflation, P_t/P_{t-1}	0.27	-	0.21	0.6116	0.2	0.5718

Table 1.1: Volatility (σ_X) of economic variables and their correlation (ρ_{YX}) with output in the U.S. data, in the Asymmetric Information model (AI) and in the Symmetric Information model (SI).

tence of the money supply shock over time forces households to take expected inflation into consideration when deciding their consumption-investment spendings. Therefore, households would shift from consumption (the cash good) to investment (the credit good) and potentially reduce their labor supply. It is not the case for the model above because the number of hours worked increases.

Although credit market imperfections amplify the economy's response to a monetary policy shock, one major limit is related to the persistence of the liquidity effect observed in the data. Limited participation models have shown their incapacity to replicate a persistent liquidity effect because households are able to review their saving's decision during the period after the shock. Whether there is asymmetric information in the credit market or not, this weakness persists and one can recognize from figure 7 that the liquidity effect does not last more than 4 quarters. Overall, the model with credit market imperfections shows a robustness in terms of qualitative results comparing to the Bayesian VAR inferences. One can also examine the moments of the variables in the model economy, their correlation with output and compare them to their stylized values observed in U.S data. These results are reported in table 2.

The most dramatic finding coming from table 2 is that output and investment have the same degree of volatility, which is significantly high for real output in both models comparing to that in the data. Moreover, consumption and employment are less volatile in both models comparing to the data. Keep referring to the data, asymmetric information model replicates a more volatile investment comparing to the symmetric volatility model which is doing very well. This increased volatility in investment is due mainly to the increased sensitivity of the demand for funds to the lending rate. On the other hand, the real output and employment has almost the same volatility. In the models, real output volatility is considerably higher than employment's. It is worth emphasizing that the asymmetric information model replicates a higher volatility for all variables than does the symmetric information model.

Generally, the contemporaneous correlations with output is higher for both models than those in the U.S. data. The only exception is the consumption whose contemporaneous correlation with output is substantially lower in both models than the one observed in the data. In both models, the nominal interest rate is negatively associated with output contemporaneously, reflecting the liquidity effect observed after a positive money supply shock. Interestingly, the correlation is higher in the asymmetric information model than it is in the symmetric information model.

1.6 Conclusion

In this paper, a monetary business cycle model with asymmetric information in the credit market is developed. The monetary version of Carlstrom and Fuerst (1997a) with flexible prices and limited participation of households. The model was able to generate the liquidity effect. Comparing to a model where the credit is frictionless, the ex-post moral hazard in lending amplified the liquidity effect and improved the propagation mechanism of a monetary shock by activating the broad credit channel.

The model matches very well the empirical evidence suggesting a procyclical risk premium and default rate. Using the U.S. Senior Loan Officer (SLO) Survey, an identification of both credit supply and credit demand was possible. In addition, the survey offers data related to banks' appetite for risk. The collected data are embedded in an otherwise structural VAR, estimated using the bayesian techniques. The main findings where that a positive money supply shock induces a decrease of the short-term nominal interest rate, raises loans demand and supply and increases banks' appetite to risk. Numerical analysis showed that the asymmetric information model was able to replicate all these facts observed in the data. Although the increase of the risk premium dampens the initial "pure" liquidity effect, it raises significantly the price-elasticity of the loanable funds's demand. This new transmission channel is activated only when informational frictions in the credit market are introduced. This finding supports the claim in the literature that credit market imperfections are important in replicating and explaining the effect of the monetary policy on real economy and its potency.

An exogenous increase of the marginal cost of monitoring is found to have an adverse impact on the liquidity effect. This cost is supposed to be an exogenous constant, referring to the auditing, legal and asset liquidation costs incurred when there is a bankruptcy. Although the exogeneity assumption seems to be suitable for the analysis above, explaining the fluctuations of this marginal cost seems to be harder. This implicit assumption, used in all studies, implies that the financial intermediary recovers bad loans within the same period (usually one quarter) and that the fraction of loans recovered is exogenously determined. However, Acharya et al.(2007) and Chen (2010) argue that recovery rates cannot be exogenous and they should depend on economic conditions, especially in emerging market economies with volatile business cycles. In addition, according to the World Bank's Doing Business reports, the average number of years to enforce a bad loan is 3.03 years, computed over the period $(2004 - 2011)$, for 181 countries. As expected, the average duration for developing and less-developed economies is relatively high (3.35 years) and overtakes the one in advanced economies, (2.02 years). Based on these facts, as an extension of the model above, one can introduce an endogenous recovery rate and assumes that the recovery of a bad loan is not immediate and depends on the duration of bankruptcy proceedings. This new feature may improve the propagation of monetary shocks and induces a more persistent liquidity effect.

Appendices

Appendix

A Data description : The US Senior Loan Officer Survey

Question	Variable	Measure
Q3.a: If your bank has tightened or eased its credit standards or its terms for C&I loans or credit lines over the past three months, how important have been the following possible reasons for the change? Deterioration in the bank's current or expected capital position as a reason for tightening credit standards vs improvement in the bank's current or expected capital position as a reason for easing credit standards	Pure credit supply	**Net percentage** is the difference between the sum of banks who answered "somewhat important" and "very important" for improvement in the bank's current or expected capital position and the sum of banks who answered "somewhat important" and "very important" for deterioration in the bank's current or expected capital position as a percentage of total number of banks.
Q4:Apart from normal seasonal variation, how has demand for C&I loans changed over the past three months?	Credit demand	**Net percentage** is the difference between the sum of banks who answered "substantially stronger" and "moderately stronger" for demand of loans and the sum of banks who answered "substantially weaker" and "moderately weaker" for demand of loans to risk as a percentage of total number of banks.

Q3.b: If your bank has tightened or eased its credit standards or its terms for C&I loans or credit lines over the past three months, how important have been the following possible reasons for the change? Less favorable or more uncertain economic outlook as a reason for tightening credit standards vs more favorable or less uncertain economic outlook as a reason for easing credit standards	Borrowers' quality	**Net percentage** is the difference between the sum of banks who answered "somewhat important" and "very important" for more favorable or less uncertain economic outlook and the sum of banks who answered "somewhat important" and "very important" for less favorable or more uncertain economic outlook as a percentage of total number of banks.
Q3.c: If your bank has tightened or eased its credit standards or its terms for C&I loans or credit lines over the past three months, how important have been the following possible reasons for the change? worsening of industry-specific problems as a reason for tightening credit standards vs improvement in industry-specific problems as a reason for easing credit standards	Borrowers' quality	**Net percentage** is the difference between the sum of banks who answered "somewhat important" and "very important" for improvement in industry-specific problems and the sum of banks who answered "somewhat important" and "very important" for worsening in industry-specific problems as a percentage of total number of banks.
Q3.e: If your bank has tightened or eased its credit standards or its terms for C&I loans or credit lines over the past three months, how important have been the following possible reasons for the change? Reduced tolerance for risk as a reason for tightening credit standards vs Increased tolerance for risk as a reason for easing credit standards	Banks' appetite to risk	**Net percentage** is the difference between the sum of banks who answered "somewhat important" and "very important" for increased tolerance to risk and the sum of banks who answered "somewhat important" and "very important" for reduced tolerance to risk as a percentage of total number of banks.

B Proof of proposition 1

Using the investment supply equation (1.6), I get the following loanable funds demand equation :

$$p_t(I_t - N_t) = \frac{p_t q_t g(\bar{\omega}_t)}{p_t R_t - q_t g(\bar{\omega}_t)} N_t \tag{.0.47}$$

Combining equation (.0.47) with the credit market clearing condition (1.25) and using the definition of the relative price of capital, I obtain the following relation :

$$\frac{p_t q_t g(\bar{\omega}_t)}{p_t R_t - q_t g(\bar{\omega}_t)} N_t - \tau_t - d_t + 1 = 0 \tag{.0.48}$$

Applying the implicit function theorem to equation (.0.48) implies :

$$\frac{\partial R_t}{\partial \tau_t} = -\frac{\Big[p_t R_t - q_t g(\bar{\omega}_t)\Big]^2}{p_t^2 N_t q_t g(\bar{\omega}_t)} < 0 \tag{.0.49}$$

$$\frac{\partial q_t}{\partial \tau_t} = \frac{\Big[p_t R_t - q_t g(\bar{\omega}_t)\Big]^2}{p_t^2 N_t R_t g(\bar{\omega}_t)} > 0 \tag{.0.50}$$

$$\frac{\partial \bar{\omega}_t}{\partial \tau_t} = \frac{\Big[p_t R_t - q_t g(\bar{\omega}_t)\Big]^2}{p_t^2 N_t R_t q_t g'(\bar{\omega}_t)} > 0 \tag{.0.51}$$

$g'(\bar{\omega}_t)$ is positive since the lender would never choose an $\bar{\omega}_t$ where his expected return is decreasing[22].

We know that :

$$\frac{\partial \Delta_t}{\partial \tau_t} = \frac{\partial \Delta_t}{\partial \bar{\omega}_t}\frac{\partial \bar{\omega}_t}{\partial \tau_t} \tag{.0.52}$$

Using the definition of the risk premium Δ_t given by equation (1.7) and the share of expected retur $g(\bar{\omega}_t)$ going to the bank, we have :

$$\frac{\partial \Delta_t}{\partial \bar{\omega}_t} = \frac{g(\bar{\omega}_t) - \bar{\omega}_t g'(\bar{\omega}_t)}{g^2(\bar{\omega}_t)} \tag{.0.53}$$

The numerator is equal to :

$$g(\bar{\omega}_t) - \bar{\omega}_t g'(\bar{\omega}_t) = (1-\mu)\Gamma(\bar{\omega}_t) + \mu\, \bar{\omega}_t^2 \phi(\bar{\omega}_t) > 0 \tag{.0.54}$$

[22]See Bernanke et al. (1999a) for more details.

Thus, we have : $\dfrac{\partial \Delta_t}{\partial \tau_t} > 0$

Finally, given the results in (.0.49) and (.0.50) and the increase of the supply of loanable funds, the investment level will increase so that $\dfrac{\partial I_t}{\partial \tau_t} > 0$.

C Proof of proposition 2

$$\frac{\partial}{\partial \mu}\Big(\frac{\partial R_t}{\partial \tau_t}\Big) = \frac{\partial g(\bar{\omega}_t)}{\partial \mu}\Big(p_t R_t - q_t g(\bar{\omega}_t)\Big)\frac{p_t R_t + q_t g(\bar{\omega}_t)}{g(\bar{\omega}_t)}$$

Since $\dfrac{\partial g(\bar{\omega}_t)}{\partial \mu} = -\Gamma(\bar{\omega}_t) < 0$, then :

$$\frac{\partial}{\partial \mu}\Big(\frac{\partial R_t}{\partial \tau_t}\Big) < 0.$$

D Proof of proposition 3

According to the results (.0.49) and (.0.53), we have :

$$\frac{\partial R_t}{\partial \Delta_t} = -\frac{R_t g(\bar{\omega}_t) g'(\bar{\omega}_t)}{g(\bar{\omega}_t) - \bar{\omega}_t g'(\bar{\omega}_t)}$$

Then :

$$\begin{aligned}
\left|\frac{\partial R_t}{\partial \Delta_t}\right| > \frac{R_t}{\Delta_t} &\Leftrightarrow \frac{R_t g(\bar{\omega}_t) g'(\bar{\omega}_t)}{g(\bar{\omega}_t) - \bar{\omega}_t g'(\bar{\omega}_t)} > \frac{R_t}{\Delta_t} \\
&\Leftrightarrow \frac{R_t g(\bar{\omega}_t) g'(\bar{\omega}_t)}{g(\bar{\omega}_t) - \bar{\omega}_t g'(\bar{\omega}_t)} > \frac{R_t g(\bar{\omega}_t)}{\bar{\omega}_t} \\
&\Leftrightarrow \frac{g'(\bar{\omega}_t)}{g(\bar{\omega}_t) - \bar{\omega}_t g'(\bar{\omega}_t)} > \frac{1}{\bar{\omega}_t} \\
&\Leftrightarrow \bar{\omega}_t g'(\bar{\omega}_t) > g(\bar{\omega}_t) - \bar{\omega}_t g'(\bar{\omega}_t) \\
&\Leftrightarrow \frac{\bar{\omega}_t g'(\bar{\omega}_t)}{g(\bar{\omega}_t)} > \frac{1}{2}
\end{aligned} \tag{.0.55}$$

And we know from (.0.54) that $\dfrac{\bar{\omega}_t g'(\bar{\omega}_t)}{g(\bar{\omega}_t)} < 1$.

Chapter 2

Credit shock, Uncertainty shock and Labor market dynamics: A Bayesian SVAR Approach

2.1 Introduction

The recent financial crisis had a deep impact on the real economy and generated a longstanding slowdown. The adverse impact on the labor market was important and the rise of unemployment was considerable and quite persistent. Economists are raising questions about the conventional sources of business cycle fluctuations. The argue that these adverse shocks are originating in the financial market. Financial and uncertainty shocks are important drivers of economic fluctuations.

Exogenous positive shocks to credit spreads in the credit market or to the uncertainty have an important impact on job creation and job destruction in the labor market. Bloom (2009) and Bloom et al. (2012) found a similar result but in a broader context where all the real economy is considered. They found that uncertainty is counter-cyclical, amplifying adverse shocks and reaching a maximal impact during recessions. Although, the impact of shocks to credit spreads and uncertainty are well documented, it is still hard to disentangle them empirically. Usually an increase in the financial market volatility, taken as a proxy of economic uncertainty, is associated with a rise in the credit spreads. The economic slowdown that follows is generally considered as the consequence of a combination of both shocks. Many trials that have been conducted in the literature to come up with a full identification of both shocks in a structural vector autoregressive framework. The difficulty was always related to the high responsiveness character of uncertainty and credit spreads. Caldara et al. (2014) argue that it is not possible to impose zero restrictions to identify both shocks. Moreover, it is also hard to impose sign restrictions on the impulse response functions in order to obtain an economic reasonable interpretation. The main reason is that adverse shocks to uncertainty in financial market and adverse shocks to credit spreads in the credit market have the same impact on main economic indicators. Meeks (2012) for example used the financial accelerator framework pioneered by Bernanke et al. (1999b) to justify his sign restrictions in order to identify financial shocks. The financial shock in this context is interpreted as a credit shock where an adverse credit supply shock hits the banks credit supply and generates a decrease of the quantity of loans channeled to investors. In order to implement this identification strategy, it was crucial to control for timing restrictions. The main finding was that financial shocks contribute significantly to the business cycle especially during the recessions.

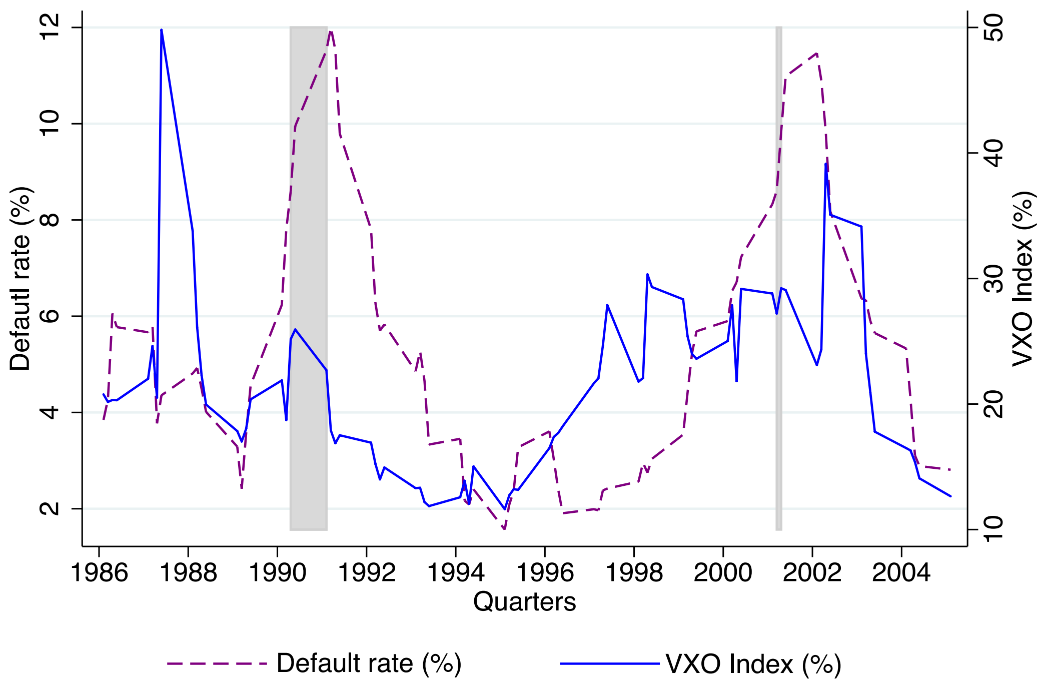

Figure 2.1: VXO index and Default rate between 1986-Q1 and 2005-Q1 for the United-States

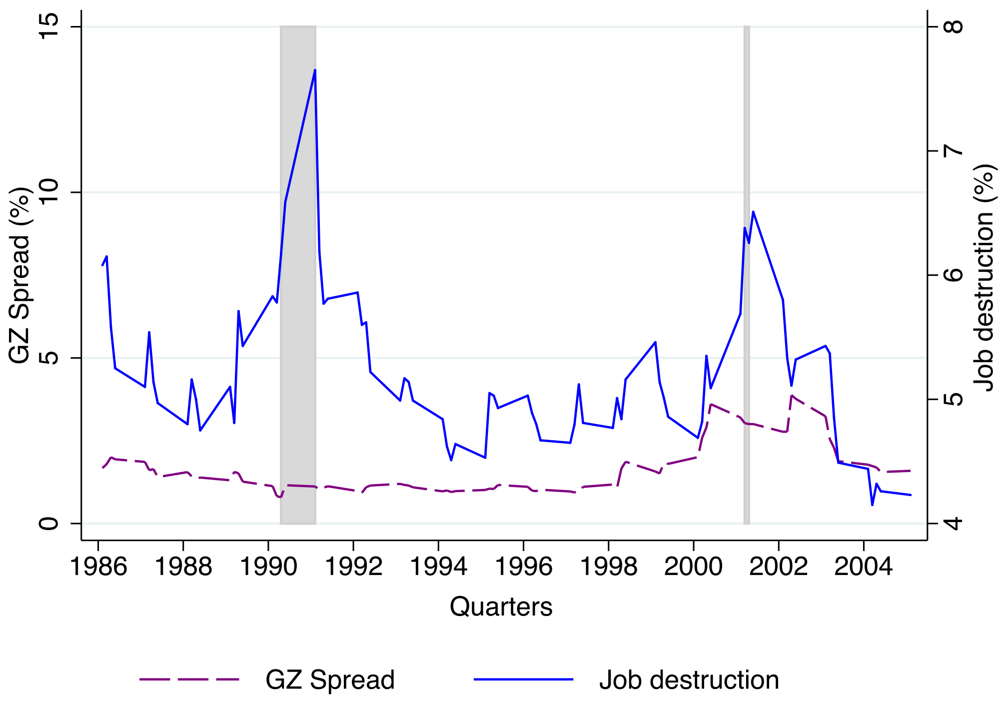

Figure 2.2: GZ spread and and Job destruction rate between 1986-Q1 and 2005-Q1 for the United-States

3.1 shows the co-movement of the VXO index as a proxy for the uncertainty in the financial market and the corporate default rate in USA. It is straightforward to depict positive correlation between both variables. A high volatility is followed by a high level of default rate. 3.2 reflects also a positive correlation between the excess bond premium or the GZ spread developed by Gilchrist and Zakrajek (2012) and the job destruction rate, especially during recessions.

In this chapter, I consider a standard monetary structural VAR, augmented with job destruction and job creation indicators, unemployment rate, the default rate, the excess bond premium as an indicator of credit conditions and the VXO index as an indicator of uncertainty in the financial market. In order to improve the efficiency of estimates and overcome the problems related to the important number of paramerters in the model, structural VAR is estimated using the Bayesian techniques. I use the Normal-Wishart distribution as a prior. I follow Gilchrist et al. (2009a) and Boivin et al. (2013) by imposing timing restrictions. I assume that only financial and credit market variables namely the credit spread and the volatility in the financial market respond contemporaneously to shocks. All other variables react after a one lag.

Main findings indicate that both credit and financial shocks drive the labor market dynamics. The first experience was studying the impact of an exogenous increase of the nominal interest rate. Such restrictive monetary policy shock induces a significant increase of the job destruction rate and a decrease of the job creation rate. In addition, the unemployment rate increase a returns to steady state after more than 4 years. The results of an adverse credit shock is consistent with the conjecture that an increase of the credit spread induces a slowdown of the economic activity. An increase of the excess bond premium induces a decrease of the job creation rate and increase of job destruction rate and unemployment. In addition, the uncertainty increases significantly in the financial market after an exogenous adverse credit shock.

The results also confirm the Caldara et al. (2014) finding that the VXO uncertainty index has a limited informative capacity regarding the economic activity. Although an increase of the VXO index does induce a decrease of the job creation rate, the total impact on job creation lasts only for 6 quarters and the increase of the unemployment rate lasts only 3 quarters. The remainder of the chapter is organized as the following. Section 2 is dedicated to the empirical methodology where the data are described and the Bayesian estimation approach is explained. Section 3 presents the main results. I conclude in section 4.

2.2 Empirical methodology

The empirical study of the impact of credit and uncertainty shocks on the economy and especially on the labor market variables is conducted using a structural Bayesian VAR (SBVAR) approach. It is a 10 variables SBVAR using quarterly data for the United States (US) between 1986Q1 and 2005Q1. We estimate the dynamic response of labor and credit markets variables to identified exogenous monetary policy, credit and uncertainty shocks.

First I describe the data used for the estimation. Second I explain the estimation methodology as well as the Bayesian techniques and the choice of the priors.

2.2.1 Data

The structural VAR estimated here is constituted of 10 variables. All the observations are seasonally adjusted quarterly data, going from 1986Q1 to 2005Q1. Although most of the variables are observable for a longer period, I limited the scope of the estimation to a shorter period because of the VXO index series, which starts only in 1986Q1. The first two variables are quite common in the VAR literature. They the log of real GDP and the inflation rate, measured as the first difference of the log of the consumer price index (CPI).

The labor market variables are the job creation rate, the job destruction rate, the real wage, the weekly number of worked hours and the unemployment rate. The job creation and job destruction rates are collected from the Davis et al. (2006a) and Davis et al. (2006b) database. All the available rates are estimated using data collected mostly from the US Bureau Labor Statistics and the Annual Survey of Manufacturers (ASM). These data cover the manufacturing sector and are, respectively, the logarithm of job creation rate for start-ups and continuing establishments and the logarithm of job destruction rate for shutdowns and continuing establishments. The real wage is equal to the hourly real compensation for the non-farm business sector. The number of hours is equal to the average weekly hours for the non-farm business sector. The unemployment rate is the civilian unemployment rate published by the Bureau of Labor Statistics. It corresponds to the ratio of civilian unemployed persons to the civilian labor force.

The financial market variables are the default rate, the GZ spread, the Baa-Aaa spread, the VXO index and the nominal interest rate. The default rate corresponds to Moody's US corporate default rate, namely the Moody's global speculative-grade default rate. This variable was used also by Helbling et al. (2011) and Meeks (2012). The GZ spread is a credit spread with a high informative capacity regarding the economic activity since it is corrected such that it is not subject of the duration mismatch. Formally, It corresponds to the average credit spread on senior unsecured bonds issued by non-financial firms. This index is constructed by Gilchrist and Zakrajek (2012). This credit spread measures the difference in yields between a private debt instrument and government securities of comparable maturity. Formally, the authors have constructed the index as follow:

$$S_t^{GZ} = \frac{1}{N_t} \sum_i \sum_k S_{it}(k) \tag{2.2.1}$$

where N_t is the number of bond observations in quarter t and $S_{it}(k)$ is the credit spread, expressed as the difference between the yield of the corporate bond k and a hypothetical Treasury security with exactly the same cash-flows as the underlying corporate bond. More precisely, for each individual bond issue in the sample, they construct a theoretical risk-free security that replicates exactly the promised cash-flows of the corresponding corporate debt instrument. So they compare the interest rate actually paid by the firm with what the US government would have paid on a loan with a similar maturity[1]. The Baa–Aaa is measured by the spread between yields on Baa- and Aaa-rated long-term industrial corporate bonds. The VXO index is the option-implied volatility on the S&P 100 stock futures index constructed by the Chicago Board of Option Exchange. This variables is taken as a measure of uncertainty in the economy.

Table 2.1: Correlation of labor market variables and risk and uncertainty measures

Variable	Pairwise Correlations					
(l)2-7	GZ spread	Default	Tightness	J.Crea	J.Destr	VXO index
GZ spread	1.00	0.46	0.11	−0.77	0.14	0.57
Default		1.00	−0.33	−0.19	0.71	0.32
Tightness			1.00	0.002	−0.26	0.34
J.Crea				1.00	0.04	−0.29
J.Destr					1.00	0.23
VXO index[a]						1.00

[a]Option-implied volatility on the S& P 100 stock future index.

Table 2.1 displays the pairwise correlations of labor market and financial market variables. Although such correlations do not imply any causality relation between these variables, it is still interesting to examine contemporaneous relations among them in

[1]The GZ spread is an arithmetic average of the credit spreads on bonds in any given quarter. According to the authors, it has a huge predictive power for the economic activity over the 1973-2010 period. It is based on micro level data set of secondary market prices of outstanding senior unsecured bonds issued by a large panel of US non financial corporations, which allows to have a spread not subject to the duration mismatch problem of standard credit spread indexes.

order to highlight co-movements during the cycle. In addition to the variables cited above, I consider the labor market tightness, computed as the ratio of the total vacancies to unemployed workers. The vacancy rate is collected from Conference Board Help Wanted OnLine (CBHWOL) database. According to the table above, the job creation rate exhibits significant negative contemporaneous correlation with the GZ spread and the default rate. The correlation with the GZ spread is the highest degree of co-movement in the group. This means that both variables are not insensitive to each other movements. Two other important features that deserve attention : the first is the negative correlation between the VXO index as a volatility measure and the job creation rate. The second is the positive correlation of this volatility index and the job destruction rate. The GZ spread exhibits a significant positive correlation the volatility index and, to a lesser extent, with the default rate.

All the correlations are consistent with the economic common sense and the underlying conjecture, except for the labor market tightness that exhibits a positive correlation with the volatility index as well as with the GZ spread.

2.2.2 Bayesian approach

SVAR approach is assumed to infer an underlying economic theory. It is a good alternative to the traditional a-theoretic VAR, since economic theory and intuition play a key role in the identifying process. Moreover, we use Bayesian methods to estimate the VAR model (Stock and Watson (2001)). The difference with unrestricted VAR models is that model parameters are treated as random variables, and some priors are assigned to them. Indeed, with VAR models, the parameter space increases geometrically with the number of dependent variables and proportionally with the number of lags. In the estimation below, I have a consequent number of dependent variables and the quarterly database is only of moderate size. Thus, empirical Bayes estimators enable to overcome the over-fitting problem of standard VAR models. The inclusion of prior information enables better precision of forecasts from VAR models and reinforces the link between VAR analysis and the economic theory.

In order to fit the data as much as possible, I use the Bayesian VAR approach. Since the number of variables is quite high and the number of observations is relatively loose, the inference will be unstable and estimates may be affected by noise instead of signals contained in the data. To overcome this 'overfitting' problem I reduce the dimension of the parameter space without imposing zero restrictions. The main idea is to add some uncertainty to the parameters values so that the parameter vector has a probability distribution instead of exact values. This distribution is known as the prior. It is updated by the information included in the data as long as it is informative enough. This approach was promoted by Doan et al. (1986) by imposing more realistic prior distributions that respect statistical characteristics of macroeconomic time series, including their trending behavior as well as their high auto-correlation. In concrete terms one can take these characteristics into consideration when estimating a VAR model by imposing a probability distribution such that the mean and the variance of different coefficients are controlled. In other words, first, the mean of the parameters associated to all lags, except the first one, is equal to zero. Second, The variance of the parameters is inverse function of the number of lags. Third, every coefficient associated to a variable X_{-i} has a lower variance than the equation of the variable X_i. Formally, these assumptions are equivalent to introduce a vector of hyper-parameters that controls for the values of the mean and the variance of different coefficients for different lags.

A structural VAR is a p-equations, p-variables model in which each variable is explained by its lagged values, current and past values of the other variables. So the model aims to capture linear interdependences among multiple variables. The structural VAR considered is given by:

$$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + ... + A_L X_{t-L} + \epsilon_t, \quad t = 1, ..., T \tag{2.2.2}$$

where X_t is a $p \times 1$ vector of variables at date t, A_0 is a $p \times 1$ vector of constants and A_i is a $p \times p$ coefficient matrix for each lag of the variable vector. ϵ_t is $p \times 1$ vector of error terms independently, identically and normally distributed, with a variance-covariance matrix, Σ. So that $E(\epsilon_t \epsilon_t^{'}) = \Sigma$, $E(\epsilon_t) = 0$ and $E(\epsilon_t \epsilon_t^{'}) = 0$, $\forall t \neq s$. The unknown parameters that need to be estimated are summarized by the vector β where $\beta = vec(A_0, A_1, A_2, ..., A_L)$ and the matrix Σ.

The estimation of 2.2.2 using the Bayesian approach is equivalent to find the joint posterior distribution of parameters conditional on the information contained in the data, $p(\beta, \Sigma \mid X)$. Formally, the posterior is given by :

$$p(\beta, \Sigma \mid X) \propto p(\beta, \Sigma)\mathcal{L}(X \mid \beta, \Sigma)$$

where $p(\beta, \Sigma)$ is the prior distribution and $\mathcal{L}(X \mid \beta, \Sigma)$ is the likelihood function that summarizes all the information included in the data. It is given by :

$$\mathcal{L}(X \mid \beta, \Sigma) \propto \mid \Sigma \mid^{-T/2} \exp\Big\{ -\frac{1}{2}\sum_t (X_t - Z_t\beta)'\Sigma^{-1}(X_t - Z_t\beta)\Big\}$$

where $Z_t = I_p \otimes (I_p, X'_{t-1}, X'_{t-2}, ..., X'_{t-L})$.

Once $p(\beta, \Sigma \mid X)$ is computed, one can deduce the marginal posterior distributions of β and Σ conditional on the data, which are given by $p(\beta \mid X)$ and $p(\Sigma \mid X)$, respectively. The computation of the marginal posteriors is based on integrating $p(\beta, \Sigma \mid X)$, which is quite difficult analytically. Therefore, I use the Monte Carlo simulation method for numerical integration. One special method that is used mostly in the literature is Gibbs sampler[2].

The estimation is based on the choice of the prior distribution $p(\beta, \Sigma)$. For the estimation below, I used the Normal-Wishart distribution. This distribution is an extension of the Minnesota prior by relaxing the assumption of a constant and diagonal variance-covariance matrix of the disturbances Σ. In addition, The conjugacy property is applied so that the posterior distribution has the same parametric form as the prior

[2]This method assumes that the full conditional posterior distributions $p(\beta \mid \Sigma, X)$ and $p(\Sigma \mid \beta, X)$ are known. The sampler starts from initial values of β and Σ and samples from the density of each parameter conditional on the values of other parameters sampled in the step before. After a sufficiently high number of iterations, the alternate sampling gives rise to a Markov chain of parameters that can be considered as the "true" joint posterior distribution.

distribution. Formally, the priors are given by:

$$p(\beta \mid \Sigma) = N(\bar{\beta}, \Sigma \otimes \bar{\Omega}) \tag{2.2.3}$$

$$p(\Sigma) = iW(\bar{\Sigma}, \alpha) \tag{2.2.4}$$

where $E(\beta) = \bar{\beta}$ and $V(\beta) = (\alpha - p - 1)^{-1}\bar{\Sigma} \otimes \bar{\omega}$, with α denotes the degrees of freedom of the inverse-Wishart, satisfying $\alpha > n+1$ and $\bar{\Omega}$ is the variance-covariance matrix of β.

Given the priors specification above, the posterior distributions of β and Σ have the following expressions:

$$p(\beta \mid \Sigma, Y) = N(\tilde{\beta}, \Sigma \otimes \tilde{\Omega}) \tag{2.2.5}$$

$$p(\Sigma \mid Y) = iW(\tilde{\Sigma}, T + \alpha) \tag{2.2.6}$$

where,

$$\tilde{\Omega} = (\bar{\Omega}^{-1} + X'X)^{-1} \tag{2.2.7}$$

$$\tilde{\beta} = \tilde{\Omega}(\bar{\Omega}^{-1}\bar{A} + X'X\hat{A}_{ols}) \tag{2.2.8}$$

$$\begin{aligned}\tilde{\Sigma} = \hat{A}'_{ols}X'X\hat{A}_{ols} + \bar{A}'\bar{\Omega}^{-1}\bar{A} + \bar{\Sigma} \\ + (Y - X\hat{A}_{ols})'(Y - X\hat{A}_{ols}) \\ - \tilde{A}'(\bar{\Omega}^{-1} + X'X)\tilde{A}\end{aligned} \tag{2.2.9}$$

with $A = [A'_0, ..., A'_L]$ and $iW(R, r)$ is the inverse Wishart distribution[3] with scale matrix R and r degrees of freedom. This distribution is the conjugate prior distribution of the multivariate Normal covariance matrix.

In order to get the marginal posterior distribution of A, Σ should be integrated out of the joint posterior distribution given by (2.2.8). This marginal distribution follows a multivariate Student distribution. At this level, the $\bar{\beta}$, $\bar{\Omega}$ and Σ are fixed. In practice, I took the Minnesota type of specification for a matter of simplicity and parsimony. α,

[3]The Wishart distribution, $W(R, r)$, is the multivariate generalization of the Gamma distribution. A variable X follows an inverse Wishart distribution iff $X^{-1} \sim W(R, r)$.

the Whishart distribution degrees of freedom is chosen such that the prior variances of different parameters exist. In addition, the respective values of the diagonal elements of $\bar{\Sigma}$ denoted by $\bar{\sigma}_{ii}$, are proportional to the variances of the same elements obtained from univariate AR(L) σ^2_{ii}, with $\bar{\sigma}^2_{ii} = (\alpha - p - 1)\sigma^2_{ii}$.

The VAR model is estimated in log levels, except for the interest rate, unemployment rate, default rate and credit spreads, which are included in percent. Lag lengths are determined for each shock by using Schwarz-Bayes (SB), Hannan-Quinn (HQ) and Akaike's Final Prediction Error (FPE) criteria. The optimal number of lags is equal to $L = 1$.

Empirical evidence are presented for the United-States between 1986Q1-2005Q1. We decide to stop before the Great Recession, either before the Federal Reserve begins unconventional monetary policy measures. The identification strategy adopted is not able to capture exactly this type of measures. Furthermore, our data on job creation and job destruction are only available until 2005Q1.

The structural VAR model is used to study the impact of monetary and credit shocks on labor and credit market variables. Identification assumptions are required in order to interpret correlation as causality among variables. Both shocks identification is based on the recursivness assumption as in Christiano et al. (2005) and Popescu and Smets (2010).

2.2.3 Shocks identification

Monetary policy shock

To identify monetary policy shocks, I use the recursiveness assumption as in Christiano et al. (1999b) and Christiano et al. (2013).

First, the short-term nominal interest rate, the Federal funds rate R_t, is considered as the instrument of monetary policy. The monetary authority is assumed to conduct its monetary policy following a simple reaction function :

$$R_t = f(\Omega_t) + \epsilon_t^R \tag{2.2.10}$$

f is a linear function, Ω_t is the information set of the monetary authority and ϵ_t^R is the monetary policy shock.

The monetary policy shock, ϵ_t^R, is assumed to be orthogonal to the information set of the monetary authority, Ω_t. This information set includes the contemporaneous values of all variables included in z_t (eight variables), but the contemporaneous value of the Baa-Aaa credit spread is not included. This assumption means that no variable in z_t responds contemporaneously to an unexpected change in the Federal funds rate, except for the Baa-Aaa spread. Thus, the dynamic responses to a monetary policy shock are identified by assuming that the monetary authority observes the current and lagged values of all variables in z_t, and only the lagged values of the credit spread. Hence, this process will depend on the Federal funds rate current realizations. So, the order of the variables included in the vector X_t imposes a number of additional short-run restrictions, which corresponds to the Cholesky decomposition. However, the ordering of variables in z_t does not influence the coefficients in the impulse response functions.

The decision to include all variables except for the Baa-Aaa spread can be justified by the idea that some macroeconomic variables do not respond instantaneously to policy shocks. Friedman and Kuttner (1998), Gilchrist et al. (2009b) and Faust et al. (2013) showed empirically that credit spreads are monetary policy indicators, and have a strong information content with respect to business cycle fluctuations. They are as a mirror of monetary policy. Furthermore, even if the assumption can be criticized, our analysis is consistent as the same assumption is made in our theoretical model (Christiano et al. (2005)).

Credit and uncertainty shocks

Similar to Helbling et al. (2011), we want to see if exogenous shocks originating in credit markets and uncertainty in financial market are important source of labor market variables fluctuations because linkages between the real economy and credit markets are worth to focus on. Credit shocks are frictions that prevent firms from funding all desired recruitment or investment. This incapacity is assumed to be due to credit constraints or inability to borrow. Credit shock does not mean financial distress or default risk or economic distress, although these things are for sure correlated with credit shocks.

A negative credit shock is identified by assuming that it leads to an increase in the price of credit, here represented by the GZ spread. An uncertainty shock is supposed to lead to an increase of the credit spread. Finally, I assume that both variables, the credit spread and the volatility index respond contemporaneously to shocks.

2.3 Main results

The structural impulse response functions measure the impact on the level of each X_t variables at time $t+s$ for different values of s of a one-standard deviation shock in the structural errors terms. We assume that this error returns to zero in future periods, and that all other errors are equal to zero. Errors are indeed assumed to be uncorrelated across equations. We use the Cholesky orthogonalised impulse responses to unexpected shocks. It enables to see what are the effects of identified structural shocks on labor and credit markets variables. As there are nine variables in z_t, the monetary policy shock, ϵ_t^R, is the tenth element of ϵ_t. And the credit shock is the eleven element of ϵ_t. We analyze a positive shock on ϵ_t^R, that corresponds to a contractionary monetary policy shock ; as well as a positive shock on the GZ spread, that corresponds to a negative credit shock, meaning that credit is more expensive.

In the following figures, the solid lines correspond to the point estimates and the dashed lines are two standard error confidence band. The horizontal axes indicate quarters. And the examination of the one-standard deviation shocks are made at the horizons up to 24 quarters.

2.3.1 Impulse responses to a monetary policy shock

The impulse responses to a monetary policy shock are obtained, by using the Baa-Aaa spread and the Normal-Wishard type priors. 3 and4 display the impulse response functions to a restrictive monetary policy shock.

It is noteworthy the large decrease of the real GDP. The peak fall in output is about 2% after almost 2 years. Firms need less workers, as the production decreases. The unemployment rate increases as a consequence. It reaches a peak increase of around 3.5% almost eight quarters after the rise in interest rate, through a strong increase in the job destruction rate and a faster decrease in the job creation rate, consistent with the results of Trigari (2009). Job destruction increases up to 1.% after 5 quarters and job creation reaches a peak response at 0.8% after only 3 quarters. The effect is persistent for both variables. Hours worked declines with a peak about 3% after 5 quarters, but the decline is less important compared to the increase of unemployment. This evidence is consistent with Ravn and Simonelli (2007) and Hansen (1985), who particularly shows that 55% of the variation in hours worked are due to variations in the number of employed people and only 20% is due to variations in average hours worked. This evidence is also consistent withTrigari (2009) finding that both extensive and intensive margins react after a monetary policy shock. Employment and hours worked per employee fall. Real wages increases slowly and lasts only for 5 quarters and starts decreasing. They are less reactive than hours worked per employee. The maximum increase in real wages is about 1.7%. A rise of inflation is also observed, with a peak effect occurring after about 2 quarters. The Baa-Aaa spread and the default rate follow the same pattern. They both increase, with a peak effect occurring after about 5 quarters. The Baa-Aaa spread reaches a peak increase of around 0.8% and the default rate of around 3%.

At longer forecast horizons, real GDP, unemployment, job creation, job destruction, inflation and Baa-Aaa spread return to their initial level. To conclude, the restrictive monetary policy shock causes a persistent economic downturn. Output, hours per worker decline and unemployment, credit spreads and default rate increase. There are two important points that deserves to be highlighted. First, the real wage increases in response to a monetary policy shock which confirms the high stickiness of the real wage. Second, the response of the uncertainty index is not significant at 10% error level. This is due to the shortage in observations. The number of variables included in the model is quite high and the tile series of VXO index is quite short. In addition, this result confirms also the limited informative capacity of the VXO index found by Caldara et al. (2014).

2.3.2 Impulse responses to a credit shock

The impulse responses to a credit shock are obtained by using the excess bond premium constructed by Gilchrist et al. (2009a), known as the GZ spread. I use the Normal-Wishart disteibution as a priors, as in Smets and Wouters (2003) and Smets and Wouters (2007). Moreover, in order to make the analysis consistent and to avoid any endogeneity problem, I excluded the default rate from the data set. Indeed, as explained by Gilchrist and Zakrajšek (2012), the GZ spread is decomposed in different parts, including an expected default rate. These responses are reported in the figure 5.

The credit shock corresponds to an increase in the credit spread. An important decrease of the real GDP is observed, as well as an increase of inflation, although it is not very important or significant for a long period. Responses of inflation and the real GDP are consistent with the results of Popescu and Smets (2010). The peak fall in output is about 0.8% reached after 5 quarters. Inflation does not present a significant increase. It reaches 0.1% after 6 quarters. The exception is the federal funds rate that exhibits a non significant decrease of 0.2% after 5 quarters.

For the labor market side, the unemployment rate increases significantly to reach an increase of 0.5% after 6 quarters. This decrease can be interpreted as the result of the increase of the job destruction rate and the decrease of the job creation rate. A positive shock to the credit spread increases the cost of the external financing for firms, inducing a reduction in their production, their investment plans and jobs creation. Job creation reaches a peak decline of 0.4% at about four quarters and job destruction increases up to 0.4% after 4 quarters also. As found by Popescu and Smets (2010), the impact on real GDP is more important than the impact on unemployment. Hours per worker decrease also until t12 quarters, with a peak decrease of 0.5% at 6 quarters. The extensive margin of employment is more sensitive to the credit shock more than the intensive margin. The response if unemployment to an adverse credit shock is more important and more persistent than the impact on number of hours. The real wage decreases reflecting a persistent deterioration of the payroll .

A tightening of credit conditions induces a deterioration of the labor market conditions leading to higher unemployment rate. One of the most discussed channel in literature is the credit channel. An increase of the cost of external finance tightens the firms and investors constraints, leading to a decrease of investment and production levels. Consequently, the labor demand will decrease with the real wages such that no more vacancies are posted and the labor market tightness decreases.

2.3.3 Impulse responses to an uncertainty shock

The figure 6 reports the response to an exogenous shock to the VXO index. This index is taken as a proxy to the volatility in the financial market. I assumed that only the credit spread responds contemporaneously to the shock.

On the real side, the real GDP increases after 4 quarters after the first shock. Although it is not expected but it sis consistent with the decline of the federal funds rate and the inflation. An increase of the volatility in the financial market has a delayed impact on the real economy. While the rela GDP does seem to be impacted by the volatility increase, the inflation rate and the federal funds rate does not follow the same pattern. They decrease at the beginning from 6 to 8 quarters and they increase substantially again to reach 2% increase for the inflation rate and 0.005% increase for the federal funds rate.

On the labor market side, the increase of the volatility in the financial market induced a deterioration the credit market conditions. While the job destruction rate increases by more than 0.015% in 2 quarters, the job creation rate decreases by more than 8% in one quarter. Despite the important decrease of the job creation rate, the unemployment rate seems to be driven essentially by the job destruction rate. It is mirroring the job destruction rate. The unemployment rate decreases starting from the fourth quarter to mimic the job destruction rate which starts increasing also from the fourth quarter.

Regarding the credit market conditions, an increase of the volatility in the financial market induces an increase of the credit spread, tightening dramatically the credit constraint. However, the increase of the excess bond premium is overcame by the decrease of the nominal interest rate. Accordingly, the final impact on the real output was not negative. Consequently, the final impact on unemployment is the combination of two opposite effects. The first one is due to the increase of the production that spurs employment and the second one is due to intensive job destruction following the uncertainty shock. Results prove that the second effect dominates in the first 4 quarters to disappear starting from the fifth quarter and unemployment rate decreases.

2.4 Conclusion

This chapter highlights the impact of credit market and financial market conditions on the labor market variables. The excess bond premium is taken as a proxy of the credit market conditions. The option-implied volatility on the S& P 100 stock futures index, known as the VXO index is taken as a proxy of the uncertainty in the financial market.

The impact of adverse financial and credit shocks on the labor market conditions are quite similar. Both of the shocks induce a deterioration of the labor market conditions. There are some differences regarding the depth of the impact as well as its persistence. An adverse credit shock is found to have a dramatic impact on the unemployment rate. It reaches more than 0.5% increase and lasts for more than four years which is quite higher than the unemployment rate increase when the economy is hit by an uncertainty shock. This finding confirms the importance of the credit channel and the importance of the credit conditions as a main driver of business cycles.

The uncertainty is found to increase after an adverse credit shock which raises the eventuality that fluctuations in uncertainty are substantially affected by the developments in the credit market. This result is confirmed by the insignificant impact of the uncertainty shock on the credit spread while the impact of an adverse credit shock on the uncertainty level in the financial market is quire important. This result supports the idea that uncertainty increase in financial market is a symptom of credit market disruptions.

Appendices

Appendix A: Impulse responses to a monetary policy shock

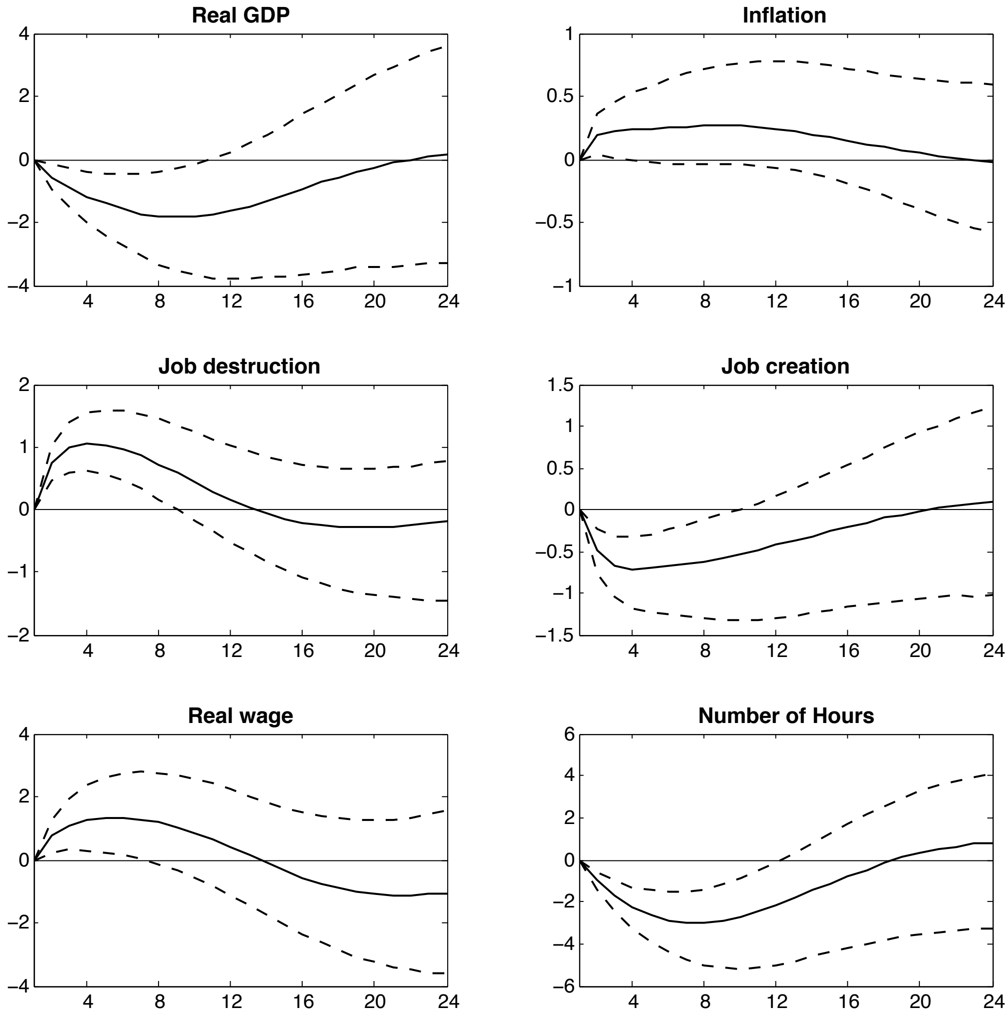

Figure 3: The median response to a one standard deviation positive shock to Federal funds rate. The solid lines correspond to the point estimates. The dashed lines are the 90% upper and lower bands of the credibility interval for

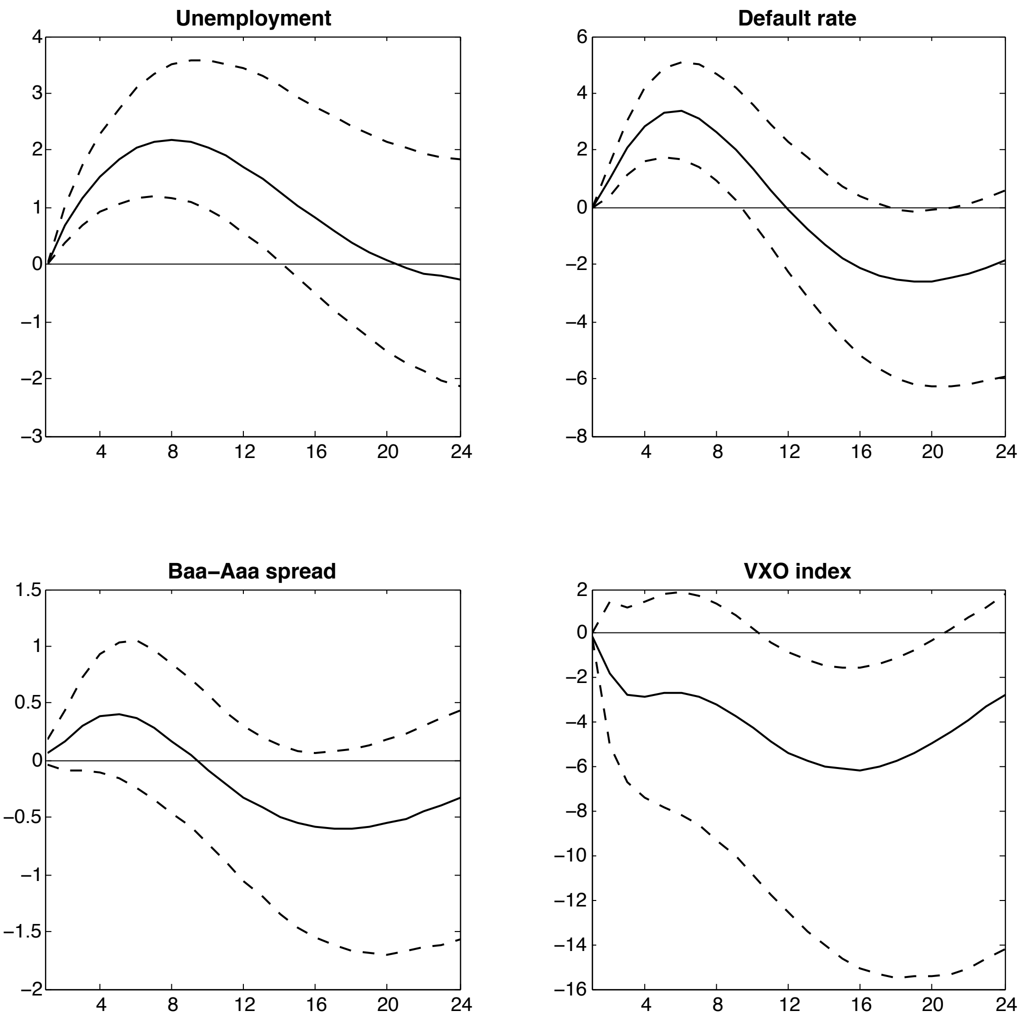

Figure 4: The median response to a one standard deviation positive shock to Federal funds rate. The solid lines correspond to the point estimates. The dashed lines are the 90% upper and lower bands of the credibility interval for each variable.

Appendix B: Impulse responses to a credit shock

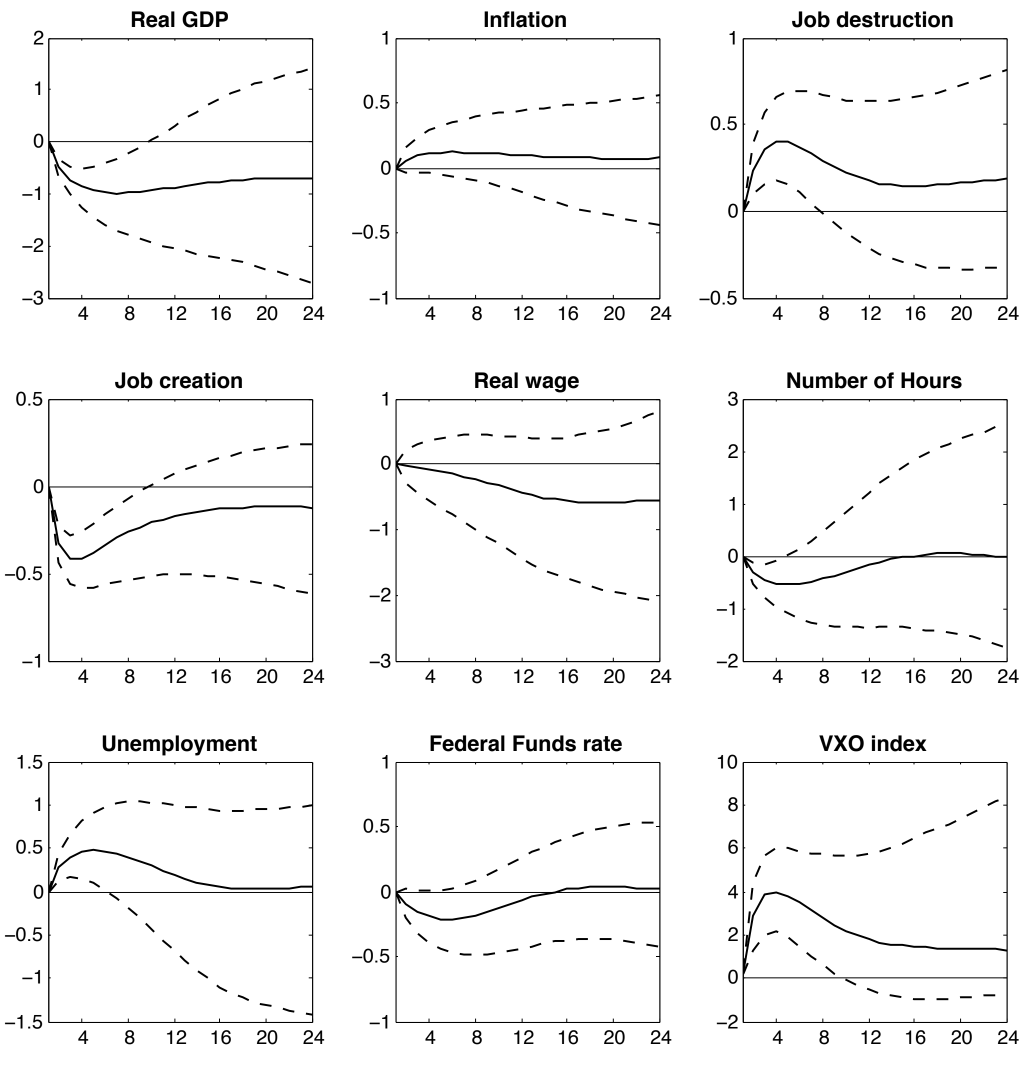

Figure 5: The median response to a one standard deviation positive shock to GZ spread. The solid lines correspond to the point estimates. The dashed lines are the 90% upper and lower bands of the credibility interval for each variable.

Appendix C: Impulse responses to an uncertainty shock

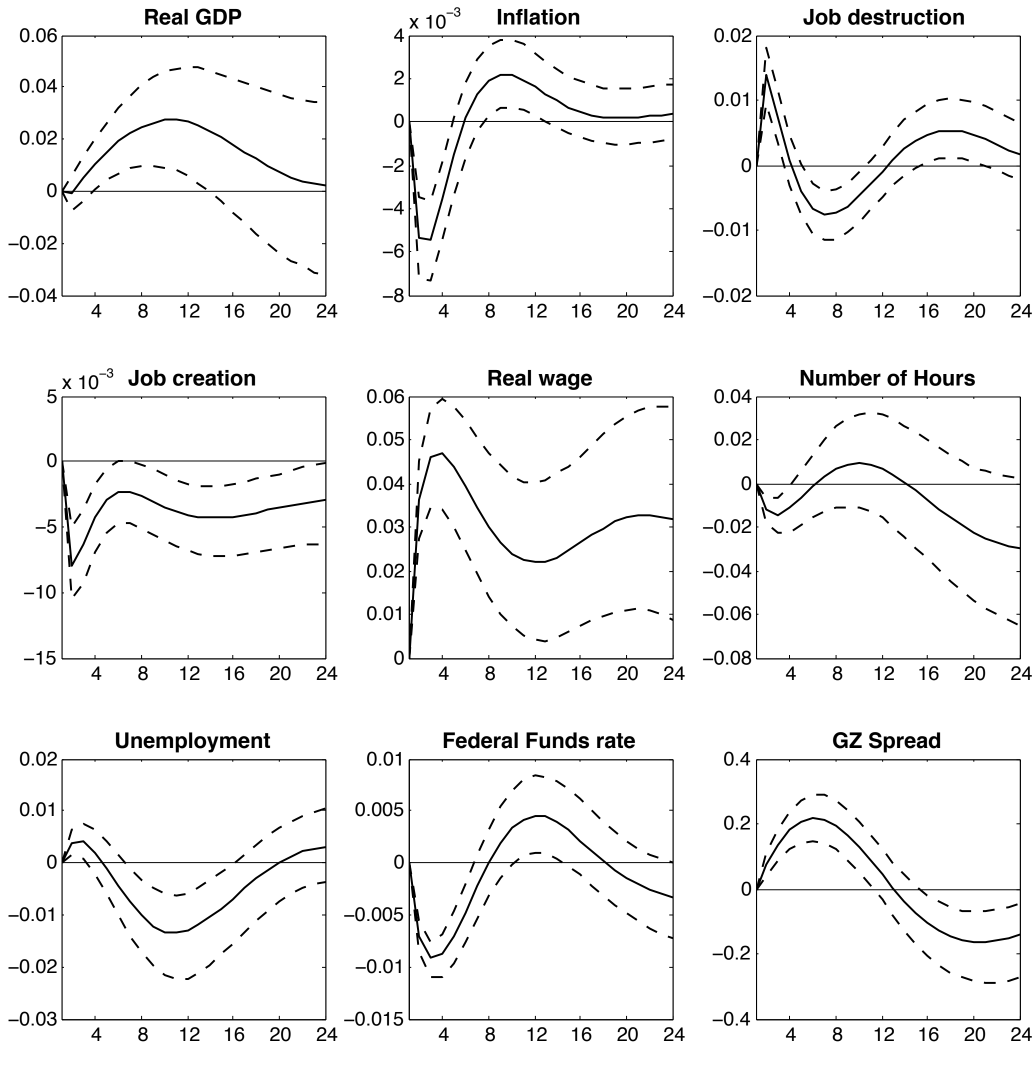

Figure 6: The median response to a one standard deviation positive shock to VXO uncertainty index. The solid lines correspond to the point estimates. The dashed lines are the 68% upper and lower bands of the credibility interval for each variable.

Chapter 3

Credit Imperfections, Labor Market Frictions and Unemployment: a DSGE approach

3.1 Introduction

The model is a monetary new-Keynesian model with asymmetric information in the credit market à la Bernanke et al. (1999b) and a search and matching process in the labor market à la Mortensen and Pissarides (1994). We use the costly state verification (CSV) framework because of its tractability and the facility that it offers to embed informational frictions in a general equilibrium analysis. Moreover, it allows to illustrate how credit market imperfections alter the transmission of monetary policy.

Our model enables to better understand cyclical fluctuations in key labor market variables (unemployment, vacancies, hours worked per employee and wages) and in credit market central variables (risk premium and default rate). Indeed, since capital spending, wage bill and vacancies costs are assumed to be paid partially by external funds, the interaction between frictions in credit and labor markets are key to better analyze the propagation and amplification of shocks on principal variables of both markets.

According to our theoretical model, we find that the procyclicality of the risk premium (the cost of external over internal funds) impacts the vacancy posting decisions, the wage bill and unemployment levels in the economy. In periods of downturn, the risk premium increases and the net worth of firms decreases. It increases their dependence on external funds, making job posting more expensive. So, less vacancies are posted and a higher equilibrium unemployment is obtained. Thus, asymmetric information in the credit market pushes up marginal costs and prices, as well as hiring costs by a financial mark-up, depending on the levels of monitoring cost and idiosyncratic shock threshold. This financial mark-up is made to overcome the agency problem between financial intermediaries and wholesale-good firms. But it will be charged in return by these firms on prices and will affect their hiring behavior, as well as the wage and employment levels in the economy.

As shown in figures (3.1) and (3.2), the evolutions of unemployment rate, Baa-Aaa spread and default rate between 1970-Q1 and 2007-Q4 for the United-States (US) are represented. The unemployment rate is the ratio of civilian unemployed persons to the civilian labor force. The default rate is the default rate for Moody's rated US speculative-grade corporate bonds. The Baa-Aaa spread is the Moody's seasoned Baa-Aaa corporate bond yield. A degree of correlation is observed among variables, especially for the unemployment and the Baa-Aaa spread. The correlation among these two variables is equal to 0.76. Thus, the higher the unemployment rate is, the higher the Baa-Aaa spread is and conversely. For the default rate, the correlation is less explicit, due to plausible structural forces between 1971 and 1980. However, some periods of correlation exist: 1970-Q1 until 1971-Q2 (0.81), 1979-Q1 until 1985-Q4 (0.6) and from 1990 (0.32). Based on these empirical correlations, in our paper, we demonstrate that the unemployment rate is in part determined by the evolution of credit spreads and default rate.

Given all these empirical figures and observations, we simulated the mode in order to highlight the interactions between the financial sphere and the labor market. We calibrate the model to match main the US economy features. We find that employment rates and vacancies posting increase following positive credit and net worth shocks. While a positive uncertainty shock induces a persistent increase of unemployment. A positive shock to the net worth is interpreted as a positive wealth shock. We found

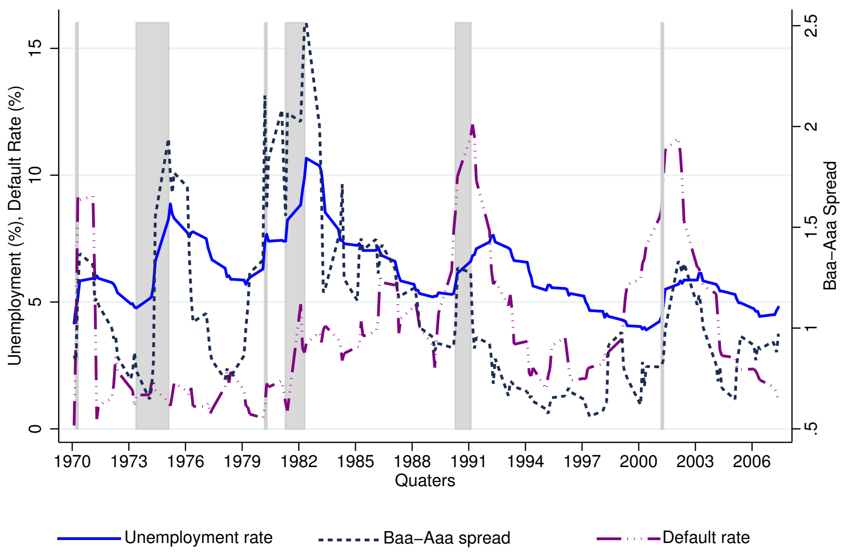

Figure 3.1: Unemployment, Baa-Aaa Spread and Default Rate between 1970-Q1 and 2007-Q4 for the United-States

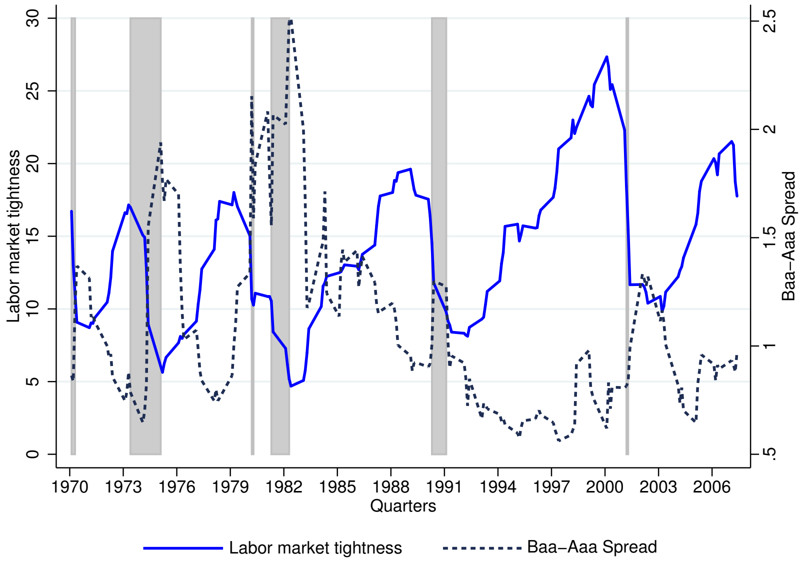

Figure 3.2: Labor-market tightness and Baa-Aaa Spread between 1970-Q1 and 2007-Q4 for the United-States

that the impact of such a shock on the employment is quite high and more persistent than the impact of a reduction of monitoring costs. Moreover, both shocks induce a substitution effect between the intensive and the extensive margins of employment. Improved credit market conditions encourages entrepreneurs to post more vacancies, firms to expand production and employees to work less number of hours. This finding is consistent with empirical figures. The model allowed to highlight the main transmission channels of shocks originating in the credit market to the labor market and results appear to be consistent with stylized facts and theoretical conjectures.

3.2 Related literature

Our work is at the intersection of different lines of research. First, a number of research papers introduce search and matching frictions on labor markets in real business cycle (RBC) models or in new-Keynesian (NK) models. Other articles highlight the role of financial frictions for macroeconomic dynamics, without taking into account search and matching frictions on labor markets. Finally, more recent studies embody simultaneously frictions in labor and credit markets in partial equilibrium models or in dynamic stochastic general equilibrium (DSGE) models, to study interactions and implications of these two types of frictions.

The assumption of Walrasian labor markets is considered as a weakness of standard RBC and NK models. Indeed, these models do not take into account variations in the number of unemployed, the extensive margin that never changes. They allow only to study variations in hours worked per employee, the intensive margin. This may seem annoying to the extent that unemployment is an important indicator of performances of the economy in its use of resources and it is a major policy issue. Furthermore, this kind of models is ineffective to explain many stylized facts, such as the inertia of inflation together with the large and persistent response of output after a monetary policy shock or the propagation mechanism of output after a technological shock. They are not able also to study the effect of aggregate shocks on unemployment dynamics. As a consequence, many articles have introduced search and matching frictions in labor markets, based on Mortensen and Pissarides (1994) framework, in RBC models or in NK models (Merz (1995), Andolfatto (1996), Walsh (2005), Krause et al. (2008), Gertler and Trigari (2009), Thomas and Zanetti (2009), Trigari (2009), Christoffel et al. (2009), Lechthaler et al. (2010), Blanchard and Galí (2010), Galí et al. (2011), Campolmi and Faia (2011), Christiano et al. (2013)).

Papers, as those of Merz (1995) and Andolfatto (1996), study implications of search and matching frictions for economic fluctuations in a standard RBC model. Both model show that labor market frictions are a mechanism of amplification and persistence for technology shocks. These frictions improve the empirical performance of RBC models, compared to a standard one, even if they do not predict enough cyclical movements in vacancies and output compared to data. Moreover,Andolfatto (1996), by introducing extensive and intensive margins, finds that most of the variability of total hours worked is due to changes in unemployment level rather than hours worked per employee.

Then, several papers in the same spirit (Walsh (2005), Trigari (2009), Thomas and Zanetti (2009), Lechthaler et al. (2010) and Campolmi and Faia (2011)) examine the role of matching frictions in new-Keynesian models. Walsh (2005) develops a new-Keynesien DSGE model with labor market frictions and with different potential sources of persistence (habit persistence, price stickiness and policy inertia) to see if it generates persistence in output and inflation after a monetary policy shock as observed in data. He founds through calibration that it amplifies for US data the output response and decreases the inflation response to a monetary policy shock, as well as it generates persistence in output and inflation as observed in data and as standard NK models do not succeed to generate. Trigari (2009) considers cyclical fluctuations of output, inflation and labor market variables following a monetary shock. She studies the possibility of endogenous separation between firms and workers, as well as extensive and intensive margins. Her estimated model is able to replicate well for US data the observed responses of output, inflation and labor market data to a monetary policy shock. Using a VAR, she finds as observed in data that in a model with labor market frictions, the response of inflation is less volatile and response of output more persistent after a monetary policy shock than in a standard NK model. Finally, Campolmi and Faia (2011) study also the role of search and matching frictions in new-Keynesian model, but by adopting the framework of a small open economy. They find that real wages, marginal costs and profits are more sensitives to productivity and monetary policy shocks for countries with lower replacement rates.

However, the Mortensen-Pissarides search and matching model of unemployment remains unable to match important stylized facts observed in data. In particular, these types of models are not performing well to explain high volatility and persistence of unemployment, vacancies and market tightness (Shimer (2004) and Hall (2005)) and the relative smooth behavior of real wages found in data. The framework of wage Nash bargaining leads to an exaggerated procyclical movements in wages after a positive productivity shock for example, that dampens the firm's incentives to hire. Wages absorb much of the change in the expected benefit to a new worker induced by fluctuations in labor productivity. As a consequence, several papers try to tackle this issue by introducing wage rigidity mechanisms (Shimer (2004), Gertler and Trigari (2009) and Christiano et al. (2013)), hiring and firing costs. First, Blanchard and Galí (2010) find that search and matching frictions modify the level of unemployment but the unemployment rate is invariant to productivity shocks. Thus, they study alternative wage-setting (Nash bargaining wage and more rigid real wages) and show that rigid wages enable to have inefficient fluctuations in unemployment after a productivity shock . Lechthaler et al. (2010) introduce in a new-Keynesian model labor market frictions, through hiring and firing costs but no wage rigidity. They find trough a calibration on a given European country, more persistence in output and unemployment in response to real and monetary policy shocks and in inflation in response to real shocks, as well as a strong amplification effect of these shocks on unemployment and on the job finding rate. Gertler and Trigari (2009) reproduce by calibration, in a standard Mortensen-Pissarides search and matching framework with a staggered multiperiod Nash wage, the relatively volatile behavior of unemployment and the relative smooth behavior of real wages over the business cycle as observed in data.

On the other hand, frictions have been also studied on the credit market side (Bernanke and Gertler (1989), Bernanke and Gertler (1995a), Carlstrom and Fuerst (1998), Kiyotaki and Moore (1997), Bernanke et al. (1999b), Carlstrom and Fuerst (2001), Paustian (2004a) and Fiore and Tristani (2013)). They have been devoted to understand the relationship between financial markets and overall macroeconomic performances. Financial factors are indeed suspected to amplify and increase persistence of macroeconomic variables responses to aggregate shocks. The idea behind is that deteriorating credit conditions could be the source of poor economic activity and not the consequence of a declining real economy.

Bernanke and Gertler (1989), Kiyotaki and Moore (1997) and Bernanke et al. (1999b) develop the concept of a financial accelerator in DSGE models integrating money and price stickiness. Without credit frictions, an entrepreneur can resort to external financing to raise capital at a risk-free interest rate. With credit market frictions, information asymmetry appears in the form of moral hazard between the lender and the borrower. Borrower will indeed be induced to report to the lender a lower real output produced than their true level. As a consequence, this type of asymmetric information can lead first to borrowing restrictions for borrowers on the amount of external financing available, based on the existence of collateral constraints to cover their potential inability to reimburse loans as in Kiyotaki and Moore (1997). Then, it can lead to a second type of financial frictions, namely a higher cost of external financing compared to internal financing opportunity cost (the risk-free interest rate), that to say an external finance premium or a risk premium, pays by entrepreneurs.

In a very similar spirit, Carlstrom and Fuerst (1997b) introduce in a canonical RBC model the same kind of informational asymmetry between lenders and borrowers and show that it leads the economy to return more slowly to the steady-state after being hit by a shock (propagation mechanism) and leads to less amplification because agency costs create an endogenous mark-up in an output model. The mark-up distorts factor markets, so wages and capital rental rates are below their corresponding productivities. Thus, increases in net worth lower agency costs and hence the mark-up. Debt arises as the optimal financial contract between firms and banks and firms must borrow at a premium over the risk-free rate. The financial contract is designed to minimize the expected agency costs. It specifies the returns when bankruptcy or success occurs and a monitoring threshold (for reported profits below the threshold, the lender pays the state verification costs and above the threshold, the lender does not pay to audit the project result). The threshold is a decreasing function of borrower's capital and an increasing function of the deposit risk free-rate (opportunity cost).

Fiore and Tristani (2013) show, by adopting the costly state verification set-up, that financial market conditions are important to explain macroeconomic outcomes because its affects firms' marginal costs. Higher credit spreads increase lending rates and marginal cost of credit for firms, which lead to increase prices and as a consequence, it affects output.

All these papers assume standard Walrasien labor markets. Only few papers consider both credit and labor markets frictions, as the ones of Thomas and Zanetti (2009), Christiano et al. (2011), Zanetti and Mumtaz (2011) and Petrosky-Nadeau (2014). Labor market frictions imply that it is costly to hire new workers. The functioning of frictional labor markets prevent the competitive allocation of labor resources, and thus it will interact with financial frictions to impact production, unemployment, investment and capital accumulation. Those models enhance the Bernanke et al. (1999b) framework with a more realistic labor market. Christiano et al. (2011) show in a new-Keynesian model that financial and employment frictions are able to change the model dynamics in an open economy setting, and improve the forecasting properties of the model for Swedish data, in particular for inflation. Thomas and Zanetti (2009) makes out that financial shocks are important to explain business cycles fluctuations, because they impact firm's ability to raise funds and amplify/dampen the response of macroeconomic variables (such as unemployment, wages and vacancy posting) to shocks. Petrosky-Nadeau (2014) considers that firms finance only their vacancies costs with external financing on frictional credit markets. He finds that the easing of financing constraints during an expansion (a productivity shock) reduces the opportunity cost for resources allocated to job creation (cost channel), because firms are able to accumulate net worth. Credit market frictions generate persistence in the dynamics of labor-market tightness and have a moderate effect on amplification. Zanetti and Mumtaz (2011) demonstrate that labor and financial frictions are supported by the data and that they play together to amplify or reduce the variables' reaction to shocks.

Note that our framework is different from the one of Acemoglu (2001) or Wasmer and Weil (2004), Petrosky-Nadeau and Wasmer (2014), who assume search frictions on both labor and credit markets. Search frictions and agency costs are both credit market imperfections but we decide to focus on agency costs by a costly-state verification framework. Wasmer and Weil (2004) find that labor and credit market frictions work together to amplify macroeconomic volatility. Note also that our work is included in the spirit of researches about the impact of credit market imperfections on investment flows but we decide to focus on their impact on employment flows, hours worked and wages.

3.3 The model

3.3.1 Model overview and timing summary

The model is populated by seven types of agents: households, wholesale-good firms managed by entrepreneurs, retailers, final-good firms, banks and a government that conducts monetary and fiscal policies.

The household sector is represented by a continuum of identical households of length unity. Each household is constituted of members who are either working or unemployed. All members are supposed to be risk-averse. They supply labor, consume, rent capital and save through money holding and through their deposits in a financial intermediary.

Entrepreneurs are risk-neutral and have finite lifetime. Following Bernanke et al. (1999b), each entrepreneur is assumed to have a given probability to survive to the next period. They manage wholesale firms, that produce wholesale goods using a constant return-to-scale technology using labor and capital as inputs. Surviving entrepreneurs carry their profits as a part of their net worth. Dying entrepreneurs consume everything. After deciding on the number of new workers they need, entrepreneurs, based on their net worth amount and their expected production and returns, borrow funds from banks to post vacancies (and recruit workers), to pay capital spending and the wage bill in advance. However, wholesale-good production is subject to an idiosyncratic shock, privately observed by entrepreneurs, while banks need to pay a monitoring cost to check the real output produced, as well as the efficiency of the recruitment process. This agency problem will alter the real recruitment cost and the marginal cost of production for wholesale firms.

As soon as funds are obtained, entrepreneurs enter the labor market, match with their potential employees and bargain on wages. Whenever it happens, the match is assumed to keep going on until it is exogenously costlessly destroyed.

Finally, the production sector has three different layers in the spirit of Bernanke et al. (1999b). At the first layer, where agency problem and search and matching frictions occur, as just explained before, a continuum of perfectly competitive wholesale firms produce homogeneous goods using capital and labor. At the second layer, where price stickiness arises, wholesale goods are differentiated costlessly by a continuum of monopolistic firms. The realized profits are rebated lump-sum to households. The final good is then homogeneous and can be used for consumption, capital accumulation and government spending.

The seven agents are thus interacting in seven different markets (labor market, capital market, credit market, liquidity market, wholesale-good market, intermediate and final-good markets), where the timing is given by the following sequence of events.

Firstly, a given fraction of entrepreneurs are born so as to ensure a constant fraction of entrepreneurs at each period. An exogenous amount is given to all entrepreneurs, to be sure that they remain entrepreneurs.

Then, monetary policy and aggregate shocks are realized. The liquidity market opens. Given all expected prices and revenues in the economy, households decide on their level of consumption, deposits, money holding, investment and on the capital rate of utilization.

The credit market opens. Banks accumulate the deposited amounts by households at the end of period $t-1$ in order to grant them as loans at the beginning of the current period t. The credit market clears when the amount of deposits and money injected in the economy equals the amount of granted loans.

Entrepreneurs own and manage the wholesale production sector. They enter period t with a net worth, either composed by the exogenous endowment and the accumulated net worth at the end of period $t-1$ for the last period solvent entrepreneurs. Or they enter the period t with a net worth given by the exogenous endowment for the entrepreneurs who went bankrupt last period. They all borrow from banks using a nominal financial contract, in order to cover their expected production bill (labor and capital costs) and vacancies costs. Indeed, these elements are assumed to be paid in advance.

After, the labor market opens. Entrepreneurs post vacancies at a real unit cost and recruit a given number of workers. The wage is established after a Nash bargaining process and new hired employees start working immediately. The Nash bargained wage and the vacancies costs have to be paid immediately by entrepreneurs, using their loans.

The capital market opens, where households are assumed to own the capital stock of the economy. They rent effective capital to entrepreneurs at a perfectly competitive price. They accumulate capital at the end of the period $t-1$ to lend it during the current period t to entrepreneurs. The capital market clears when the amount of effective capital supplied by households is equal to the amount demanded by entrepreneurs. Entrepreneurs have to pay immediately their capital costs to households, using their loans.

The three production markets can now opened. First, wholesale goods are produced by wholesale-good firms thanks to labor and capital. Entrepreneurs sell it to retailers and declare either being solvent or bankrupt, after having observed privately their own idiosyncratic shocks. Solvent entrepreneurs, characterized by a sufficiently high idiosyncratic shock, pay back their loan and keep the remaining amount to use it at the end of the period t (to consume and/or to accumulate net worth). For bankrupt entrepreneurs, the bank spends a monitoring cost, proportional to the realized firm's value, in order to check the output they produced and confiscates the proceeds of production left by these entrepreneurs. These later can neither consume nor carry over net worth to the coming period. Then, banks reimburse households deposits. The role of the financial intermediary is well defined: it allows to mitigate the monitoring cost and to avoid its duplication.

Retailers, that are a set of monopolistically competitive firms owned by households, buy the wholesale good and differentiate it costlessly. However, only a given fraction of retailers are able to fully re-optimize their prices. All the realized profits are transferred to households at the end of the period t.

Final goods are then sold to households (to consume and to accumulate capital), to the government (government spending) and to solvent exiting entrepreneurs (to consume), at a consumer's price index.

Finally, households consume, invest, make their deposits and their money holding. Solvent entrepreneurs decide either on their consumption or on their net worth, depending on their probability of death in the current period t: those exiting the economy at the end of the period t consume all their net worth just before death, and those keeping in the economy will accumulate totally their net worth thanks to money.

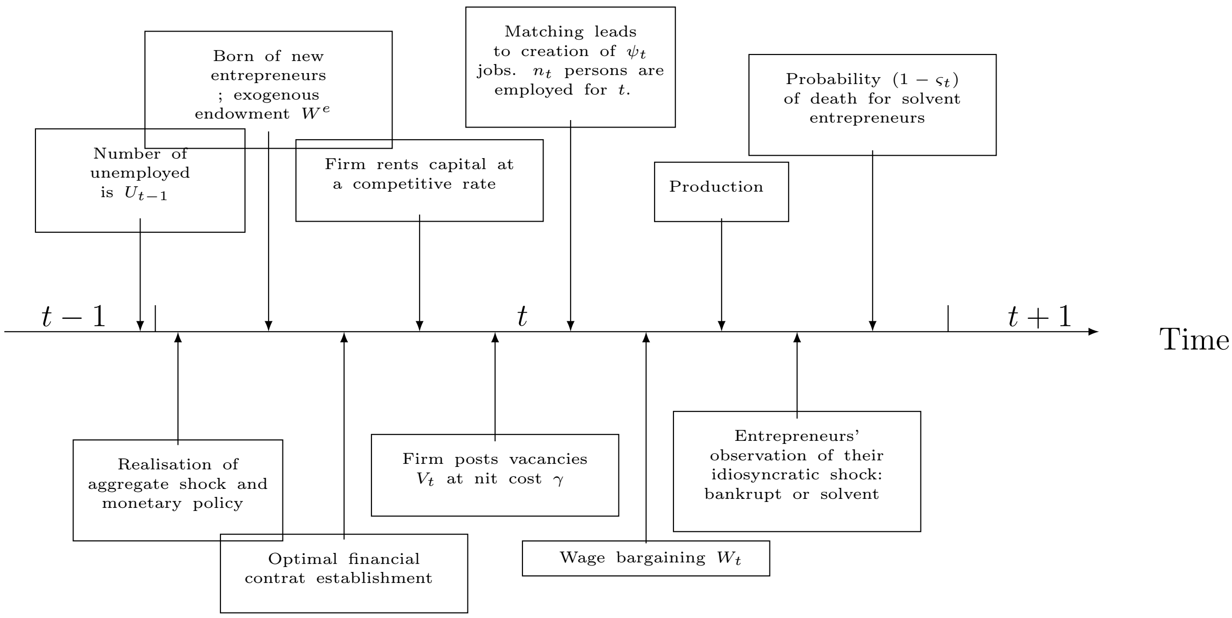

Figure 3.3: Timing of events

3.3.2 Households

Households consume, save through deposits, hold money, invest in capital and supply passively labor to entrepreneurs. They transfer wealth form a period to another by holding money.

At the beginning of the period t, given all expected prices and revenues in the economy, households decide how much they want to consume, to save through deposits and money and how much they want to invest final goods to accumulate capital.

This capital will be rented at the next period $t+1$ to entrepreneurs on a perfectly competitive capital market. Households decide also the capital utilization rate for the current period t, which will determine the effective capital submitted for rent in this period t.

To decide, households expect as resources, wages earned after the matching process of the period t by workers, and unemployment benefits earned by unemployed at the end of period t. They earn also incomes from the rental of capital and profits from retailers, as they own them. Finally, they receive from banks, after reimbursements of wholesale-good firms loans, the last period risk-free interest rate, multiplied by the amount of deposits decided last period. This revenue is sure because financial intermediation is assumed to be realized through a large number of atomistic risk-neutral banks, holding enough large and diversified portfolios to ensure perfect risk pooling for their main creditors, the households.

Then, when the labor market opens, unemployed households members supply labor to entrepreneurs passively. A fraction of them is matched with entrepreneurs and begins to work immediately. The other fraction is not matched and stays unemployed. Newly matched workers and workers who have been matched without exogenous destruction in the period $t-1$ receive their wages immediately after the wage bargaining. The unemployed have to wait the end of the period to receive unemployment benefits.

At the end of the period, after the production of final goods, households have to pay lump-sum taxes to the government, that will finance unemployment benefits and government spending. Finally, households consume effectively, invest final goods to accumulate capital, hold money and make their deposits to banks.

Employed and unemployed members

After obtaining its loan from a bank, a wholesale firm i posts actively V_{it} job vacancies at a real unit cost, γ, to attract unemployed workers, U_t, who are searching passively for a job.

Assumption 1. Only the unemployed workers can search passively for a job and can be hired. Current employed workers are not allowed to look for another job. Job-to-job transition is not considered.

Job creation occurs when an entrepreneur and an unemployed worker meet on the labor market after a search and matching process à la Mortensen and Pissarides (1994), and when they agree on a Nash bargaining wage. At the end of this process, a wholesale firm i employs n_{it} workers at a real hourly wage W_{it}. As there exists a continuum of wholesale firms represented by the unit interval, the total number of vacancies during the matching process of period t, and the total number of employed workers after the matching process of period t, are:

$$V_t = \int_0^1 V_{it}\, di$$
$$n_t = \int_0^1 n_{it}\, di$$

As the labor force is normalized to one, the number of unemployed searching for a job during the matching of the period t corresponds to:

$$U_t = 1 - (1 - \delta_{t-1})n_{t-1} \tag{3.3.1}$$

Assumption 2. There is a full participation of workers. They are either employed or unemployed workers looking for a job. The transition between in and out the labor force is ignored.

Formally, total vacancies, V_t, will be filled by unemployed workers, U_t, via an aggregate constant return to scale matching function, $M(U_t, V_t)$, specified by[1]:

$$m(U_t, V_t) = U_t^{\rho} V_t^{1-\rho} \tag{3.3.2}$$

where $\rho \in (0, 1)$ is the elasticity of matches to unemployment. Moreover, as standard in the literature, the matching technology is assumed to be concave and increasing in both arguments. It represents the aggregate flows of hires in period t.

Assumption 3. As soon as the matching happens, new hired workers start working immediately[2]. Employed workers for whom the matching ends exogenously during period t are allowed to search for a new job in the same period[3]. But a new matching is only possible after financial contracts and loans are decided and obtained, so only at the opening of the labor market at the next period.

The ratio of total vacancies to unemployed workers, θ_t, defines the labor market tightness during the matching process of the period t from the firm point of view, so that:

$$\theta_t \equiv \frac{V_t}{U_t}$$

The probability for a firm to fill a vacancy job during the matching process of the period t, p_t, is given by:

$$p_t = \frac{m(U_t, V_t)}{V_t} = m(\theta_t^{-1}, 1) \tag{3.3.3}$$

And the probability for an unemployed worker to find a job during the matching process of the period t, q_t, is given by:

$$q_t = \frac{m(U_t, V_t)}{U_t} = m(1, \theta_t) \tag{3.3.4}$$

[1]Gertler et al. (2008) use the same specification. The Cobb-Douglas matching function is used in almost all macroeconomic models with search and matching frictions. Furthermore, the constant returns to scale assumption (homogeneity of degree one) seems to be supported empirically according to Petrongolo and Pissarides (2001).

[2]Following Krause and Lubik (2007), Gertler et al. (2008), Thomas and Zanetti (2009) and Blanchard and Galí (2010), workers are assumed to be immediately productive after being hired.

[3]Many papers on searching and matching literature are considering the same assumption. See Blanchard and Galí (2010) for example.

Therefore, the number of hired workers during the matching of the period t, ψ_t, is given by:

$$\psi_t = p_t V_t = m(U_t, V_t) \tag{3.3.5}$$

Note that $q_t = \theta_t p_t$ and $\partial p_t / \partial \theta_t < 0$, $\partial q_t / \partial \theta_t > 0$. The higher vacancy posts on unemployment (or the higher the labor market tightness from the firm point of view), the higher the probability for an unemployed worker to find a job and the lower the probability for a firm to fill a job. Both unemployed workers and firms are assumed to take q_t and p_t as given.

Assumption 4. A job is assumed to be destroyed at an exogenous rate, δ_t, which evolves exogenously according to:

$$\delta_t = \bar{\delta} \epsilon_t^{\delta} \tag{3.3.6}$$

$$\log(\epsilon_t^{\delta}) = \rho_\delta \log(\epsilon_{t-1}^{\delta}) + u_t^{\delta}, \quad \rho_\delta \in (0,1) \text{ where } u_t^{\delta} \overset{iid}{\sim} N(0, \sigma_\delta^2)$$

where $\bar{\delta}$ is the steady state value of the destruction rate.
According to our timing, the exogenous destruction of a match can occur only between the end of the matching process and the end of the period t.

Finally, the total number of employed workers after the matching process of the period t, n_t, is defined as the sum of the surviving workers from the exogenous separation at the end of period $t-1$, $(1-\delta_{t-1})n_{t-1}$, and the new hires from the matching of the period t, ψ_t:

$$n_t = (1-\delta_{t-1})n_{t-1} + \psi_t \tag{3.3.7}$$

Since workers who discontinue their match during the period t are assumed to be allowed to search passively for a new job in the same period, the number of unemployed searching workers at the end of the period t is $1-(1-\delta_t)n_t$.

Household behavior

Households are seen as a large representative family represented by the unit interval, consisting of a continuum of members, either employed or unemployed. As in Merz (1995) and Andolfatto (1996), there is a full risk sharing of consumption in order to avoid distributional issues due to heterogeneity in incomes among family members. So, the family pools its income such that a perfect consumption is fully insured for all members. The same notation is then used for the consumption of the representative household and for the consumption of each member[4].

After a search and matching process à la Mortensen and Pissarides (1994) on the labor market, the number of employed family members is $n_t \in (0,1)$, whereas the remaining members, $1 - n_t$, are unemployed. Each employed worker supplies labor at a real Nash bargaining wage, W_t. Entrepreneurs set unilaterally effective hours of work, H_t, at the time of the financial contract establishment. Therefore, the total number of hours worked by a representative household, N_t, is given by:

$$N_t = n_t H_t$$

In addition to the real wage income, $W_t N_t$, earned by employed workers and real unemployment benefits, b[5], received by unemployed workers, the representative family has a diversified ownership stake in monopolistic retailers, paying out a nominal lump-sum profit, Π_t. The family receives also from banks the last period risk-free interest rate, R_{t-1}, multiplied by the amount of deposits decided last period, D_{t-1}. Then, households hold an amount M_{t-1} of money carried from the previous period. As the household owns the capital stock of the economy, he rents effective capital, K_t, to wholesale firms at a real interest rate, r_t^K. He has also to make a nominal lump-sum transfer for a nominal amount T_t to the government.

Finally, this total income is used to consume a real amount C_t of final goods,

[4]The family optimally allocates the same consumption for each member, regardless their respective individual income.

[5]b can be interpreted as home production or as unemployment benefits, as we do, provided by the government and financed by lump-sum taxes.

to invest a real amount I_t, to save a nominal amount D_t of bank deposits remunerated at a risk free rate, R_t, and to accumulate a nominal amount of money M_t. Thus, the representative household budget constraint is given by:

$$\begin{aligned} W_t n_t H_t + U_t b + \frac{R_{t-1}D_{t-1}}{P_t} + [r_t^K \nu_t - (\epsilon_t^I)^{-1}\Upsilon(\nu_t)]K_{t-1}^p + \frac{\Pi_t}{P_t} + \frac{T_t}{P_t} \\ = \frac{M_t - M_{t-1}}{P_t} + C_t + I_t + \frac{D_t}{P_t} \end{aligned} \tag{3.3.8}$$

where P_t is the nominal aggregate price level.

Households are assumed to own the economy's stock of physical capital, K_{t-1}^p, and so, they choose the capital utilization rate, ν_t, which transforms physical capital into effective capital, K_t. The amount of effective capital that households rent to wholesale firms in period t is given by:

$$K_t = \nu_t K_{t-1}^p \tag{3.3.9}$$

$\Upsilon(\nu_t)$ is the real cost of capital utilization per unit of physical capital [6]. We assume that, at the steady state, the following conditions hold: $\nu_t = 1$ and $\frac{\Upsilon''(1)}{\Upsilon'(1)} = \sigma_a$. $\bar{r}^K$ is the nonstochastic steady state value of the renting capital interest rate and σ_a is defined as the capital adjustment cost elasticity.

By investing I_t units of final goods in period t, the representative household increases the physical capital stock, K_t^p, available during period $t+1$ according to:

$$K_t^p = (1-\delta_K)K_{t-1}^p + \left[1 - \Lambda(\frac{I_t}{I_{t-1}})\right]\epsilon_t^I I_t \tag{3.3.11}$$

where δ_K is the capital depreciation rate and $\Lambda(.)$ is the investment adjustment cost

[6] Υ is specified as the following :

$$\Upsilon(\nu_t) = \frac{\bar{r}^K}{\sigma_a}\Big\{\exp[\sigma_a(\nu_t - 1)] - 1\Big\} \tag{3.3.10}$$

function. $\Lambda(.)$ is an increasing and convex function[7]. Since the aggregate productivity shock is assumed to be stationary, then $\Lambda(.)$ satisfies the following conditions at the steady state: $\Lambda(.) = \Lambda'(.) = 0$ and $\Lambda''(.) = \kappa > 0$. ϵ_t^I is an investment-specific technological shock affecting the marginal efficiency with which consumption goods are transformed into physical capital, that follows an auto-regressive process:

$$\log(\epsilon_t^I) = \rho_I \log(\epsilon_{t-1}^I) + u_t^I, \qquad \rho_I \in (0,1) \text{ where } u_t^I \overset{iid}{\sim} N(0, \sigma_I^2)$$

Conditional on $\{H_t, n_t\}_{t=0}^{\infty}$ and taking as given the set of prices $\{P_t, W_t, R_t, r_t^K\}_{t=0}^{\infty}$, the household chooses the streams of consumption of final goods $\{C_t\}_{t=0}^{\infty}$, nominal money balances $\{M_t\}_{t=0}^{\infty}$, deposits $\{D_t\}_{t=0}^{\infty}$, investment $\{I_t\}_{t=0}^{\infty}$, capital utilization rate $\{\nu_t\}_{t=0}^{\infty}$ and physical capital $\{K_t^p\}_{t=0}^{\infty}$, maximizing the following discounted utility function[8] subject to the budget constraint (3.3.8) and the physical capital law of motion (3.3.11):

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\epsilon_t^C \log(C_t - hC_{t-1}) + \xi \log\left(\frac{M_t}{P_t}\right) - \epsilon_t^H \frac{H_t^{1+\tau} n_t}{1+\tau} \right] \tag{3.3.12}$$

where $0 < \beta < 1$ is the intertemporal discount factor, ϵ_t^C is a consumption preference shock, h is a habit persistence parameter, ϵ_t^H is a shock to supplied hours, ξ is a money preference parameter and τ denotes the inverse of the Frisch elasticity of labor supply. When $h > 0$, the model allows for habit persistence in consumption preferences to take into account the necessary empirical persistence in the consumption process. Preference and hours supply shocks obey to the following stochastic processes:

$$\log(\epsilon_t^C) = \rho_C \log(\epsilon_{t-1}^C) + u_t^C, \qquad \rho_C \in (0,1) \text{ where } u_t^C \overset{iid}{\sim} N(0, \sigma_C^2)$$
$$\log(\epsilon_t^H) = \rho_H \log(\epsilon_{t-1}^H) + u_t^H, \qquad \rho_H \in (0,1) \text{ where } u_t^H \overset{iid}{\sim} N(0, \sigma_H^2)$$

[7]We take the following specification for Λ:

$$\Lambda(x_t) = \frac{1}{2}\Big\{\exp[\sqrt{\kappa}(x_t - 1)] + \exp[-\sqrt{\kappa}(x_t - 1)] - 2\Big\},$$

where $x_t = \dfrac{I_t}{I_{t-1}}$.

[8]The form of the utility function is based on the ones used by Bernanke et al. (1999b) and Gertler et al. (2008).

The first-order conditions of the representative household's problem are given by:

$$(C_t) \qquad \lambda_t = \frac{\epsilon_t^C}{C_t - hC_{t-1}} - \beta h E_t \frac{\epsilon_{t+1}^C}{C_{t+1} - hC_t} \tag{3.3.13}$$

$$(D_t) \qquad 1 = \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \frac{R_t}{\pi_{t+1}} \right] \tag{3.3.14}$$

$$(\nu_t) \qquad r_t^K = (\epsilon_t^I)^{-1} \Upsilon'(\nu_t) \tag{3.3.15}$$

$$(I_t) \quad \epsilon_t^I Q_t \left[1 - \Lambda\left(\frac{I_t}{I_{t-1}} \right) \right] = 1 + \epsilon_t^I Q_t \frac{I_t}{I_{t-1}} \Lambda'\left(\frac{I_t}{I_{t-1}} \right) - \beta E_t \epsilon_{t+1}^I \frac{\lambda_{t+1}}{\lambda_t} Q_{t+1} \left(\frac{I_{t+1}}{I_t} \right)^2 \Lambda'\left(\frac{I_{t+1}}{I_t} \right) \tag{3.3.16}$$

$$(K_t^p) \qquad Q_t = \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left((1-\delta_K) Q_{t+1} + r_{t+1}^K \nu_{t+1} - (\epsilon_{t+1}^I)^{-1} \Upsilon(\nu_{t+1}) \right) \right] \tag{3.3.17}$$

$$(M_t) \qquad \frac{M_t}{P_t} = \xi \left[\lambda_t - \beta E_t \left(\frac{\lambda_{t+1}}{\pi_{t+1}} \right) \right]^{-1} \tag{3.3.18}$$

where $\pi_t \equiv \frac{P_t}{P_{t-1}}$ is the inflation rate, λ_t is the Lagrange multiplier associated to the household's budget constraint and Q_t is the value of an additional unit of physical capital in terms of final goods units. Q_t represents more precisely the ratio between the Lagrange multiplier associated to the capital evolution law and λ_t.

Equation 3.3.13 defines the marginal utility of consumption when there is habit formation. It states that the Lagrange multiplier equals the marginal utility of consumption. Equations 3.3.14, 3.3.15, 3.3.16 and 3.3.17 correspond to the choices of the household in terms of deposits, rate of capital utilization, investment and physical capital. Equation 3.3.18 express the demand for real balances.

3.3.3 Wholesale-good firms

Wholesale-good firms, indexed by $i \in [0,1]$, need labor and capital to produce. Y_{it}^{ws} is the quantity of wholesale goods produced by a firm i using N_{it} total hours of labor and K_{it} units of effective capital, according to the following production function:

$$Y_{it}^{ws} = A_t K_{it}^{\alpha} N_{it}^{1-\alpha} \tag{3.3.19}$$

where A_t is the aggregate technology shock, realized at the beginning of each period, source of systematic risk. This shock is assumed to be stationary and evolves according to:

$$\log(A_t) = \rho_A \log(A_{t-1}) + u_t^A, \qquad \rho_A \in (0,1) \text{ where } u_t^A \overset{iid}{\sim} N(0, \sigma_A^2)$$

Effective capital, K_{it}, is rented from households at a competitive price, r_t^K. Total hours worked, N_{it}, are paid to employed workers through the wage, W_{it}. Needed new hires, ψ_{it}, are obtained through a matching process on the labor market, implying vacancy posting costs, γV_{it}. The expected production bill, $W_t N_{it} + r_t K_{it}$, and vacancy posting costs, γV_{it}, are assumed to be paid prior to production.

Each wholesale firm is managed by a finite lived risk-neutral entrepreneur, who may die at each period with a probability $(1 - \varsigma_t)$. This assumption is made to be sure that entrepreneurs will not accumulate net worth and that they will borrow from banks at each period[9]. Intra-period entry into and exit out of wholesale firms at each period are ruled out. Entrepreneurs have a net worth, composed by a real exogenous entrepreneurial wage, W^e, and for the one solvent and not exiting the economy last period, by the net worth accumulated from the previous period. But this net worth will not be sufficient to cover the total production bill, as well as the vacancy posting costs. Entrepreneurs have to borrow from banks. Thus, a financial intermediation is realized through a large number of atomistic risk-neutral banks. They receive deposits from households at the end of period $t-1$, that they use to lend to entrepreneurs in period t. Furthermore, entrepreneurs are subject to idiosyncratic shocks, privately observed by them, but not observed by banks. So banks have to monitor wholesale firms, which declare themselves bankrupt after the production occurs. The monitoring is costly and has to be integrated in the financial contract. An optimal financial contract is thus determined between banks and entrepreneurs, maximizing the entrepreneurs expected returns, subject to the bank's participation constraint.

[9] The same assumption is made by Bernanke et al. (1999b) and Paustian (2004b). Carlstrom and Fuerst (1998) make the different assumption, that consumers and entrepreneurs have different time-discount factors, with entrepreneurs less impatient than consumers.

Hiring decision

Before the financial contract establishment, based on the firm's expected net returns, the number of needed new hires, ψ_{it}, is determined by the human resources department of each firm. Indeed, wholesale firms consist of different departments. There are a human resources department, which is in charge with the recruitment process, and a management department, directed by the entrepreneur, which is in charge with the borrowing process. The human resources department decides on the labor needs of the firm in order to maximize its discounted value of future profits. To do so, this department determines the price of a new worker, or to be more precise, the potential net value of this new worker for the firm. Each new worker is thus evaluated through this value, by assuming that the bank will be able to sell the worker to another firm in case of firm bankruptcy. This value will enable then the management department to go to negotiate to the bank, based on this fictive worker price. At the end, the net recruitment cost or the replacement cost of a new worker, integrating financial costs, will be obtained.

To sum up, just before the financial contract establishment, wholesale firms set up their hiring decision, based on the firm's expected net returns. They determine the number of new workers, ψ_{it}, they have to take on, knowing the given probability for a firm to fill a vacancy job, p_t. Then, the hiring section of the firm post vacancies, V_{it}, on the labor market at the real unit cost, γ, partially externally financed. The level of Z_t, the net recruitment cost of a new worker, is thus derived.

Formally, the hiring decision of a wholesale firm i is the optimal solution to the following bellman equation:

$$\begin{aligned} \Psi_{it} = \underset{\psi_{it}}{max} \quad & \frac{P_t^{ws}}{P_t} Y_{it}^{ws} - W_{it} N_{it} - \frac{Z_t}{P_t} \psi_{it} + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \Psi_{it+1} \\ \text{subject to} \quad & n_{it} = (1 - \delta_{t-1}) n_{it-1} + \psi_{it} \\ & N_{it} = n_{it} H_{it} \end{aligned} \tag{3.3.20}$$

where P_t^{ws} is the wholesale-good price and $\beta\frac{\lambda_{t+1}}{\lambda_t}$ is the firm's discount factor[10].
By taking as given the wage schedule, W_{it}, the hours of work per employee, H_{it}, the consumer price index, P_t, and the wholesale-good price, P_t^{ws}, the human resources department of a wholesale firm chooses first the number of hirings, ψ_{it}, and consequently the number of employees sought, n_{it}, so as to maximize the firm's discounted value of future profits. An univariate optimization problem can be obtained in n_{it} by embedding both constraints into the problem, since by choosing n_{it}, the human resources department determines implicitly ψ_{it}. So that the following first-order condition can be derived:

$$\frac{Z_t}{P_t} = \frac{P_t^{ws}}{P_t}\frac{(1-\alpha)Y_{it}^{ws}}{n_{it}} - W_{it}H_{it} + \beta E_t\frac{\lambda_{t+1}}{\lambda_t}\Psi_{n_t,it+1} \tag{3.3.21}$$

Using the envelop theorem, one obtains:

$$\Psi_{n_{t-1},it} = (1-\delta_{t-1})\frac{Z_t}{P_t} \tag{3.3.22}$$

By taking equation (3.3.22) one period forward and plugging it in equation (3.3.21), the following Euler equation is derived:

$$\frac{Z_t}{P_t} = \frac{P_t^{ws}}{P_t}\frac{(1-\alpha)Y_{it}^{ws}}{n_{it}} - W_{it}H_{it} + (1-\delta_t)\beta E_t\frac{\lambda_{t+1}}{\lambda_t}\frac{Z_{t+1}}{P_{t+1}} \tag{3.3.23}$$

The expected total cost of hiring a new worker must be equal to the real expected net value of a match. The real marginal value of a new hire is the sum of the net real return of a worker, which corresponds to its marginal productivity net of the marginal labor cost that is defined as the hourly wage, plus the real value of the continued relationship with the same worker, realized with the probability $(1-\delta_t)$. Therefore, the hiring decision of wholesale firms is such that the expected profit from maintaining a match with an existing worker is equal to the expected total cost of hiring a new worker. This expected cost will be now determined explicitly trough the financial contract establishment.

[10]Since all firms are owned by households, profits are evaluated in terms of utility brought to them.

Optimal financial contract

A financial contract is established between a financial intermediary and an entrepreneur, who needs to pay in advance its production bill and vacancy posting costs. The financial intermediation is realized through a large number of atomistic risk-neutral banks. Banks are assumed to hold enough large and diversified portfolios to ensure perfect risk pooling for their main creditors, the households, carrying deposits to banks.[11].

Although we use the same costly state verification framework (CSV) used in Carlstrom and Fuerst (1998), Bernanke et al. (1999b) and others, asymmetric information is introduced between wholesale-good producers, called entrepreneurs, and banks. Financial intermediaries and banks are used interchangeably in the model. They are operating in a competitive market, so that only the behavior of a representative bank will be considered below.

Unlike the costly state verification framework similar to Carlstrom and Fuerst (1998), credit contracts are here nominal. They stipulate one-period loans, established after the aggregate shock, A_t, has occurred. Indeed, in order to eliminate aggregate uncertainty from the lender-borrower relationship, the aggregate technology shock, A_t, is assumed to be observed by all agents in the economy and it is realized before any loan contract is established. On the other hand, an idiosyncratic shock, ω_{it}, is privately observed by the entrepreneur i after the production takes place and it can be verified by the lender only at a monitoring cost, μ_t, proportional to the realized value of the firm. Thus, this private information creates a moral hazard problem as the entrepreneur may be encouraged to under-report the true value of its production, when it has to reimburse the loan after the production occurrence.

Finally, under a costly state verification framework, the perfectly competitive fi-

[11]Infinitely-lived households are risk averse, but they become risk neutral for the financial contract. Carlstrom and Fuerst (1998) explain this fact by the absence of uncertainty about the term of the one-period contract since the aggregate uncertainty is realized before the contract establishment. Furthermore, by the law of large numbers as banks are financing a continuum of different entrepreneurs, households know they will receive the expected return of the idiosyncratic shock.

nancial intermediaries' setting ensures that each firm-bank pair writes the borrowing contract that maximizes the expected return of the borrower, the entrepreneur, under the constraint that the expected return to the lender, the bank, exceeds its opportunity cost, namely the risk free interest rate, R_t. So the optimal incentive-compatible financial arrangement is just a standard risky debt contract, whose terms are the optimal solution to a standard principle-agent problem between entrepreneurs and banks[12].

After the wholesale-good production takes place, each entrepreneur draws an idiosyncratic shock, ω_{it}, defined as a productivity and management efficiency shock, reflecting its management skills, recruitment efficiency, hires' quality and input utilization skills. This idiosyncratic shock is the source of wholesale firms' heterogeneity. ω_{it} is i.i.d. with a continuous distribution function, $\Phi(.)$, and a density function, $\phi(.)$. ω_{it} is defined over a non-negative support, has a mean of unity and $\Phi(0) = 0$. Moreover, its variance, reflecting the shock's volatility and the entrepreneurs' riskiness, is time-varying and its standard deviation, $\sigma_{\omega,t}$, follows a first-order auto-regressive process given by:

$$\log(\sigma_{\omega,t}) = (1-\rho_\sigma)\log(\bar{\sigma}_\omega) + \rho_\sigma \log(\sigma_{\omega,t-1}) + u_t^\sigma, \quad \rho_\sigma \in (0,1) \text{ where } u_t^\sigma \overset{iid}{\sim} N(0,\sigma_\sigma^2)$$

$\bar{\sigma}_\omega$ is the steady-state value of the standard deviation, $\sigma_{\omega,t}$.

To justify the recourse to external funding, entrepreneurs are assumed to pay their real production bill, $r_t^K K_{it} + W_{it}N_{it}$, as well as the real vacancy posting costs, γV_{it}, prior to production[13]. But due to idiosyncratic shocks, firms face default risk on their debt. For low values of ω_{it}, some firms may not be able to reimburse the credit. Let B_{it} be the total expected real amount of the production bill, including vacancy posting costs, for a firm i, so that:

$$B_{it} = W_{it}N_{it} + r_t^K K_{it} + \gamma V_{it}$$

The wholesale firm borrows a nominal amount of $P_t(B_{it} - X_{it})$ from the bank at an

[12] See Townsend (1979b) and Gale and Hellwig (1985).

[13] Recall that entrepreneurs have a probability to die at each period, $1-\varsigma_t$, that ensures that they do not accumulate net worth and have to borrow from banks at each period.

implicit interest rate, R_t^l, where X_{it} is its real net worth. An entrepreneur and a representative bank agree on a financial contract specifying a break-even entrepreneur-specific productivity level, $\bar{\omega}_{it}$, satisfying $R_t^l P_t(B_{it} - X_{it}) = \bar{\omega}_{it}(P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it})$.

Indeed, if $\omega_{it} \geq \bar{\omega}_{it}$, the entrepreneur pays back the value $\bar{\omega}_{it}(P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it})$, the loan amount augmented with interest.
If $\omega_{it} < \bar{\omega}_{it}$, the firm is insolvent and the bank confiscates the total output produced. The bank can observe this state of nature at a monitoring cost $\mu_t \in (0, 1)$, a fraction of the realized value of the firm. After the realization of shocks and production occurrence, this firm's value is given by $\omega_{it}(P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it})$. The monitoring is non-stochastic and the lender actions are pre-committed.

Formally, the expected return earned by the wholesale firm i, E_{it}^f, is given by:

$$E_{it}^f = (P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it}) \int_{\omega > \bar{\omega}_{it}} (\omega - \bar{\omega}_{it}) \phi(\omega, \sigma_\omega) d\omega \tag{3.3.24}$$

Using the statistic properties of the random idiosyncratic shock, equation (3.3.24) can be developed to see that the expected return of the wholesale firm is a fraction of its realized value:

$$E_{it}^f = (P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it}) f(\bar{\omega}_{it}, \sigma_{\omega,t}) \tag{3.3.25}$$

where $f(\bar{\omega}_{it}, \sigma_{\omega,t}) = \int_{\omega > \bar{\omega}_{it}} \omega \phi(\omega, \sigma_\omega) d\omega - \bar{\omega}_{it}[1 - \Phi(\bar{\omega}_{it}, \sigma_{\omega,t})]$.

Note that $f(\bar{\omega}_{it}, \sigma_{\omega,t}) \in (0, 1)$[14] and
$f'(\bar{\omega}_{it}, \sigma_{\omega,t}) = \Phi(\bar{\omega}_{it}, \sigma_{\omega,t}) - 1 \leq 0$. The wholesale firm's expected return is a decreasing function of $\bar{\omega}_{it}$. This result is quite intuitive since an increase of the default rate, $\Phi(\bar{\omega}_{it}, \sigma_{\omega,t})$, reduces the gross share of return going to the firm.

Similarly, the expected return earned by the bank, E_{it}^b, is given by:

$$E_{it}^b = (P_t^{ws} Y_{it}^{ws} + Z_t \psi_{it}) \Big[\int_{\omega > \bar{\omega}_{it}} \bar{\omega}_{it} \phi(\omega, \sigma_\omega) d\omega + (1 - \mu_t) \int_{\omega < \bar{\omega}_{it}} \omega \phi(\omega, \sigma_\omega) d\omega \Big]$$

[14] $f'(\bar{\omega}, \sigma_\omega) \leq 0, \forall \bar{\omega} \in [0, \infty)$. In addition, $\lim_{\bar{\omega} \to 0} f(\bar{\omega}, \sigma_\omega) = 1$ and $\lim_{\bar{\omega} \to \infty} f(\bar{\omega}, \sigma_\omega) = 0$. Then, $f(\bar{\omega}, \sigma_\omega) \in (0, 1)$.

It is straightforward to show that lender's expected return is also a fraction $g(\bar{\omega}_{it}, \sigma_{\omega,t}) \in (0,1)$, of the total realized value of the wholesale firm[15]. Then,

$$E^b_{it} = (P^{ws}_t Y^{ws}_{it} + Z_t \psi_{it}) g(\bar{\omega}_{it}, \sigma_{\omega,t}) \tag{3.3.26}$$

where,

$$g(\bar{\omega}_{it}, \sigma_{\omega,t}) = 1 - f(\bar{\omega}_{it}, \sigma_{\omega,t}) - \mu_t \Gamma(\bar{\omega}_{it}, \sigma_{\omega,t})$$

with $\Gamma(\bar{\omega}_{it}, \sigma_{\omega,t}) = \int_{\omega < \bar{\omega}_{it}} \omega \phi(\omega, \sigma_\omega) d\omega$. So, an amount of the realized firm's value is lost due to monitoring in cases of declaring bankruptcy by the borrower. In this context, the monitoring cost spending is a synonym of bankruptcy and it is spent in terms of currency so that bankruptcy has no impact on the real output. As a consequence, the proportion of the total amount recovered by the bank in case of bankruptcy is $(1-\mu_t)\Gamma(\bar{\omega}_{it}, \sigma_{\omega,t})$. $(1-\mu_t)$ is thus interpreted as the recovery rate. Following Livdan et al. (2009) and Petrosky-Nadeau (2014), this recovery rate is assumed to be time-varying and to have the following specification:

$$1 - \mu_t = s_{0,t} \exp s_1(\omega_{it} - 1) \tag{3.3.27}$$

s_1 is the elasticity of the recovery rate to the entrepreneurial productivity level and $s_{0,t}$ is interpreted as a credit shock, following a first-order auto-regressive process:

$$\log s_{0,t} = (1-\rho_{s0}) \log \bar{s_0} + \rho_{s0} \log s_{0,t-1} + u^{s0}_t, \quad \rho_{s0} \in (0,1) \text{ where } u^{s0}_t \overset{iid}{\sim} N(0, \sigma^2_{s0})$$

where $\bar{s_0}$ is the steady-state value of the credit shock, $s_{0,t}$.

Finally, the optimal debt contract is a solution to a maximization problem, where the entrepreneur maximizes its expected return subject to the bank's participation constraint (Paustian (2004b)), knowing the level of n_{it} decided by the human resources department in the previous step. The bank is willing to lend funds only and only if

[15] Since $1 - f(\bar{\omega}, \sigma_\omega) \in (0,1)$ and by definition, we have $\int_{\omega < \bar{\omega}_{it}} \omega \phi(\omega, \sigma_\omega) d\omega \in (0,1)$ and $\int_{\omega > \bar{\omega}_{it}} \bar{\omega}_{it} \phi(\omega, \sigma_\omega) d\omega + \int_{\omega < \bar{\omega}_{it}} \omega \phi(\omega, \sigma_\omega) d\omega \in (0,1)$, then $g(\bar{\omega}, \sigma_\omega) \in (0,1)$, $\lim_{\bar{\omega} \to 0} g(\bar{\omega}, \sigma_\omega) = 0$ and $\lim_{\bar{\omega} \to \infty} g(\bar{\omega}, \sigma_\omega) = 1 - \mu$.

the contract yields an expected return greater or equal to the riskless rate of return, R_t:

$$\begin{aligned} \max_{K_{it},H_{it},V_{it},\bar{\omega}_{it}} \quad & [P_t^{ws}Y_{it}^{ws} + Z_t\psi_{it}]f(\bar{\omega}_{it},\sigma_{\omega,t}) \\ \text{subject to} \quad & [P_t^{ws}Y_{it}^{ws} + Z_t\psi_{it}]g(\bar{\omega}_{it},\sigma_{\omega,t}) \geq R_tP_t(W_{it}N_{it} + \gamma V_{it} + r_t^K K_{it} - X_{it}) \\ & \psi_{it} = p_tV_{it} \\ & N_{it} = n_{it}H_{it} \end{aligned} \tag{3.3.28}$$

The first-order conditions for the wholesale firm's problem are summarized by the three following equations:

$$Y_K^{ws}(K_{it},H_{it} \mid n_{it}) = \frac{P_t}{P_t^{ws}} r_t^K R_t S_{it} \tag{3.3.29}$$

$$Y_H^{ws}(K_{it},H_{it} \mid n_{it}) = \frac{P_t}{P_t^{ws}} n_{it} W_{it} R_t S_{it} \tag{3.3.30}$$

$$\frac{Z_t}{P_t} = \frac{\gamma}{p_t} R_t S_{it} \tag{3.3.31}$$

where $S_{it} = \{1 - \mu_t[\Gamma(\bar{\omega}_{it},\sigma_{\omega,t}) + \bar{\omega}_{it}h(\bar{\omega}_{it},\sigma_{\omega,t})f(\bar{\omega}_{it},\sigma_{\omega,t})]\}^{-1}$, with $h(\bar{\omega}_{it},\sigma_{\omega,t})$ the hazard rate[16] defined by $h(\bar{\omega}_{it},\sigma_{\omega,t}) = \dfrac{\phi(\bar{\omega}_{it},\sigma_{\omega,t})}{1-\Phi(\bar{\omega}_{it},\sigma_{\omega,t})}$.

In order to keep the representative-firm context, we assume that the threshold value of the entrepreneurial productivity, $\bar{\omega}_{it}$, is the same for all wholesale firms. This assumption guarantees a constant capital-labor ratio across firms. At the equilibrium, this is an important assumption since all firms will have the same financial mark-up, S_{it}, and they will bargain the same wage, W_{it}. Consequently, according to our assumption, the subscript i is dropped in what follows.

Further, asymmetric information in the credit market generates inefficiencies in both markets, the wholesale-good market and the labor market. On the one hand, the marginal productivity of labor is higher than its corresponding real marginal

[16]We assume that $\bar{\omega}h(\bar{\omega},\sigma_\omega)$ is increasing in $\bar{\omega}$ in order to ensure the concavity of the lender's net share of return, $g(\bar{\omega},\sigma_\omega)$, and avoid any credit rationing at the equilibrium. This regularity condition is without loss of generality and it is satisfied by most of the continuous probability distributions. See Bernanke et al. (1999b) for details.

cost. The final real price of the wholesale good is augmented by a financial mark-up, $S_t > 1$[17], used to overcome the agency problem between entrepreneurs and banks. As a consequence, credit market conditions matter because they affect firms' marginal costs and are transmitted to the rest of the economy through the selling price's mark-up. Banks have a margin behavior, that will pass trough the rest of the economy by the wholesale-good price. This framework breaks down the Modigliani-Miller theorem and makes the firms' external borrowing costs higher than internal funds opportunity costs. Indeed, firms must borrow at a premium over the risk-free rate.

Aggregating over entrepreneurs and embedding equations (3.3.29)-(3.3.31) in the lender's break even constraint, the firms' leverage ratio, $\mathcal{L}_t$, is given by:

$$\mathcal{L}_t \equiv \frac{B_t}{X_t} = \frac{1}{1 - S_t(\bar{\omega}_t, \sigma_{\omega,t})g(\bar{\omega}_t, \sigma_{\omega,t})} \tag{3.3.32}$$

with $\mathcal{L}_{\bar{\omega}} > 0$. For a given level of net worth X_t, a higher leverage ratio is associated with a higher default rate. Indeed, the probability of default increases as the loan amount raises (see Stiglitz and Weiss (1981)).

It is straightforward to show that, at the optimum, equation (3.3.28) is binding. Using this result with the condition on $\bar{\omega}_t$, the risk premium, Δ_t, defined as the ratio of the lending rate to the risk free rate, R_t^l/R_t, is given by:

$$\Delta_t = \frac{\bar{\omega}_t}{g(\bar{\omega}_t, \sigma_{\omega,t})}$$

Figure 3.4. shows the evolution of the risk premium as a convex increasing function of the entrepreneurial productivity threshold, $\bar{\omega}$. This result is quite familiar in the financial accelerator literature. A higher default probability of firms induces a higher cost of lending for banks and consequently, a higher loan spread.

On the other hand, the cost of a new hire, Z_t, depends also on the financial contract conditions. Besides the unit cost stemming from hiring, γ, and the average

[17] See appendix A for the proof.

duration of vacancies, $1/p_t$, the total cost of recruitment is augmented by the same financial mark-up, S_t. Financial contract conditions affect the labor market efficiency through the total vacancy posting cost, that becomes an endogenous variable. This relation is represented by figure 3.5., where the real posting cost is also an increasing and convex function of $\bar{\omega}$ and its slope raises with monitoring costs, μ. For a higher default likelihood (higher $\bar{\omega}$), banks charge a higher risk premium, Δ, so that entrepreneurs obtain their credit at a higher lending rate, R^l, which makes their external funds more expensive and reduces their willingness to open vacancies.

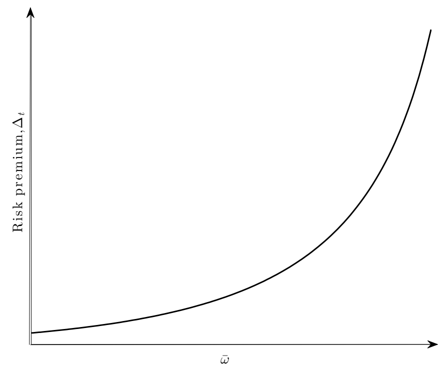

Figure 3.4: The risk premium as a function of $\bar{\omega}$

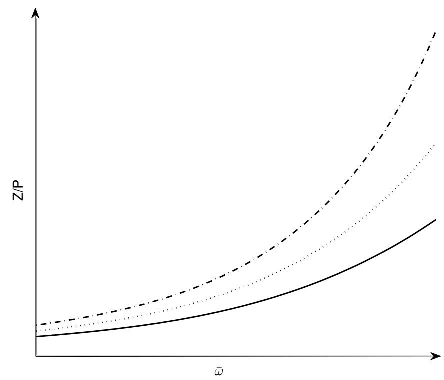

Figure 3.5: Real vacancy posting cost as a function of $\bar{\omega}$ for different values of monitoring costs: $\mu = 0.15$ (solid line), $\mu = 0.2$ (dotted line) and $\mu = 0.25$ (dashed line)

An increase of μ shifts the real vacancy posting cost upward. For a fixed level of $\bar{\omega}$, the real cost of a new hire raises with monitoring costs. As these costs are expressed in terms of currency, and not in terms of physical goods, they do not generate a loss of resources through a destruction of goods, which could have been used for consumption. However, they generate an additional cost taken into account by banks when agreeing on an appropriate interest rate on loans. Fluctuations in monitoring costs and bankruptcy rates will have an impact on welfare only indirectly, through their implications on the mark-up pricing.

Now, by making use of the optimal financial contract conditions derived below and the hiring condition given by equation (3.3.23), the job creation condition under financial frictions in the credit market is obtained:

$$\frac{\gamma}{p_t} R_t S_t = W_t H_t [R_t S_t - 1] + (1 - \delta_t)\beta E_t \frac{\lambda_{t+1}}{\lambda_t} \frac{\gamma}{p_{t+1}} R_{t+1} S_{t+1} \tag{3.3.33}$$

For any positive monitoring cost, financial frictions increase as expected the average cost of filling a vacancy. The evolution of credit market conditions changes the opportunity cost for resources used to create new jobs. Thus, it alters the dynamics of job vacancies. Credit spreads are a key element to understand the cyclical behavior of job creation and the general dynamics of labor markets. Agency problems on credit markets affect the performance of labor markets. And labor market conditions will be an alternative channel for transmission of monetary policy shocks that affect the cost of credit.

Wage bargaining

Once entrepreneurs decided the number of new workers they need and once they obtained a loan covering their production bill, as well as vacancies costs, they enter the labor market to post vacancies, match with unemployed workers and bargain on wages. The real hourly wage is assumed to be determined on a period-by-period basis and through a Nash bargaining between a representative entrepreneur and a representative household.

Bellman equations

The Nash real hourly wage splits by definition the joint surplus of the employment relationship between a representative entrepreneur and a representative household, depending on their respective bargaining power, η.
The discounted value of employment for a worker in terms of current consumption is given by:

$$\mathcal{W}_t^n = W_t H_t - \frac{\varepsilon_t^H H_t^{1+\tau}}{(1+\tau)\lambda_t} + \beta E_t \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\delta_t(1-q_{t+1}))\mathcal{W}_{t+1}^n + \delta_t(1-q_{t+1})\mathcal{W}_{t+1}^u \right] \quad (3.34)$$

The discounted value of a job for a worker in terms of current consumption is the sum of the total real wage earned, reduced for the marginal disutility of working and the expected discounted gain from being either employed or unemployed during the subsequent period. A worker will be again employed at the period $t+1$ if the match has not been destroyed, with a probability $(1-\delta_t)$, after the matching of the period t ; or if the match has been destroyed with the probability δ_t after the matching of the period t, but that another matching occurs at the period $t+1$ with the probability q_{t+1}. And a worker will become unemployed at the period $t+1$ if the match is destroyed after the matching of the period t and if he or she does not find a job at the period $t+1$, that to say with the probability $\delta_t(1-q_{t+1})$.

The discounted value of unemployment for a worker in terms of current consumption is given by:

$$\mathcal{W}_t^U = b + \beta E_t \frac{\lambda_{t+1}}{\lambda_t}\left[q_{t+1}\mathcal{W}_{t+1}^n + (1-q_{t+1})\mathcal{W}_{t+1}^U\right] \tag{3.3.35}$$

In the same spirit, the discounted value to be unemployed for a worker in terms of current consumption is the sum of real unemployment benefits and the expected discounted gain from being either employed (with probability q_{t+1}) or unemployed (with probability $1-q_{t+1}$) after the matching of the period $t+1$. Therefore, the worker's surplus of an employment relationship is given by:

$$\mathcal{W}_t^n - \mathcal{W}_t^U = W_t H_t - \frac{\varepsilon_t^H H_t^{1+\tau}}{(1+\tau)\lambda_t} - b + \beta E_t \frac{\lambda_{t+1}}{\lambda_t}\left[(1-\delta_t)(1-q_{t+1})(\mathcal{W}_{t+1}^n - \mathcal{W}_{t+1}^U)\right] \tag{3.3.36}$$

For a firm, the discounted value of an employed worker in terms of current consumption is defined as:

$$J_t^n = \frac{P_t^{ws}}{P_t}\frac{(1-\alpha)Y_t^{ws}}{n_t} - W_t H_t + \beta E_t \frac{\lambda_{t+1}}{\lambda_t}(1-\delta_t)J_{t+1}^n \tag{3.3.37}$$

This discounted value is equal to the current profits from an employed worker, plus the expected discounted continuation value. The job is still provided at the period $t+1$ if the match has not been destroyed with a probability $(1-\delta_t)$ after the matching of the period t. And if the job is not provided at the period $t+1$, the continuation value will be equal to zero.

Then, the discounted value of an open vacancy job for a firm in terms of current consumption is given by:

$$J_t^V = -\frac{Z_t}{P_t} + \beta E_t \frac{\lambda_{t+1}}{\lambda_t}\left[p_{t+1}J_{t+1}^n + (1-p_{t+1})J_{t+1}^V\right] \tag{3.3.38}$$

The discounted value of an open vacancy job for a firm in terms of current consumption is equal to the real total hiring costs of the vacancy job, plus the expected discounted gain to fill or not the vacant job during the following period. The vacancy job is filled at the period $t+1$ with a probability p_{t+1}, if a match occurs during the matching of this period. Otherwise, with a probability $(1-p_{t+1})$, the job remains vacant in $t+1$.

Nash bargaining and wage setting

The Nash wage bargaining consists of maximizing the net surplus of the employment relationship for a representative firm, $(J_t^n - J_t^V)$, and a representative household, $(\mathcal{W}_t^n - \mathcal{W}_t^U)$, depending on the households' bargaining power, η. As a consequence, the chosen real hourly wage is the one that maximizes[18]

$$\underset{W_t}{max} \quad (\mathcal{W}_t^n - \mathcal{W}_t^U)^{\eta}(J_t^n - J_t^V)^{(1-\eta)}$$

Since there is a free-entry condition on the labor market, at the equilibrium, $J_t^V = 0$ is satisfied. Indeed, if $J_t^V > 0$, a firm has an incentive to post vacancies as the value of a vacant job is positive. As the number of vacancies increases relative to the number of unemployed workers, the probability to fill a vacancy job, p_t, decreases. Indeed, the labor market tightness, θ_t, increases and p_t decreases since $\partial p_t/\partial\theta_t < 0$. That reduces the incentive to post vacancies and diminishes the value of J_t^V, until it equals zero. Therefore, the first-order necessary condition for the Nash bargaining solution is given by:

$$\eta J_t^n = (1-\eta)(\mathcal{W}_t^n - \mathcal{W}_t^U) \tag{3.3.39}$$

[18]Recall that by assuming an identical threshold value of entrepreneurial productivity for all wholesale firms, we keep a representative-firm context.

The following Nash real hourly wage is then obtained:

$$W_t H_t = \eta \left[\frac{P_t^{ws}}{P_t} \frac{(1-\alpha) Y_t^{ws}}{n_t} + (1-\delta_t) \frac{Z_t}{P_t} E_t(\theta_{t+1}) \right] + (1-\eta) \left[b + \frac{\epsilon_t^H H_t^{1+\tau}}{(1+\tau)\lambda_t} \right] \quad (3.3.40)$$

The wage shares costs and benefits from the match between workers and entrepreneurs according to the parameter η. Workers are compensated for a fraction $(1-\eta)$ for the disutility they suffer from supplying hours of work and for the foregone unemployment benefits. And they obtain a fraction η of the firm's revenues, as well as a fraction η of the firm's saving of total hiring costs, depending on the probability that the match will not be destroyed exogenously until the end of the period t and the expected labor market tightness of period $t+1$. If the matching is broken, workers and entrepreneurs have to look for another partner in the next period, which is costly. This cost is thus incorporated in the wage.

The wholesale-good production takes place, once capital and labor inputs are obtained. The production process is then split into two other sectors, as standard in medium scale DSGE models, a competitive final goods sector and a monopolistically competitive intermediate goods sector, that use wholesale goods as inputs.

3.3.4 Intermediate and final-good production

Final-good firms proceed in a perfectly competitive market and are owned by households. They purchase a continuum of differentiated intermediate goods indexed by $j \in [0,1]$ and aggregate theses varieties to produce Y_t units of final good. They have no other cost, except the one to buy to intermediate-good firms the different varieties.

Final goods are produced using a standard constant return to scale technology given by:

$$Y_t = \left[\int_0^1 Y_{j,t}^{\frac{\epsilon_t - 1}{\epsilon_t}} dj \right]^{\frac{\epsilon_t}{\epsilon_t - 1}} \quad (3.3.41)$$

where $\epsilon_t > 1$ is a time-varying parameter governing the degree of monopolistic competition in the intermediate good sector (or the time-varying elasticity of substitution between intermediate goods). It follows an exogenous first-order auto-regressive process:

$$\log(\epsilon_t) = (1-\rho_\epsilon)\log(\bar{\epsilon}) + \rho_\epsilon \log(\epsilon_{t-1}) + u_t^\epsilon, \quad \rho_\epsilon \in [0,1) \text{ where } u_t^\epsilon \overset{iid}{\sim} N(0,\sigma_\epsilon^2) \quad (3.3.42)$$

$\bar{\epsilon}$ is the steady-state value for the degree of monopolistic competition, ϵ_t.

Each competitive final-good firms choose their own input demand functions for each variety of intermediate goods, $Y_{j,t}$, so as to maximize their nominal profit, Π_t, defined as:

$$\Pi_t = P_t Y_t - \int_0^1 P_{j,t} Y_{j,t} dj$$

where P_t is the bundler's technology price-index that corresponds to the consumer's price index. The solution to the maximization problem[19] yields the following demand function for the intermediate good of variety j:

$$Y_{j,t} = \left[\frac{P_{j,t}}{P_t}\right]^{-\epsilon_t} Y_t \quad (3.3.43)$$

So, the demand for each variety of intermediate good is a downward sloping demand curve, which gives to the intermediate-good firms some pricing power.

Then, as we are in a competitive setting, the zero-profit condition applies at the equilibrium for final-good firms and it yields:

$$P_t Y_t = \int_{j=0}^1 P_{j,t} Y_{j,t} dj$$

From this condition, the output price or the consumer's price index can be easily derived by plugging the demand function into the zero-profit condition:

$$P_t Y_t = \int_{j=0}^1 P_{j,t} \left(\frac{P_{j,t}}{P_t}\right)^{-\epsilon_t} Y_t dj$$

[19] Final-good firms maximize their expected stream of profits, which is equivalent to maximizing their profit period by period since they purchase intermediate goods at the same frequency.

which gives:

$$P_t = \left[\int_{j=0}^{1} P_{j,t}^{(1-\epsilon_t)} dj\right]^{\frac{1}{1-\epsilon_t}} \tag{3.3.44}$$

For the production of the intermediate good, there is a continuum of monopolistically competitive retailers. These retailers are owned by households. They buy from entrepreneurs homogeneous wholesale goods at the price P_t^{ws}. They differentiate costessly each unit of these goods into a unit of retail goods, $Y_{j,t}$. These firms are assumed to have no other inputs or costs than the homogeneous good. Following Yun (1996), Christiano et al. (2005) and Trigari (2009), a price stickiness for these firms is formulated in the spirit of Calvo (1983). Every period, only a random fraction $(1-\varrho) \in [0,1)$ of firms is able to fully re-optimize their nominal prices knowing the aggregate shock, A_t. The hazard rate, ϱ, is constant across firms and time. And prices are thus fixed on average for $\frac{1}{1-\varrho}$ periods. The remaining fraction of firms does not re-optimize their prices and following Christiano et al. (2013), they keep their prices unchanged. So the price set by a retailer j, $P_{j,t}$, corresponds to:

$$P_{j,t} = \begin{cases} P_{j,t-1} \ \text{ with probability } \ \varrho \\ P_t^* \ \text{ with probability } \ 1-\varrho \end{cases} \tag{3.3.45}$$

where P_t^* is the optimal price set by the fraction ϱ of retailers who are able to re-optimize their prices at time t. Note that P_t^* does not depend on j because all firms that can re-optimize their prices at time t choose the same price as they are assumed to be symmetric (find a justification Yun 1996 or Woodford 1996 may be). Then, for firms not able to re-optimize their prices, there is no price indexation to replicate the observation that many prices can remain unchanged over time (Eichenbaum, Jaimovich and Rebelo, 2011 and Klenow and Malin, 2011). So, the price index, P_t, is thus given by:

$$P_t = \left[\int_0^1 P_{j,t}^{1-\epsilon_t} dj\right]^{\frac{1}{1-\epsilon_t}} = \left[(1-\varrho)(P_t^*)^{1-\epsilon_t} + \varrho(P_{t-1})^{1-\epsilon_t}\right]^{\frac{1}{1-\epsilon_t}} \tag{3.3.46}$$

The price index is a CES aggregate of all retail goods prices in the economy at t. The sum in equation (3.3.46) can then be transformed into a convex combination of two prices because firms of each type are assumed to be respectively symmetric. A costless price regulation mechanism is assumed, which guarantees that a consumer pays the same price whatever the firm at which he realizes his purchases[20]. So, the uniform price index corresponds to a weighted average price of the fraction ϱ of firms who can re-optimize their prices after the aggregate shock, A_t, and the fraction $(1-\varrho)$ of firms who can not.

Firms that can re-optimize their price, maximize the expected discounted value of their profits given the demand for the good they produce, since firms expect to keep this price for more than the current period. They take into account that the price may be fixed for many periods. If the expected probability of price stickiness is high, firms able to re-optimize their price at the period t will be relatively more concerned about the future when they make their current pricing decisions.
Thus, these firms face the following problem, subject to the total demand (3.3.43) it faces:

$$\max_{P_{j,t}} \quad E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} \left[\left(\frac{P_{j,t}}{P_{t+s}} \right)^{1-\epsilon_t} Y_{t+s} - \left(\frac{P_{j,t}}{P_{t+s}} \right)^{-\epsilon_t} \left(\frac{P^{ws}_{t+s}}{P_{t+s}} \right) Y_{t+s} \right]$$

Note that ϱ is integrated in the discount rate because there is a probability ϱ^s that the price chosen is still applied in s periods time.

The first-order condition of the problem is given by:

$$E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} P_{t+s}^{(\epsilon_t - 1)} Y_{t+s} \left(\epsilon_t P^{ws}_{t+s} P^{*(-\epsilon_t - 1)} + (1-\epsilon_t) P_t^{*(-\epsilon_t)} \right) = 0$$

The optimal price, P_t^* , sets by firms who are able to re-optimize their prices is thus given by:

$$P_t^* = \frac{\epsilon_t}{\epsilon_t - 1} \frac{E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} P^{ws}_{t+s} P^{\epsilon_t}_{t+s} Y_{t+s}}{E_t \sum_{s=0}^{\infty} (\varrho\beta)^s \frac{\lambda_{t+s}}{\lambda_t} P^{\epsilon_t - 1}_{t+s} Y_{t+s}} \tag{3.3.47}$$

The mark-up depends negatively on the time-varying elasticity of substitution, ϵ_t.

Flexible-price firms set their price such that it equals the present discounted value

[20] The matching of consumers and firms is ignored.

of marginal costs. The optimal price is a markup over a weighted average of future marginal costs. The size of the markup depends on the elasticity of the demand to the price. If there is no price-stickiness, $\varrho = 0$, the monopoly standard mark-up formula is obtained:

$$P_t^* = \frac{\epsilon_t}{\epsilon_t - 1} P_{t+s}^{ws}, \qquad \text{where } \frac{\epsilon_t}{\epsilon_t - 1} > 1 \tag{3.3.48}$$

The final-good market clearing condition implies that final goods, Y_t, may be consumed by households, C_t, and entrepreneurs, C_t^e, or be used as investment, I_t, as government expenditures, G_t, or as capital utilization costs, $\Upsilon(\nu_t)K_{t-1}^p$. The following aggregate resource constraint is thus obtained:

$$Y_t = C_t + C_t^e + I_t + G_t + \Upsilon(\nu_t)K_{t-1}^p \tag{3.3.49}$$

3.3.5 Entrepreneurs

Entrepreneurs own wholesale-good firms. At the beginning of period t, they borrow from banks to cover hiring costs, wage bill and renting capital because they have to pay them prior to the production. Then, after receiving the amount borrowed from the bank, they rent and pay immediately capital from households on a perfectly competitive capital market. At the same time, vacancies are posting and matches take place with workers. Entrepreneurs pay also immediately vacancies costs and wages of workers hired and of workers already hired at previous periods. Finally, after the wholesale-good sale, some entrepreneurs will be declared solvent or bankrupt, depending on their production and idiosyncratic shock levels. Entrepreneurs declared bankrupt are not able to reimburse their entire loan. The bank will confiscate the proceeds of the production. As a consequence, bankrupted entrepreneurs will not consume, nor accumulate net-worth. But at the beginning of the next period $t + 1$, entrepreneurs are assumed to receive an exogenous endowment, W^e, which will be used as collateral or net worth to borrow from banks at the beginning of the next period, in order to be sure that this kind of agents, specialized in managing production, will be able to continue their activities. Entrepreneurs declared solvent reimburse their entire loan to banks. Then, they have to wait the production of the final good to consume or accumulate a net worth. To ensure that entrepreneurs do not accumulate net worth, such that they could be able to self-finance their production at the next period, we assume that each entrepreneur has a constant probability, $1 - \varsigma$, to die at the end of the period. It will limit the size of aggregate net worth in an infinite horizon set up. Indeed, since the rate of return on internal funds is higher than the one of external funds, due to asymmetric information on credit markets, risk neutral entrepreneurs may be willing to postpone consumption and would only accumulate funds.

So solvent entrepreneurs who exit the economy at the end of the period will consume all their net worth. Thus, the aggregate entrepreneurial consumption, C_t^e, is given by:

$$C_t^e = (1 - \varsigma_t)\frac{P_t^{ws}}{P_t}Y_t^{ws} f(\bar{\omega}_t) \tag{3.3.50}$$

To be sure however to have a constant fraction of entrepreneurs in the economy in every period, we assume that the birth of rate of entrepreneurs at the beginning of each period ensures this constant fraction.

Solvent entrepreneurs who do not exit the economy at the end of the period will keep accumulating net worth using their realized return. Consequently, the evolution of the aggregate entrepreneurial real net worth is given by:

$$X_{t+1} = W^e + \varsigma_t \frac{P_t^{ws}}{P_t}Y_t^{ws} f(\bar{\omega}_t) \tag{3.3.51}$$

Thus, ς_t is interpreted as a shock to entrepreneurs' net worth. It evolves according to:

$$\varsigma_t = \bar{\varsigma}\epsilon_t^{\varsigma} \tag{3.3.52}$$

$$\log(\epsilon_t^{\varsigma}) = \rho_{\varsigma}\log(\epsilon_{t-1}^{\varsigma}) + u_t^{\varsigma}, \quad \rho_{\delta} \in (0,1) \text{ where } u_t^{\varsigma} \overset{iid}{\sim} N(0, \sigma_{\varsigma}^2)$$

where $\bar{\varsigma}$ is the steady state value of the shock to entrepreneurs' net worth, ς_t.

3.3.6 Monetary and fiscal policy

Monetary policy

The monetary policy is decided and carried out by the central bank following an interest rate Taylor-type rule[21]. The nominal interest rate of each period will be set depending on deviations in output, inflation and nominal interest rate from their steady-state level:

$$\frac{R_{t+1}}{\bar{R}} = \left(\frac{R_t}{R}\right)^{\rho_r} \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\rho_\pi} \left(\frac{Y_t}{\bar{Y}}\right)^{\rho_Y}\right]^{1-\rho_r} \epsilon_t^R \tag{3.3.53}$$

where ρ_R is the degree of interest rate smoothing, ρ_Y and ρ_π are the response coefficients to output and inflation variables and variables without a time subscript are steady state values. ϵ_t^R is the monetary policy shock, following a first-order auto-regressive process:

$$\log(\epsilon_t^R) = \rho_R \log(\epsilon_{t-1}^R) + u_t^R, \quad \rho_R \in (0,1) \text{ where } u_t^R \overset{iid}{\sim} N(0, \sigma_R^2)$$

R_{t+1} is the interest rate decided today by the central bank, that will pay off in period $t+1$. So this interest rate is known at time t. Then, knowing this nominal interest rate, the central bank adjusts the money supply so as to achieve the equilibrium in the money market.

Fiscal policy

The fiscal policy is decided and carried out by the government at the end of the period t. After the final-good production, households pay nominal lump-sum taxes, T_t, to the government. Then, we assume that the government earns mainly revenue through printing of real money. Central bank returns this revenue back to the fiscal authority. With these taxes and seignoriage revenue, $\frac{M_{t+1}-M_t}{P_t}$, the government finance the real exogenous government spending, G_t, and the amount of real unemployment benefits, $(1-n_t)b$, for unemployed workers. The level of the unemployed is known by the government at the end of the matching process on the labor market.

[21]The same kind of Taylor rule is used by Gertler et al. (1999), Krause et al. (2008) and Trigari (2009).

So the government budget constraint is the following:

$$G_t + (1 - n_t)b = \frac{T_t}{P_t} + \frac{M_{t+1} - M_t}{P_t} \tag{3.3.54}$$

where G_t is the exogenous government spending, which obeys to:

$$G_t = (1 - \frac{1}{\epsilon^G})Y_t \tag{3.3.55}$$

3.4 Model simulation

We proceed to simulate the non linear model above relying on a first order approximation around the non-stochastic steady state. First, we calibrate the model using a standard approach in the literature in order to fix the set of parameters and compute the steady state. Then, we examine the impulse response functions of the economy to a one standard deviation of shocks stemming from the credit market. The first result is the impact of a positive to the entrepreneurs' net worth. The second experience is an exogenous positive shock to the monitoring cost in the credit market and the last one is a positive shock to the standard deviation of the entrepreneurial idiosyncratic shock. We start by discussing the calibration and the choice of different values for the parameters.

3.4.1 Calibration

The household discount factor, β, is set to 0.99 implying an annual real interest rate of 4 percent. The capital depreciation rate, δ_K, is fixed to 0.025 corresponding to an average annual depreciation rate of 10 percent. For the wholesale-good sector, the capital share in output, α, is standard and equals to 0.36. This value is based on calculation of Kydland and Prescott (1982) using US time series data.

Following Shimer (2004) and Petrosky-Nadeau (2014), the elasticity of matches to unemployment, ρ, is set to 0.72 as in This value is almost within the range of values of 0.5 to 0.7 reported by Petrongolo and Pissarides (2001) in their survey of the literature on the estimation of the matching function[22].

The inverse of the elasticity of worked hours to real hourly wage (or the inverse of the Frish elasticity), τ, is equal to 10 as in Trigari (2009), who has extensive and intensive margin in her paper.

The external habit persistence parameter is fixed to 0.5 as in Gertler et al. (2008). For the intermediate-good sector, the monopolistic mark-up or the elasticity of substitution across inputs, ϵ , is fixed to 11 to have a conventional price-mark-up on marginal costs at 10 percent as in Walsh (2005) and Trigari (2009). The Calvo stickiness of prices, ϱ, is set to 0.66 as in Gertler et al. (2008).

Regarding the credit market side, the entrepreneurial survival rate is equal to 0.9728 in line with Bernanke and Gertler (1995a) and Zanetti and Mumtaz (2011). The gross external finance premium, s_1, is set to 5.84, as in Petrosky-Nadeau (2014).

Regarding the labor market side, the conventional value, 0.5, is given to the bargaining power, η, as in Gertler et al. (2008). The vacancy posting cost, γ, is set to 0.147, as in Petrosky-Nadeau (2014). The destruction rate parameter is set to 0.06 according to Petrosky-Nadeau (2014). It is compatible with those used in the literature which range from 0.07 in Merz (1995) to 0.15 in Andolfatto (1996). Finally, the unemployment benefits, b, is equal to 0.71 as in Petrosky-Nadeau (2014).

For the Taylor rule, conventional value are also taken. The interest rate smoothing coefficient, ρ_R, is set to 0.75. Coefficients for the responses of interest rate to inflation, ρ_π and to the output gap as in are fixed respectively to 1.7 and 0.125 as in Gertler et al. (2008).

Table 3.1: Baseline calibration

[22]Others values are used such as 0.4 in Blanchard and Diamond (1989), Merz (1995), Andolfatto (1996) and Mortensen and Nagypal (2007) or 0.5 in Gertler et al. (2008).

Parameter	Value	Description
Preferences		
β	0.99	Households discount factor
Technology		
α	0.36	Capital share in production
δ_K	0.025	Capital depreciation rate
σ_A	5	Cost of capital utilization
κ	4	Investment adjustment cost
Preferences		
ϵ_M	1.9	Matching function parameter
τ	10	Inverse of the Frisch labor supply elasticity
h	0.5	External habit persistence
Job market		
ρ	0.72	Elasticity of matches to unemployment
γ	0.147	Unit cost of job vacancies
δ	0.06	Job destruction rate
b	0.71	Unemployment benefits
η	0.5	Bargaining power
Entrepreneurs and financial market		
s_1	5.84	Marginal monitoring cost
$\bar{s}_0$	7.3678	Marginal monitoring cost
$\bar{\varsigma}$	0.04	Entrepreneurs exit rate
W^e	0.01	Entrepreneurial endowment
Intermediate-good market		
ϱ	0.66	Calvo stickiness of prices
Monetary and fiscal policy		
ρ_A	0.95	Aggregate shock persistence
ϵ^G	1/0.8	Government expenditure share
ρ_ς	0.97	Wealth shock persistence

ρ_{s0}	0.95	Credit shock persistence
ρ_{ω}	0.97	Uncertainty shock persistence
ρ_R	0.75	Interest rate smoothing coefficient
ρ_{π}	1.7	Response to inflation
ρ_Y	0.125	Response to output

3.4.2 Financial shocks and Labor market

Impulse responses to a wealth shock

We study the impact of a one standard deviation positive shock to the entrepreneurs' net worth. According to our model, it corresponds to a positive increase in ς_t. The aggregate real net worth raises as the probability of dying for each entrepreneur decreases. A positive net worth shock is interpreted as a wealth shock since all entrepreneurs accumulate their actual profits as a part of their future self-financing capacity. A positive shock means that they will carry on to the next period $t+1$ a higher real amount of net worth. Based on this net worth amount and their expected production and returns, entrepreneurs borrow funds from banks to post vacancies, to pay capital spending and the wage bill in advance. So the net worth is a mean for entrepreneurs to lower the external finance cost.

Figure (3.6) shows impulse responses to a positive one standard deviation net worth shock. According to our simulation exercise, firstly, an increase in the aggregate real net worth has a positive effect on the financial sphere. By a positive effect, we mean that it decreases the financial mark-up, highlighting a financial accelerator mechanism. The higher is the level of the aggregate real net worth, the lower is the financial markup charged by banks to entrepreneurs, as found by Zanetti and Mumtaz (2011). As a consequence of the real aggregate net worth increase and of the financial markup decrease, the default rate is also decreasing. The decline of the cost of credit induces an increase in the gross share of returns going to the firm according to our model.

These results on the financial sphere will impact the real sphere of the economy, especially the labor market. An increase in the aggregate real net worth of

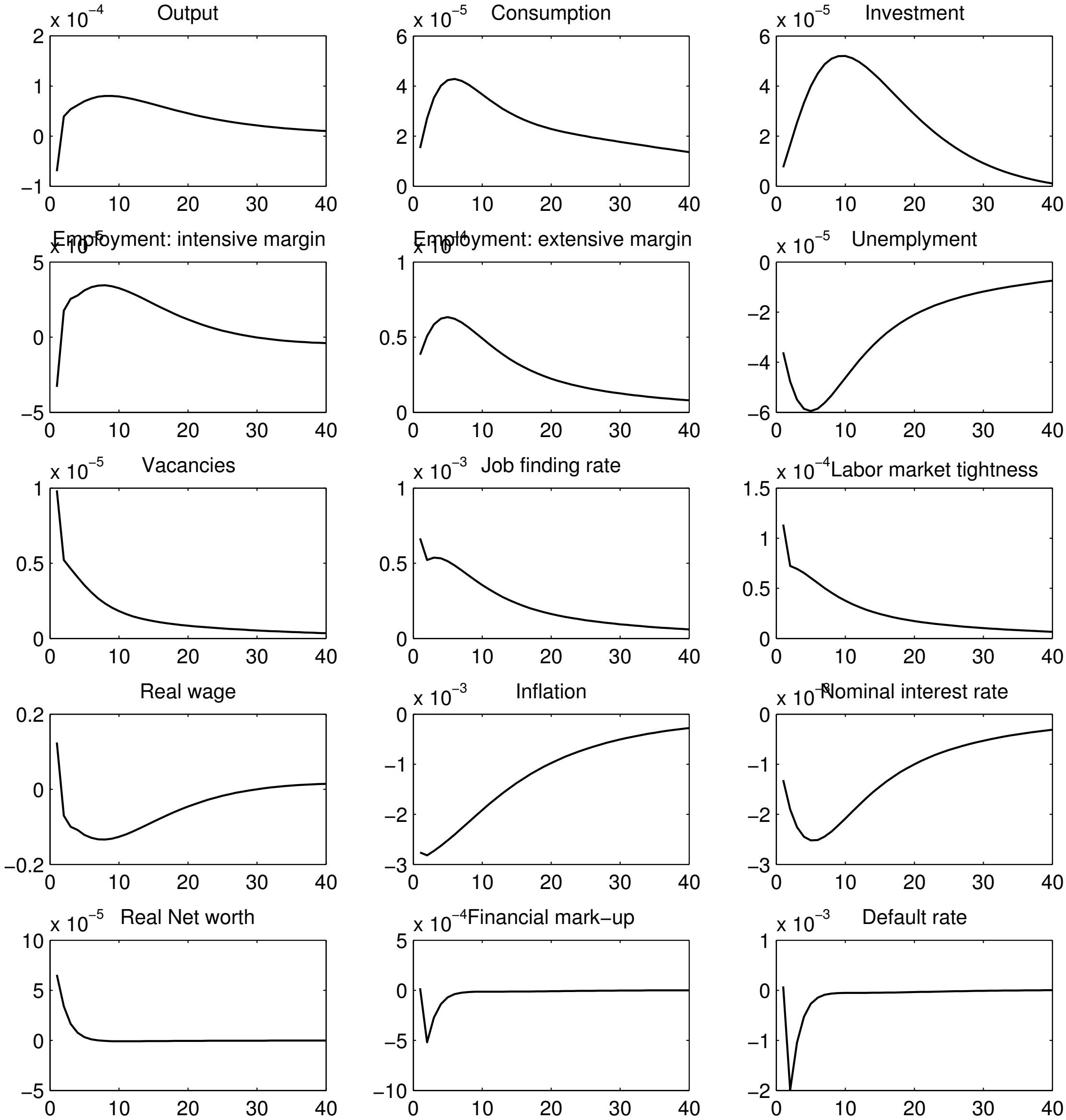

Figure 3.6: Impulse responses to a positive wealth shock

entrepreneurs leads to a decrease in the unemployment rate, following a decreasing hump-shaped function, thanks to an fall in their financing costs. Indeed, entrepreneurs are now able to finance by themselves a higher part of their production and vacancies costs, and are willing to expand their production activity since the financial markup charged by banks declines. So the aggregate real wholesale firm's marginal costs are reduced according to our model. This reduction induces entrepreneurs to post more vacancies, and the unemployment rate decreases as a consequence, as found in the estimation of Zanetti and Mumtaz (2011). The job finding rate for workers increases as expected and the labor market tightness from the firm's point of view decreases.

It is noteworthy to mention the existence of a substitution effect between hours worked per employee and the amount of employed workers. It is a clear substitution effect between the extensive and the intensive margins of employment. This results is found also by Christiano et al. (2011) when they estimated a DSGE model with unemployment. This phenomenon highlights the interaction between intensive and extensive margins on labor markets. As a consequence of the easing of financing costs, entrepreneurs are willing to hire more workers, but they decrease their demand for hours worked per employee. This fact is also observed in data; extensive margin is indeed more reactive than the intensive margins when the economy is hit by a shock.

Furthermore, wages constitute another channel through which shocks to the financial market are transmitted to the labor market. An easing in financial constraints increases the labor market tightness from the firm's point of view. And the reduction in aggregate real marginal costs passes through prices according to our model, leading to a lower inflation rate as observed in the simulation exercise. These two facts contribute to an increase of the real wage in the economy. However, these results are not found in the estimation of Zanetti and Mumtaz (2011). It could be linked to the fact they integrate only the capital stock as the production cost to pay in advance.

Obviously, the previous results on the financial sphere have also an impact on goods' market. An increase in the net worth of entrepreneurs generates a positive hump-shaped response of consumption, through according to our model, the higher wages, more vacancies posted and less unemployment. The net worth positive shock induces also a positive hump-shaped response, larger than the one for consumption, of investment. This increase in investment can be explained by our model as the consequence of more employed workers and higher wages for households that are able to invest more, and through a higher demand for capital expressed by entrepreneurs, as net worth and financial mark-up decrease (Zanetti and Mumtaz (2011)). The conjunction of higher consumption and higher investment leads to an increase of output, after a first decrease, possibly due to the existence of investment adjustment costs and higher wages.

So the economy is better off, at least in terms of consumption and employment, when all firms are able at the aggregate level to self-finance a higher part of their production and vacancies costs. Financial frictions are indeed less at stake as a consequence, through a decrease in the amount of loans demanded by firms and a decrease in the level of marginal costs, realized by a lower financial mark-up. The most important impact appears to be on the labor market, where vacancies increase and unemployment rate decreases, as expected by our model.

Impulse responses to a credit shock

A positive credit shock is realized in the economy through a positive shock to the process $s_{0,t}$ that can be interpreted as a decrease of the marginal monitoring costs, μ_t. More precisely, the recovery rate defined in our model following (Livdan et al. (2009)) and (Petrosky-Nadeau (2014)) increases (so the monitoring cost decreases), by an increase of $s_{0,t}$, interpreted as a credit shock. Recall that in our model monitoring costs appear because wholesale-good production is subject to an idiosyncratic shock, observed privately by entrepreneurs. Thus, banks have to pay a monitoring cost, when bankruptcy occurs, to check the real output produced and the efficiency of the recruitment process. This monitoring cost is assumed to be proportional to the realized firm's value. Furthermore, it is spent in terms of currency.

Figure (3.7) shows impulse responses to a positive credit shock. As for the net worth shock, a positive credit shock has an impact on the financial sphere. A decrease of the monitoring cost leads to a reduction of the default rate. It was strongly expected as in our model, the monitoring cost spending is a direct synonym of bankruptcy. The lower are the monitoring costs, the lower is the default rate according to our framework. Then, the positive credit shock leads to a reduction of the financial markup charged by banks to entrepreneurs. It could be easily explained through our model by the

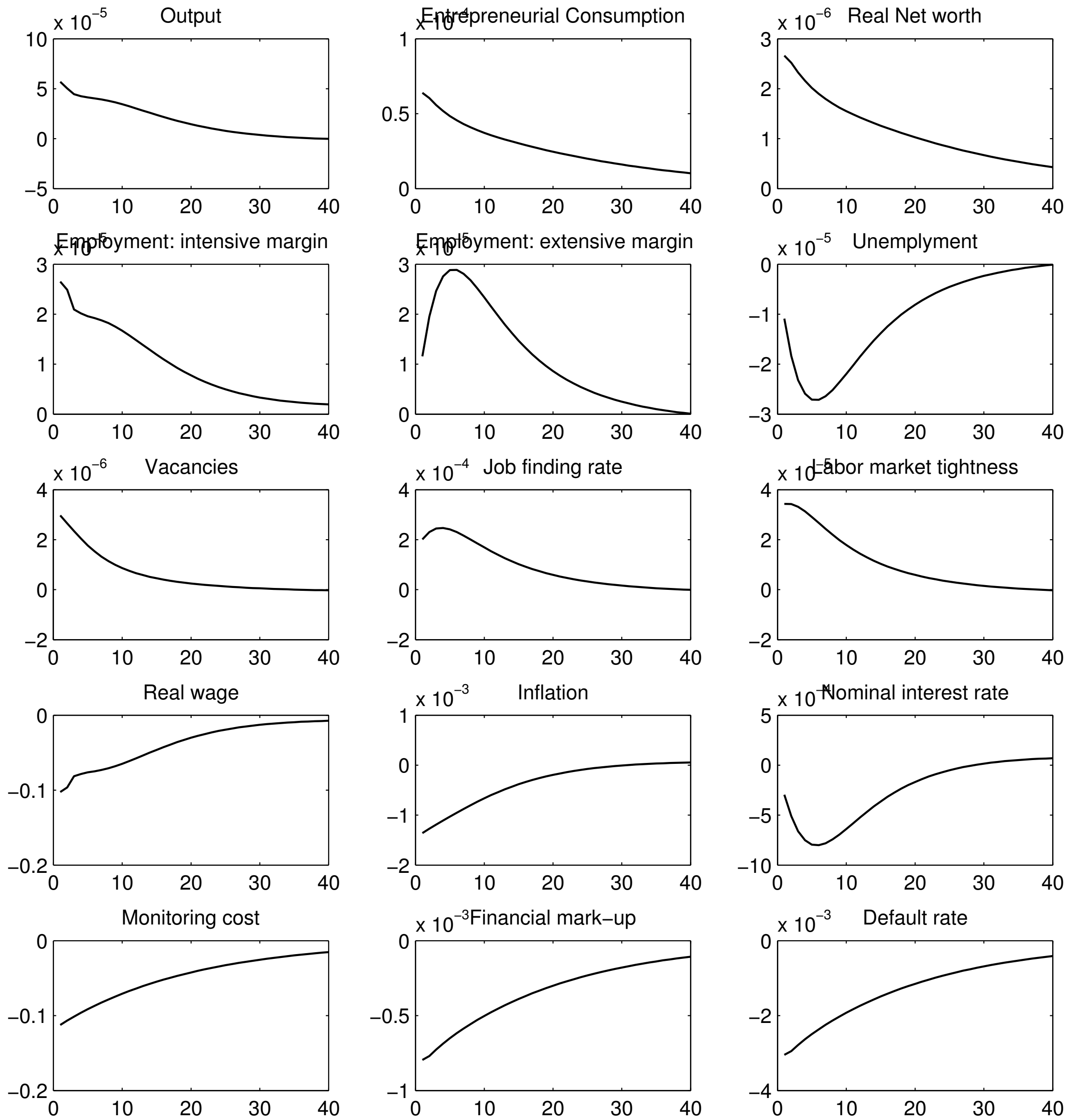

Figure 3.7: Impulse responses to a positive credit shock

expression of the financial markup S_t that depends negatively on the recovery rate. A positive credit shock means that the recovery rate for banks increases. The proportion of the real amount recovered by banks is higher. So banks do not need to charged, everything else equal, the same amount of financial mark up to entrepreneurs.

For the real part of the economy, following our model, the agency problem between banks and entrepreneurs alter the real recruitment cost and the marginal cost of production for wholesale firms. We observe in our simulation exercise that it is the case: a positive credit shock induces an increase of vacancies and a decrease of unemployment, following a negative hump-shaped with a peak at one year and half. Petrosky-Nadeau (2014) finds in the same spirit following a negative credit shock a positive hump-shaped for unemployment with a peak just over a year after the shock, that is considered as comparable to the results of Jermann and Quadrini (2012), but with a specific insight into the labor market. So, lower marginal costs, thanks to lower financial mark up, induce firms to recruit more, to post more vacancies. The labor market tightness from the firm point of view increases, and the job finding rate for households increases as a consequence, as in Petrosky-Nadeau (2014). In our model, we find as well that the slope of the real posting cost raises with the monitoring costs. The real cost of a new hire raises with monitoring costs, everything else equal.

The substitution effect between hours worked per employee and number of employed workers does not appear here after a positive credit shock. On the contrary, a complementary effect is observed: employed workers are more, and each of them are working more. That is a first reason why we could observe a positive impact on the output compared to the previous case.

Concerning the output, in the model, we assume that the monitoring cost spending, synonym of bankruptcy is spent in nominal terms, and not in terms of physical goods. Bankruptcy has no direct impact on the real output. However, the simulation shows a clear indirect impact on output. Indeed, monitoring costs are additional costs taken into account by banks when agreeing on an appropriate interest rate on loans. A reduction in monitoring costs and bankruptcy rates has an impact on welfare indirectly, through their implications on the mark up pricing. The simulation illustrates this phenomenon: the decrease in monitoring costs reduce real marginal costs of firms, reducing the level of inflation in the economy, as well as the level of nominal interest rate. It generates an increase in consumption and investment that in turns increase the output level. Then, a slow decrease in the level of the real wages can be observed probably as the consequence of the inflation rate decrease.

Finally, the entrepreneurial consumption and the aggregate real net worth increases as a consequence of the reduction of the monitoring cost, and of marginal costs. Solvent dying and not dying entrepreneurs have indeed a larger share of the net output to consume and to save to the next period.

Thus, a positive credit shock pushes down marginal costs and prices, as well as hiring costs by a financial mark-up, depending on the level of monitoring cost. A reduction of monitoring costs in an economy has a strong impact on the vacancies and employment levels, as expected in our model.

Impulse responses to uncertainty shock

An uncertainty shock is defined as a variation in the standard deviation of the idiosyncratic productivity shock of entrepreneurs . According to our model, this variance is interpreted as the entrepreneurs' riskiness for banks. As a consequence, banks are facing a higher risk when they decide to lend to entrepreneurs. Recall that in our model, banks do not observe firm's idiosyncratic shocks, but they only know the cumulative and density functions of these idiosyncratic shocks.

Figure (3.8) shows impulse responses to a positive uncertainty shock. As expected, after an increase in the level of uncertainty for banks about the idiosyncratic shock of firms, banks charge a higher financial mark-up to protect themselves against the asymmetric information. The default rate increases in quite huge proportion, due to the increase of uncertainty in the economy, and due to the increase in the financial mark-up that raises firm's real marginal costs.

On the real side of the economy, a higher uncertainty decreases employment, output, consumption and investment. As a consequence, labor market tightness from the workers point of view increases. Indeed, firms are posting fewer vacancies. The reason is linked to the increase of the financial mark-up. After an increase in the level of uncertainty, according to our model, the increase of the financial markup is

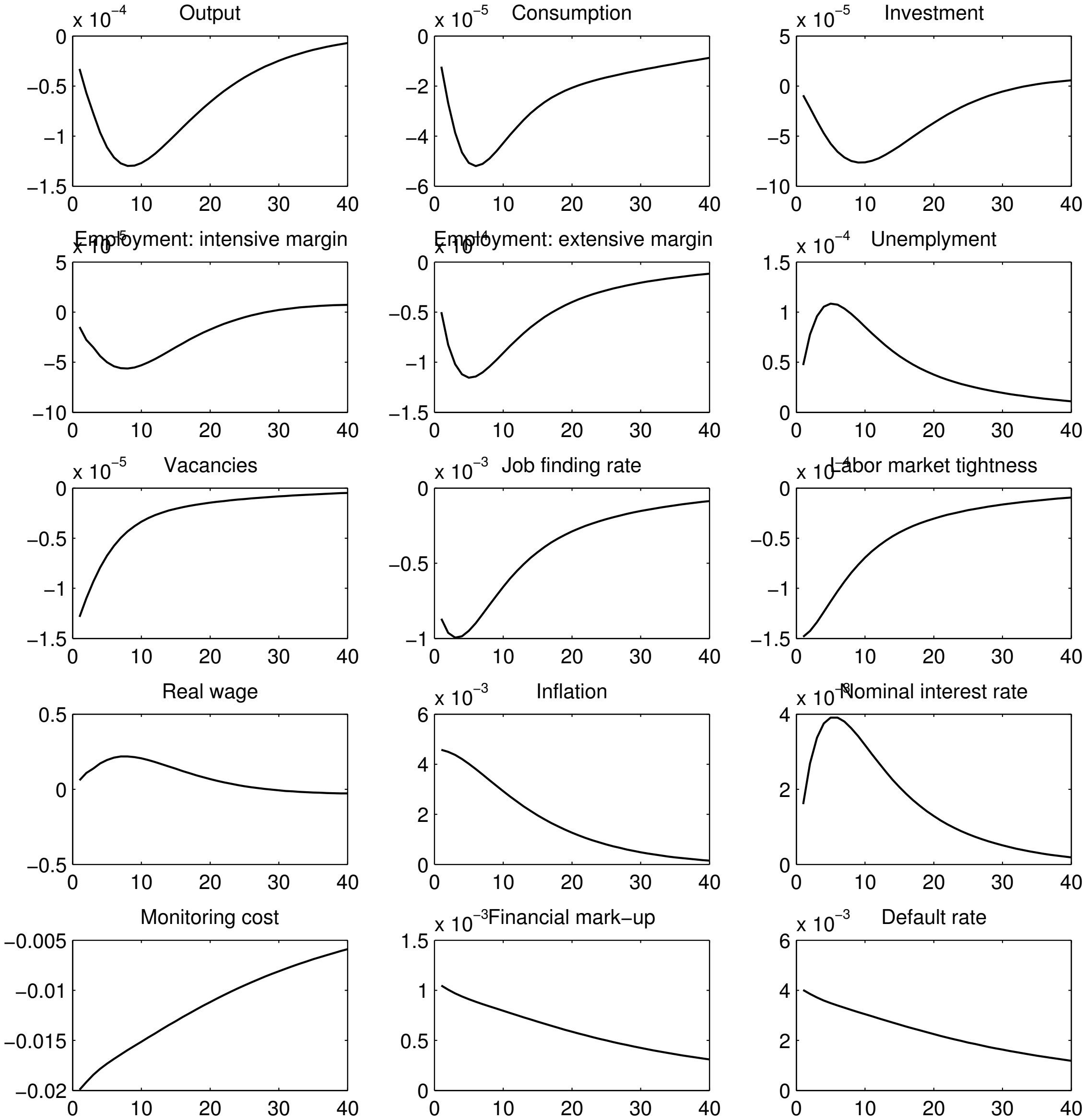

Figure 3.8: Impulse responses to positive uncertainty shock

passing through real marginal costs and prices in the economy. Firms are induced to post fewer vacancies, to hire fewer workers because of this increase in financing costs. Furthermore, inflation increases, as well as the nominal interest rate. Intensive and extensive margins appear here to move in the same direction. Hours worked per employee decrease also. So, fewer workers are employed in the economy and each employed workers are working less. According to our model, it could explain why consumption and investment are going down. Households have a less amount of resources to invest and the demand for capital by firms decreases, due to the increase in the financial mark up.

Thus, the economy reaches a negative position after an increase in the uncertainty concerning the idiosyncratic shock of wholesale firms. Facing higher risks, banks need, to overcome the agency problem they face with entrepreneurs, to increase the financial markup that they charge to them. The real marginal financing costs of entrepreneurs increase. It reduces as a consequence the value of a new hire, and leads to lower vacancies. The unemployment goes down. Furthermore, the higher marginal costs are pass through prices to the rest of the economy, leading to higher inflation, less consumption, and less output.

By moving three dimensions involving different degrees of financial frictions, we observe through our simulation exercise a clear impact from the financial market to the labor market. Increasing asymmetric information in financial markets (through higher monitoring costs, higher uncertainty or lower entrepreneurial net worth) leads clearly to higher unemployment in the economy, through different channels. These channels converge all to the role of the financial mark-up that is charged by banks to overcome agency problems. This financial mark-up is pass through the rest of the economy by higher marginal costs, and higher inflation. That in turn reduces the levels of vacancies posting, employment, wages and consumption, and finally, the level of output. The evolution of credit market conditions changes the opportunity cost for resources used to create new jobs. Thus, it alters the dynamics of job vacancies and unemployment. For our three shocks, the unemployment jumps up or goes down to its highest level in the first period and then slowly converges back to its steady state level.

3.5 Conclusion

We construct a new-Keynesien DSGE model integrating sticky prices, asymmetric information in the credit market and a search, matching, wage-bargaining framework the labor market. We find that credit market frictions may be the source of lower posting vacancies and higher unemployment level. Asymmetric information pushes up wholesale firms' marginal costs, as well as hiring costs by a financial mark-up charged by financial intermediaries. The impact of credit market imperfections operates through different channels. Any shock originating in the credit market that contributes to the increase of the financial mark-up is transmitted by these firms through prices. Thus, it affects their hiring behavior, as well as wage and employment levels in the economy. Then, we simulate the model after calibrating it to the US economy. We consider three shocks: a net worth shock, a credit shock and an uncertainty shocks. The first one is an exogenous and instantaneous increase of the net worth, while the second is a decrease of the marginal monitoring cost and the third is just an increase of the standard deviation of the entrepreneurial idiosyncratic productivity shock. We find that employment rates and vacancies posting increase following one of theses shocks. Moreover, there a substitution effect between the extensive and the intensive margins inducing to a decrease of unemployment. The fall of unemployment is more important and persistent when the shock is a wealth shock. It last fore more than 45 quarters. All the shocks seem to be transmitted trough prices. The main channels of propagation from the financial sphere of the economy to the labor market are investigated and appear to be consistent with our theoretical model.

Appendices

Appendix A

In this appendix, we prove that $S_t > 1, \quad \forall\ \bar{\omega} \in [0, \infty)$, where $S_t = \{1 - \mu_t[\Gamma(\bar{\omega}_t) + \bar{\omega}_t h(\bar{\omega}_t) f(\bar{\omega}_t)]\}^{-1}$.

Using the assumption that $\bar{\omega}_t h(\bar{\omega}_t)$ is increasing in $\bar{\omega}_t$ and taking derivatives, we obtain

$$S_t' = \frac{\mu_t}{1 - \Phi(\bar{\omega}_t)} \frac{d(\bar{\omega}_t h(\bar{\omega}_t))}{d\bar{\omega}_t} \frac{1}{S_t^2} > 0.$$

Given this result, S_t is an increasing function of $\bar{\omega}_t$.

Now taking limits of $\Gamma(\bar{\omega}_t)$ and $\bar{\omega}_t h(\bar{\omega}_t) f(\bar{\omega}_t)$ at the lower bound of $\bar{\omega}$, we get

$$\lim_{\bar{\omega} \to 0} \Gamma(\bar{\omega}_t) = 0, \qquad \lim_{\bar{!} \to 0} \bar{!}_t \mathrm{h}(\bar{!}_t) \mathrm{f}(\bar{!}_t) = 0$$

Thus, $\lim_{\bar{\omega} \to 0} S_t = 1$.

Combining the previous results, $S_t \geq 1, \ \ \forall\, \bar{\omega} \in [0, \infty)$.

Appendix B: Log-normal distribution and financial contract

Financial contract: Technical issues

The idiosyncratic shock ω_t has a log-normal distribution with mean 1 and standard error $\sigma_{\omega,t}$. In order to resolve the model numerically, some simplifications and analytic expressions regarding $f(\bar{\omega}_t, \sigma_{\omega,t})$, $g(\bar{\omega}_t, \sigma_{\omega,t})$ and $S(\bar{\omega}_t, \sigma_{\omega,t})$ are needed. Since $E(\omega_t) = 1$ and $V(\omega_t) = \sigma^2_{\omega,t}$, then the parameters of the log-normal distribution are given by $\Big(-0.5 \ln(1 + \sigma^2_{\omega,t}), \ln(1 + \sigma^2_{\omega,t}) \Big)$. So that the density function $\phi(\omega_t, \sigma_{\omega,t})$ can be expressed by:

$$\phi(\omega_t, \sigma_{\omega,t}) = \frac{1}{\omega_t \sqrt{2\pi} \sqrt{\ln(1 + \sigma^2_{\omega,t})}} \exp\Bigg[- \frac{\Big(\ln(\omega_t) + 0.5 \ln(1 + \sigma^2_{\omega,t}) \Big)^2}{2 \ln(1 + \sigma^2_{\omega,t})} \Bigg] \tag{.0.1}$$

- <u>**Finding** $\Phi(\omega_t, \sigma_{\omega,t})$ **and** $\Gamma(\omega_t, \sigma_{\omega,t})$</u> . We know that:

$$\Phi(\bar{\omega}_t, \sigma_{\omega,t}) = \int_0^{\bar{\omega}_t} \phi(\omega, \sigma_{\omega,t}) \mathrm{d}\omega$$

By making the change of variables, we get $x_{1,t}$ and $x_{2,t}$ defined by:

$$x_{1,t} = \frac{\ln(\omega_t) + 0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}} \qquad \text{then} \qquad \omega_t = \exp\Big[\sqrt{\ln(1+\sigma^2_{\omega,t})}x_{1,t} - 0.5\ln(1+\sigma^2_{\omega,t})\Big]$$

$$x_{2,t} = \frac{\ln(\omega_t) - 0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}} \qquad \text{then} \qquad \omega_t = \exp\Big[\sqrt{\ln(1+\sigma^2_{\omega,t})}x_{2,t} + 0.5\ln(1+\sigma^2_{\omega,t})\Big]$$

with

$$\mathrm{d}x_1 = \mathrm{d}x_2 = \frac{1}{\omega\sqrt{\ln(1+\sigma^2_{\omega})}}\mathrm{d}\omega$$

and

$$\lim_{\omega_t \to 0} x_{1,t} = -\infty, \quad \lim_{\omega \to \bar{\omega}_t} x_{1,t} = \frac{\ln(\bar{\omega}_t) + 0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}.$$

$$\lim_{\omega_t \to 0} x_{2,t} = -\infty, \quad \lim_{\omega \to \bar{\omega}_t} x_{2,t} = \frac{\ln(\bar{\omega}_t) - 0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}.$$

Substituting ω_t by $x_{1,t}$ and applying the substitution rule in integration, we get:

$$\Phi(\bar{\omega}_t, \sigma_{\omega,t}) = \int_{-\infty}^{\frac{\ln(\bar{\omega}_t)+0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}} \frac{1}{\sqrt{2\pi}}\exp\Big[-\frac{x_1^2}{2}\Big]\mathrm{d}x_1 = F\Big[\frac{\ln(\bar{\omega}_t) + 0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}\Big] \tag{.0.2}$$

where F(.) is the cumulative distribution function of a standard Normal distribution.

Similarly,we know that:

$$\Gamma(\bar{\omega}_t, \sigma_{\omega,t}) = \int_0^{\bar{\omega}_t} \omega\phi(\omega, \sigma_{\omega,t})\mathrm{d}\omega$$

Substituting ω_t by $x_{2,t}$ and applying the substitution rule in integration, we get:

$$\begin{aligned}
\Gamma(\bar{\omega}_t, \sigma_{\omega,t}) &= \int_{-\infty}^{\frac{\ln(\bar{\omega}_t)-0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}} \frac{1}{\sqrt{2\pi}} \exp\Big[-\frac{\Big(x_2+\sqrt{\ln(1+\sigma^2_{\omega,t})}\Big)^2}{2}\Big]\omega \mathrm{d}x_2 \\
&= \int_{-\infty}^{\frac{\ln(\bar{\omega}_t)-0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}} \frac{1}{\sqrt{2\pi}} \exp\Big[-\frac{x_1^2}{2}\Big]\mathrm{d}x_2 \\
&= \int_{-\infty}^{\frac{\ln(\bar{\omega}_t)-0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}} \frac{1}{\sqrt{2\pi}} \exp\Big[-\frac{x_1^2}{2}\Big]\mathrm{d}x_1 \\
&= F\Big[\frac{\ln(\bar{\omega}_t)-0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}\Big]
\end{aligned}$$

Given the obtained results, we get the following:

$$f(\bar{\omega}_t, \sigma_{\omega,t}) = 1 - F\Big[\frac{\ln(\bar{\omega}_t)-0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}\Big] - \bar{\omega}_t\Big(1 - F\Big[\frac{\ln(\bar{\omega}_t)+0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}\Big]\Big)$$

$$g(\bar{\omega}_t, \sigma_{\omega,t}) = (1-\mu_t)F\Big[\frac{\ln(\bar{\omega}_t)-0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}\Big] + \bar{\omega}_t\Big(1 - F\Big[\frac{\ln(\bar{\omega}_t)+0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}\Big]\Big)$$

$$h(\bar{\omega}_t, \sigma_{\omega,t}) = \frac{1}{\bar{\omega}_t\sqrt{2\pi\ln(1+\sigma^2_{\omega,t})}} \frac{\exp\Big[-\frac{\Big(\ln(\bar{\omega}_t)+0.5\ln(1+\sigma^2_{\omega,t})\Big)^2}{2\ln(1+\sigma^2_{\omega,t})}\Big]}{1-F\Big[\frac{\ln(\bar{\omega}_t)+0.5\ln(1+\sigma^2_{\omega,t})}{\sqrt{\ln(1+\sigma^2_{\omega,t})}}\Big]}$$

$$S(\bar{\omega}_t, \sigma_{\omega,t}) = \Big[1 - \mu_t\Big(\Gamma(\bar{\omega}_t, \sigma_{\omega,t}) + \bar{\omega}_t h(\bar{\omega}_t, \sigma_{\omega,t}) f(\bar{\omega}_t, \sigma_{\omega,t})\Big)\Big]^{-1}$$

- **Derivatives computation**

$$\begin{aligned}
\bar{f}_\omega &= \Phi(\bar{\omega}, \bar{\sigma}_\omega) - 1 \\
\bar{f}_{\sigma_\omega} &= \bar{\omega} f_{\sigma_\omega}(\bar{\omega}, \bar{\sigma}_\omega) - \Gamma_{\sigma_\omega}(\bar{\omega}, \bar{\sigma}_\omega) \\
\bar{g}_\omega &= 1 - \Phi(\bar{\omega}, \bar{\sigma}_\omega) - \bar{\mu}\bar{\omega}\phi(\bar{\omega}, \bar{\sigma}_\omega) \\
\bar{g}_{\sigma_\omega} &= -f_{\sigma_\omega}(\bar{\omega}, \bar{\sigma}_\omega) - \bar{\mu}\Gamma_{\sigma_\omega}(\bar{\omega}, \bar{\sigma}_\omega)
\end{aligned}$$

Appendix C

The steady state

- Wholesale-good production technology

$$\bar{Y}^{ws} = \bar{N}^{(1-\alpha)}\bar{K}^{\alpha} \tag{.0.3}$$

- Effective and physical capital

$$\bar{K} = \bar{K}^{p} \tag{.0.4}$$

- Consumption Euler equation

$$\bar{R} = \frac{\bar{\pi}}{\beta} \tag{.0.5}$$

- Marginal utility of consumption

$$\bar{\lambda} = \frac{1-\beta h}{\bar{C}(1-h)} \tag{.0.6}$$

- Investment

$$\bar{I} = \delta_K \bar{K}^{p} \tag{.0.7}$$

- Physical capital value

$$\bar{Q} = 1 \tag{.0.8}$$

- Physical capital accumulation

$$\bar{r}^{K} = \frac{1-\beta(1-\delta_K)}{\beta} \tag{.0.9}$$

- Money demand

$$\frac{\bar{M}}{\bar{P}} = \frac{\xi}{\bar{\lambda}(1-\beta)} \tag{.0.10}$$

- Matching

$$\bar{m} = \bar{U}^{\rho}\bar{V}^{(1-\rho)} \tag{.0.11}$$

- Probability of filling a vacancy

$$\bar{p} = (\bar{\theta})^{-\rho} \quad (.0.12)$$

- Probability of finding a job

$$\bar{q} = (\bar{\theta})^{1-\rho} \quad (.0.13)$$

- Labor market tightness

$$\bar{\theta} = \frac{\bar{V}}{\bar{U}} \quad (.0.14)$$

- Number of hired workers

$$\bar{\psi} = \bar{p}\bar{V} \quad (.0.15)$$

- Employment

$$\bar{\delta}\bar{n} = \bar{\psi} = \bar{m} \quad (.0.16)$$

- Unemployment

$$\bar{U} = 1 - (1 - \delta)\bar{n} \quad (.0.17)$$

- Total hours worked

$$\bar{N} = \bar{n}\bar{H} \quad (.0.18)$$

- Marginal product of capital

$$\alpha\frac{\bar{Y}^{ws}}{\bar{K}} = \frac{\bar{P}}{\bar{P}^{ws}}\bar{R}\bar{S}\bar{r}^{k} \quad (.0.19)$$

Marginal product of worked hours

$$(1 - \alpha)\frac{\bar{Y}^{ws}}{\bar{H}} = \frac{\bar{P}}{\bar{P}^{ws}}\bar{R}\bar{S}\bar{n}\bar{W} \quad (.0.20)$$

Vacancies' posting marginal cost

$$\frac{\bar{Z}}{\bar{O}} = \frac{\gamma}{\bar{p}}\bar{R}\bar{S} \quad (0.0.21)$$

The loglinearized model

- Wholesale-good production technology

$$\hat{Y}_t^{ws} = \hat{A}_t + (1-\alpha)\hat{N}_t + \alpha\hat{K}_t \tag{0.0.22}$$

- Aggregate technology shock

$$\hat{A}_t = \rho_A \hat{A}_{t-1} + u_t^A \tag{0.0.23}$$

- Resource constraint

$$\hat{Y}_t = \frac{\overline{C}}{\overline{Y}}\hat{C}_t + \frac{\overline{C}^e}{\overline{Y}}\hat{C}_t^e + \frac{\overline{I}}{\overline{Y}}\hat{I}_t + \frac{\overline{G}}{\overline{Y}}\hat{G}_t + \frac{\bar{r}^K\overline{K}^p}{\overline{Y}}(\frac{\hat{K}_{t-1}^p}{\sigma_A} + \hat{\nu}_t) \tag{0.0.24}$$

- Effective capital dynamics

$$\hat{K}_t = \hat{\nu}_t + \hat{K}_{t-1}^p \tag{0.0.25}$$

- Physical capital dynamics

$$\hat{K}_t^p = (1-\delta_K)\hat{K}_{t-1}^p + \delta_K(\hat{I}_t + \hat{\epsilon}_t^I) \tag{0.0.26}$$

- Consumption Euler equation

$$\hat{\lambda}_t = E_t\hat{\lambda}_{t+1} + (\hat{R}_t - E_t\hat{\pi}_{t+1}) \tag{0.0.27}$$

- Marginal utility of consumption

$$(1-h)(1-\beta h)\hat{\lambda}_t = h\hat{C}_{t-1} - (1+\beta h^2)\hat{C}_t + \beta h E_t\hat{C}_{t+1} + (1-h)(\hat{\epsilon}_t^C - \beta h E_t\hat{\epsilon}_{t+1}^C) \tag{0.0.28}$$

- Capital renting rate

$$\hat{r}_t^K = \sigma_A\hat{\nu}_t - \hat{\epsilon}_t^I \tag{0.0.29}$$

- Investment

$$\hat{I}_t = \frac{1}{1+\beta}\hat{I}_{t-1} + \frac{\beta}{1+\beta}E_t\hat{I}_{t+1} + \frac{1}{\kappa(1+\beta)}(\hat{Q}_t + \hat{\epsilon}_t^I) \quad (0.0.30)$$

- Tobin's Q

$$\hat{Q}_t = \beta(1-\delta_K)E_t\hat{Q}_{t+1} + \frac{1-\beta(1-\delta_K)}{\sigma_a - 1}E_t\Big[\sigma_a\hat{r}_{t+1}^K + \hat{\epsilon}_{t+1}^I\Big] - (\hat{R}_t - E_t\hat{\pi}_{t+1}) \quad (0.0.31)$$

- Money demand

$$\hat{M}_t - \hat{P}_t = \frac{\beta}{\overline{\pi} - \beta}E_t(\hat{\lambda}_{t+1} - \hat{\pi}_{t+1}) - \frac{\overline{\pi}}{\overline{\pi} - \beta}\hat{\lambda}_t \quad (0.0.32)$$

- Marginal product of capital

$$\hat{Y}_t^{ws} - \hat{K}_t = \hat{P}_t - \hat{P}_t^{ws} + \hat{r}_t^K + \hat{R}_t + \frac{\bar{S}_\omega}{\bar{S}}\bar{\omega}\hat{\omega}_t + \frac{\bar{S}_{\sigma_\omega}}{\bar{S}}\bar{\sigma}_\omega\hat{\sigma}_{\omega,t} + \frac{\bar{S}_\mu}{\bar{S}}\bar{\mu}\hat{\mu}_t \quad (0.0.33)$$

- Marginal product of worked hours

$$\hat{Y}_t^{ws} - \hat{H}_t = \hat{P}_t - \hat{P}_t^{ws} + \hat{n}_t + \hat{W}_t + \hat{R}_t + \frac{\bar{S}_\omega}{\bar{S}}\bar{\omega}\hat{\omega}_t + \frac{\bar{S}_{\sigma_\omega}}{\bar{S}}\bar{\sigma}_\omega\hat{\sigma}_{\omega,t} + \frac{\bar{S}_\mu}{\bar{S}}\bar{\mu}\hat{\mu}_t \quad (0.0.34)$$

- Vacancies' posting marginal cost

$$\hat{Z}_t - \hat{P}_t = -\hat{p}_t + \hat{R}_t + \frac{\bar{S}_\omega}{\bar{S}}\bar{\omega}\hat{\omega}_t + \frac{\bar{S}_{\sigma_\omega}}{\bar{S}}\bar{\sigma}_\omega\hat{\sigma}_{\omega,t} + \frac{\bar{S}_\mu}{\bar{S}}\bar{\mu}\hat{\mu}_t \quad (0.0.35)$$

- Recovery rate

$$\hat{\mu}_t = -\frac{1-\bar{\mu}}{\bar{\mu}}\Big(\hat{s}_{0,t} + s_1\bar{\omega}\hat{\omega}_t\Big) \quad (0.0.36)$$

- Credit shock

$$\hat{s}_{0,t} = \rho_{s0}\hat{s}_{0,t-1} + u_t^{s0} \quad (0.0.37)$$

- Uncertainty shock

$$\hat{\sigma}_{\omega,t} = \rho_\sigma\hat{\sigma}_{\omega,t-1} + u_t^\sigma \quad (0.0.38)$$

- Entrepreneurial consumption

$$\hat{C}_t^e = -\frac{\bar{\varsigma}}{1-\bar{\varsigma}}\hat{\varsigma}_t + \hat{P}_t^{ws} - \hat{P}_t + \hat{Y}_t^{ws} + \frac{\bar{f}_\omega}{\bar{f}}\bar{\omega}\hat{\omega}_t + \frac{\bar{f}_{\sigma_\omega}}{\bar{f}}\bar{\sigma}_\omega\hat{\sigma}_{\omega,t} \tag{0.0.39}$$

- Entrepreneurial networth

$$E_t\hat{X}_{t+1} = \frac{\bar{Y}^{ws}\bar{P}^{ws}\bar{\varsigma}\bar{f}}{\bar{P}\bar{X}}(\hat{P}_t^{ws} - \hat{P}_t + \hat{Y}_t^{ws} + \hat{\varsigma}_t) + \frac{\bar{Y}^{ws}\bar{P}^{ws}\bar{\varsigma}}{\bar{P}\bar{X}}(\bar{f}_\omega\bar{\omega}\hat{\omega}_t + \frac{\bar{f}_{\sigma_\omega}}{\bar{f}}\bar{\sigma}_\omega\hat{\sigma}_{\omega,t}) \tag{0.0.40}$$

- Entrepreneurial survival rate

$$\hat{\varsigma}_t = \hat{\epsilon}_t^{\varsigma} \tag{0.0.41}$$

- Networth shock

$$\hat{\epsilon}_t^{\varsigma} = \rho_\varsigma\hat{\epsilon}_{t-1}^{\varsigma} + u_t^{\varsigma} \tag{0.0.42}$$

- Zero-profit condition

$$\begin{aligned}\frac{\bar{g}_\omega}{\bar{g}}\bar{\omega}\hat{\omega}_t + \frac{\bar{g}_{\sigma_\omega}}{\bar{g}}\bar{\sigma}_\omega\hat{\sigma}_{\omega,t} + \frac{\bar{g}_\mu}{\bar{g}}\bar{\mu}\hat{\mu}_t + \varphi_1(\hat{P}_t^{ws} + \hat{Y}_t^{ws}) + \varphi_2(\hat{Z}_t + \hat{\psi}_t) = \\ \hat{R}_t + \hat{P}_t + \varphi_3(\hat{N}_t + \hat{W}_t) + \varphi_4\hat{V}_t + \varphi_5(\hat{K}_t + \hat{r}_t^K) - \varphi_6\hat{X}_t\end{aligned} \tag{0.0.43}$$

where,

$$\varphi_1 = \frac{\bar{Y}^{ws}\bar{P}^{ws}}{\bar{Y}^{ws}\bar{P}^{ws} + \bar{Z}\bar{\psi}}, \quad \varphi_2 = \frac{\bar{Z}\bar{\psi}}{\bar{Y}^{ws}\bar{P}^{ws} + \bar{Z}\bar{\psi}}, \quad \varphi_3 = \frac{\bar{W}\bar{N}}{\bar{W}\bar{N} + \gamma\bar{V} + \bar{r}^K\bar{K} - \bar{X}},$$

$$\varphi_4 = \frac{\gamma\bar{V}}{\bar{W}\bar{N} + \gamma\bar{V} + \bar{r}^K\bar{K} - \bar{X}}, \quad \varphi_5 = \frac{\bar{K}\bar{r}^K}{\bar{W}\bar{N} + \gamma\bar{V} + \bar{r}^K\bar{K} - \bar{X}}, \quad \varphi_6 = \frac{\bar{X}}{\bar{W}\bar{N} + \gamma\bar{V} + \bar{r}^K\bar{K} - \bar{X}}.$$

- Credit market clearing

$$\hat{D}_t + \frac{\bar{M}}{\bar{P}\bar{D}}(\hat{M}_{t-1} - \hat{M}_t) = \frac{\bar{N}\bar{W}}{\bar{D}}(\hat{W}_t + \hat{N}_t) + \frac{\gamma\bar{V}}{\bar{D}}\hat{V}_t + \frac{\bar{r}^K\bar{K}}{\bar{D}}(\hat{r}_t^K + \hat{K}_t) - \frac{\bar{X}}{\bar{D}}\hat{X}_t \tag{0.0.44}$$

- Matching

$$\hat{m}_t = \rho\hat{U}_t + (1-\rho)\hat{V}_t \tag{0.0.45}$$

- Probability of filling a vacancy

$$\hat{p}_t = \hat{m}_t - \hat{V}_t \tag{0.0.46}$$

- Probability of finding a job

$$\hat{q}_t = \hat{m}_t - \hat{U}_t \tag{0.0.47}$$

- Labor market tightness

$$\hat{\theta}_t = \hat{V}_t - \hat{U}_t \tag{0.0.48}$$

- Number of hired workers

$$\hat{\psi}_t = \hat{p}_t + \hat{V}_t \tag{0.0.49}$$

- Job destruction evolution

$$\hat{\delta}_t = \hat{\epsilon}_t^{\delta} \tag{0.0.50}$$

- Job destruction shock

$$\hat{\epsilon}_t^{\delta} = \rho_{\delta}\hat{\epsilon}_{t-1}^{\delta} + u_t^{\delta} \tag{0.0.51}$$

- Employment

$$\hat{n}_t = (1-\bar{\delta})\hat{n}_{t-1} + \bar{\delta}\hat{\psi}_t - \bar{\delta}\hat{\delta}_{t-1} \tag{0.0.52}$$

- Unemployment

$$\hat{U}_t = -\frac{\bar{n}}{1-\bar{n}}\hat{n}_t \tag{0.0.53}$$

- Total hours worked

$$\hat{N}_t = \hat{n}_t + \hat{H}_t \tag{0.0.54}$$

- Job creation dynamics

$$\hat{Z}_t - \hat{P}_t = \varphi_7(\hat{P}_t^{ws} - \hat{P}_t - \hat{n}_t + \hat{Y}_t^{ws}) - \varphi_8(\hat{W}_t + \hat{H}_t) - \beta\bar{\delta}\hat{\delta}_t + \beta(1-\bar{\delta})(\hat{\lambda}_{t+1} - \hat{\lambda}_t + \hat{Z}_{t+1} - \hat{P}_{t+1}) \tag{0.0.55}$$

where,

$$\varphi_7 = \frac{(1-\alpha)\bar{P}^{ws}\bar{Y}^{ws}}{\bar{n}\bar{Z}}, \qquad \varphi_8 = \frac{\bar{P}\bar{W}\bar{H}}{\bar{Z}}.$$

- Aggregate wage

$$\hat{W}_t+\hat{H}_t = \varphi_9(\hat{P}_t^{ws}-\hat{P}_t+\hat{Y}_t^{ws}-\hat{n}_t)-\varphi_{10}\hat{\delta}_t+\varphi_{11}(\hat{Z}_t-\hat{P}_t+E_t\hat{\theta}_{t+1})+\varphi_{12}(\hat{\epsilon}_t^H-\hat{\lambda}_t)+\varphi_{13}\hat{H}_t \tag{0.0.56}$$

where,

$$\varphi_9 = \eta\frac{(1-\alpha)\bar{Y}^{ws}\bar{P}^{ws}}{\bar{P}\bar{n}\bar{W}\bar{H}}, \qquad \varphi_{10} = \eta\frac{\bar{Z}\bar{\theta}\bar{\delta}}{\bar{P}\bar{W}\bar{H}}, \qquad \varphi_{11} = \eta\frac{(1-\bar{\delta})\bar{\theta}\bar{Z}}{\bar{P}\bar{W}\bar{H}},$$

$$\varphi_{12} = (1-\eta)\frac{\bar{H}^{1+\tau}}{(1+\tau)\bar{\lambda}\bar{W}\bar{H}}, \qquad \varphi_{13} = (1-\eta)\frac{\bar{H}^{1+\tau}}{\bar{\lambda}\bar{W}\bar{H}}.$$

- Price index

$$\hat{\pi}_t = (1-\varrho)(\hat{P}_t^* - \hat{P}_{t-1}) \tag{0.0.57}$$

- Optimal reset price

$$\hat{P}_t^* = -\frac{1}{\bar{\epsilon}-1}\hat{\epsilon}_t + \hat{g}_{1,t} - \hat{g}_{2,t} \tag{0.0.58}$$

where,

$$\hat{g}_{1,t} = \varphi_{14}\Big[\hat{\lambda}_t + \hat{Y}_t + \hat{P}_t^{ws} + (\bar{\epsilon}-1)\hat{P}_t\Big] + \varphi_{15}\hat{\epsilon}_t + \beta\varrho E_t(\hat{g}_{1,t+1}) \tag{0.0.59}$$

$$\hat{g}_{2,t} = \varphi_{16}\Big[\hat{\lambda}_t + \hat{Y}_t + (\bar{\epsilon}-1)\hat{P}_t\Big] + \varphi_{17}\hat{\epsilon}_t + \beta\varrho E_t(\hat{g}_{2,t+1})$$

and,

$$\varphi_{14} = \frac{\bar{\lambda}\bar{Y}\bar{P}^{ws}\bar{P}^{(\bar{\epsilon}-1)}}{\bar{g}_1}, \qquad \varphi_{15} = \varphi_{14}\bar{\epsilon}\ln(\bar{P}), \qquad \varphi_{16} = \frac{\bar{\lambda}\bar{Y}\bar{P}^{(\bar{\epsilon}-1)}}{\bar{g}_2}, \qquad \varphi_{17} = \varphi_{16}\bar{\epsilon}\ln(\bar{P}).$$

- Final-good production

$$\hat{Y}_t^f = \hat{Y}_t^{ws} - \hat{\upsilon}_t^P \tag{0.0.60}$$

where,

$$\hat{\upsilon}_t^P = (1-\varrho)\bar{\epsilon}(\hat{P}_t - \hat{P}_t^*) + \varrho\bar{\epsilon}\hat{\pi}_t + \varrho\hat{\upsilon}_{t-1}^P \tag{0.0.61}$$

- Taylor rule

$$\hat{R}_t = \rho_R\hat{R}_{t-1} + (1-\rho_R)\Big[\rho_\pi\hat{\pi}_{t-1} + \rho_Y\hat{Y}_{t-1}\Big] + \hat{\epsilon}_t^R \tag{0.0.62}$$

- Monetary policy shock

$$\hat{\epsilon}_t^R = \rho_{\epsilon^R}\hat{\epsilon}_{t-1}^R + u_t^R \tag{0.0.63}$$

Conclusion

In this thesis, I tried to establish using many technical tools, a explicit relation between the financial market imperfections and the real economy. In particular, the impact of the credit market imperfections on the dynamics of labor market. The first model considered was a monetary business cycle model with asymmetric information in the credit market. A monetary model with flexible prices and limited participation of households. The model was able to generate the liquidity effect. Comparing to a model where the credit market is frictionless, the ex-post moral hazard in lending amplified the liquidity effect and improved the propagation mechanism of a monetary shock by activating the broad credit channel.

An exogenous increase of the marginal cost of monitoring is found to have an adverse impact on the liquidity effect. This cost is supposed to be an exogenous constant, referring to the auditing, legal and asset liquidation costs incurred when there is a bankruptcy. Although the exogeneity assumption seems to be suitable for the analysis above, the explanation of the fluctuations of this marginal cost is not straightforward. This implicit assumption, used in all studies, implies that the financial intermediary recovers bad loans within the same period (usually one quarter) and that the fraction of loans recovered is exogenously determined. However, many economists argue that recovery rates cannot be exogenous and they should depend on economic conditions, especially in emerging market economies with volatile business cycles. In addition, according to the World Bank's Doing Business reports, the average number of years to enforce a bad loan is 3.03 years, computed over the period $(2004 - 2011)$, for 181 countries. As expected, the average duration for developing and less-developed economies is relatively high (3.35 years) and overtakes the one in advanced economies, (2.02 years). Based on these facts, as an extension of the model above, one can introduce an endogenous recovery rate and assumes that the recovery of a bad loan is not immediate and depends on the duration of bankruptcy proceedings. This new feature may improve the propagation of monetary shocks and induces a more persistent liquidity effect.

The second experience was to highlight the impact of credit market and financial market conditions on the labor market variables. The excess bond premium is taken as a proxy of the credit market conditions. The option-implied volatility on the S& P 100 stock futures index, known as the VXO index is taken as a proxy of the uncertainty in the financial market. The impact of adverse financial and credit shocks on the labor market conditions are quite similar. Both of the shocks induce a deterioration of the labor market conditions. There are some differences regarding the depth of the impact as well as its persistence. An adverse credit shock is found to have a dramatic impact on the unemployment rate. It reaches more than 0.5% increase and lasts for more than four years which is quite higher than the unemployment rate increase when the economy is hit by an uncertainty shock. This finding confirms the importance of the credit channel and the importance of the credit conditions as a main driver of business cycles.

In line with the finding in the literature, the uncertainty increases after an adverse credit shock which raises the eventuality that fluctuations in uncertainty are substantially affected by the developments in the credit market. This result is confirmed by the insignificant impact of the uncertainty shock on the credit spread while the impact of an adverse credit shock on the uncertainty level in the financial market is quire important. This result supports the idea that uncertainty increase in financial market is a symptom of credit market disruptions.

The third experience was built on a new-Keynesien DSGE model, the model integrated sticky prices, asymmetric information in the credit market and a search, matching, wage-bargaining framework the labor market. I found that credit market frictions may be the source of lower posting vacancies and higher unemployment level. Asymmetric information pushes up wholesale firms' marginal costs, as well as hiring costs by a financial mark-up charged by financial intermediaries. The impact of credit market imperfections operates through different channels. Any shock originating in the credit market that contributes to the increase of the financial mark-up is transmitted by these firms through prices. Thus, it affects their hiring behavior, as well as wage and employment levels in the economy. Then, I simulate the model after calibrating it to the US economy. We consider three shocks: a net worth shock, a credit shock and an uncertainty shocks. The first one is an exogenous and instantaneous increase of the net worth, while the second is a decrease of the marginal monitoring cost and the third is just an increase of the standard deviation of the entrepreneurial idiosyncratic productivity shock. We find that employment rates and vacancies posting increase following one of theses shocks. Moreover, there a substitution effect between the extensive and the intensive margins inducing to a decrease of unemployment. The fall of unemployment is more important and persistent when the shock is a wealth shock. It last fore more than 45 quarters. All the shocks seem to be transmitted trough prices. The main channels of propagation from the financial sphere of the economy to the labor market are investigated and appear to be consistent with our theoretical model.

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Thesis Title : CREDIT MARKET IMPERFECTIONS AND BUSINESS CYCLES

Abstract

The crisis of 2009 raised the question whether the financial conditions matter for the business cycles and the propagation of shocks originating in the financial sphere. I tried to drive a fine analysis of this issue using micro-founded general equilibrium models. The modelling choice was backed by empirical motivations. In three essays, I study the impact of monetary and financial shocks on growth and labour market dynamics. First, an expansionary monetary policy eases credit conditions, raises risk tolerance and the quality of borrowers and generates a liquidity effect. The potency of the monetary policy and the size of the credit channel depend considerably on the degree of financial frictions in the credit market. Second, a restrictive monetary policy shock, an positive credit shock and a positive uncertainty shocks have similar effects on the economy: they plunge the economy in a recession, with output, job creations, and hours worked decreasing, while unemployment and job destructions increase. In all cases the interest rate spread increase, therefore indicating that financial conditions deteriorate, which is interpreted as a sign that financial frictions play a critical role in the propagation of these shocks. Third, the interaction between financial and labour market frictions does exist. The interplay between the two indeed plays a role in propagating the shocks. A shock to net worth, a credit shock and an uncertainty shock play a non-trivial role for the dynamics on the labour market.

Keywords: Asymetric information, state verification, credit channel, liquidity effect, financial accelerator, Bayesian VAR, credit shock, uncertainty shock, search and matching, Nash bargaining

Résumé

La crise financière de 2009 a ravivé le débat entre les classiques et les keynésiens concernant le rôle de la finance dans le cycle d'affaire. Cette thèse étudie les conséquences macroéconomiques des imperfections du marché de crédit ainsi que quantifie leur impact sur le marché de travail. L'interaction entre chômage et frictions financière passe par l'hypothèse que les postes vacants sont financés par des fonds externes qui sont plus couteux qu'un financement interne, de par de l'impact de l'asymétrie d'information sur le marché du crédit. Il est alors montré, à l'aide de simulation d'un modèle DSGE calibré sur données US., qu'un choc financier négatif, i.e. un choc qui augmente la prime de risque sur le marché du crédit ou un choc qui détériore le bilan des entrepreneurs, réduit de manière significative les capacités d'emprunt, et, par conséquent, la création d'emplois diminue. spécialement.

Mots clés: Asymétrie d'information, accélérateur financier,effet liquidité, VAR Bayésien, choc de crédit, choc financier, choc d'incertitude, recherche de travail, négociation salariale