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Salimeh Monirijavid

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Three Essays on Consumption and Welfare Theory

présentée et soutenue publiquement par

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le janvier 2021

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Jury

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General Introduction

The consumption of goods and services is an essential determinant of human welfare. For a given income level, consumption determines saving and therefore investment through capital supply. Also, the distribution of consumption among individuals has a crucial role on many important matters such as measuring living standards, poverty and inequality, in economic, political and social fields. Therefore, the analysis of consumer behavior has always held a central position in economic research throughout the last century. Over the last four decades, research on consumption has considerably progressed in different aspects of theoretical and empirical analysis.

The consumption choice of individuals across commodities can be represented by demand system, a system of equations which illustrates the relationship between quantities demanded, prices and total expenditure. An early attempt to associate statistical analysis to economic theory was done by [Stone \(1954\)](#), who assumes direct additivity, due to [Leser \(1941\)](#) and [Houthakker \(1960\)](#), who assumes indirect additivity. Stone developed the linear expression system (LES) derived explicitly from consumer theory to explain the relation between demand, price and total expenditure. In the LES, the implications of rationality are satisfied by definition. We are thus imposing the three properties on the data. The standard consumption theory states that rational consumers have demand functions with three specific attributes: homogeneity of degree zero in nominal variables, symmetry¹, and negative semi-definiteness². Many models have been developed after the LES, but perhaps the most important one in current use, apart from the original linear expenditure system, is the Rotterdam model, due to [Barten \(1964a\)](#) and [Theil \(1965\)](#). The model estimates a generalized version of LES, and shows that the data do not always satisfy the theoretical properties of the rational consumer. [Christensen et al. \(1975\)](#) developed the Rotterdam model into the translog model. Both models have been extensively estimated and have satisfied the homogeneity and symmetry restrictions of demand theory.

1. The derivative of the Hicksian demand for commodity i with respect to the price of commodity j should equal the derivative of the Hicksian demand for commodity j with respect to the price of commodity i .

2. The substitution matrix of all derivatives of Hicksian demands should be negative semi-definite.

Lluch (1971) and Deaton (1974a,b) challenged the Rotterdam model and showed that the existing demand systems did not fulfill those objectives and homogeneity is not an acceptable restriction in this model. Later in 1980, Deaton and Muellbauer introduced the “Almost Ideal Demand System” (AIDS) which was simple enough to be estimated, flexible enough to permit testing the rationality, and allowing for expenses of good to vary non-linearly with total expenditure. The AIDS model has been the most commonly used specification in applied demand analysis for more than two decades as it satisfies a number of desirable demand properties³. However, Banks et al. (1997) used parametric and non-parametric methods and showed that an additional flexibility in Engel curves is desired. For instance, for some commodity groups, like food, expressing their shares as in the original AIDS is an accurate approximation. However, for other commodity groups, Engel curves display other types of curvature. Therefore they extend the AIDS model to Engel curves with a quadratic term in income, “Quadratic Almost Ideal Demand System” (QAIDS) which provides more flexibility. There is also clear evidence that expenditure shares vary systematically with the household demographic characteristics, including the number of children and the age of its members. For the time being, dealing with this heterogeneity has become the core of the demand system analysis (Blundell and Stoker, 2005). Since the introduction of QAIDS model and quasi-AIDS (Lewbel and Pendakur, 2009), researchers have applied to estimate demand systems using data from a wide range of countries in a large number of application. For instance, in agricultural economics, international welfare comparison, within country inequality and poverty measures and so on.

Assuming that demand is derived from the rational consumer’s welfare maximization, allows the researchers to use the powerful tools of consumer theory and derive useful welfare measures, such as compensated and equivalent variation in income and consumer surplus. Hausman (1981), Vartia (1983), and Hammond (1990) have shown that theoretically correct measure of individual welfare can be

3. AIDS model satisfies axioms of choice exactly and allows exact aggregation over consumer. It is simple to estimate and can be used to test the restriction of homogeneity and symmetry through linear restriction on fixed parameters.

defined and calculated. The basic idea of consumer surplus is to assess the value to a consumer or his “willingness to pay (attach a monetary value)” of a change in the welfare resulting either from a change in consumption or in prices and budget. Since price changes affect consumer welfare, the evaluation of this effect is usually a key input for public policy decisions. One way to measure the consumer welfare change is an equivalent variation (EV) which is a closely related measure that uses old prices and the new utility level. It measures the amount of money a consumer would pay to avoid a price change, before it happens. Another method is the compensating variation (CV) method⁴. It refers to the amount of additional money an agent would need to reach their initial utility after a change in prices, or product quality. In this approach, we take the areas under the compensated or Hicksian demand curve and over a price rather than a quantity change. There is no natural preference between CV and EV measure, but rather one of interpretation⁵. The concept of compensating variation introduced by [Hicks \(1939\)](#) and developed by [Henderson \(1941\)](#) and [Hicks \(1956\)](#), along with the concept of “consumer’s surplus” remains the principal tool of analysis underlying present-day “applied welfare economics”. Applied welfare economics is ultimately concerned with measuring changes in the well-being of households, based on comparing different bundles of commodities. The compensating variation was defined by [Hicks \(1941\)](#) as the minimum amount by which the consumer would have to be compensated after a price change in order to keep the household utility level equal to its previous level of utility. Therefore

$$CV = c(u^0, p^1) - c(u^0, p^0) \quad (0.0.1)$$

where u is the utility function, p is the price and $c()$ is the minimum expenditure. It measures the money costs of a welfare affecting price change from p^0 to p^1 and it uses u^0 as reference (compensation returns consumer to the original welfare level). If the CV is positive the individual is better off under the new situation.

4. Let m^0, p^0, u^0 denote income, price, and utility before and m^1, p^1, u^1 after the change, then in term of the expenditure function, $EV = E(p^0, u^1) - m^0$ and $CV = m^1 - E(p^1, u^0)$

5. The choice of CV or EV may depend on the attitude to the policy change. If the government fixes the new price, it is more reasonable to use the CV method, but if the new price is less definitely committed, then the use of base prices (EV) may be more appropriate.

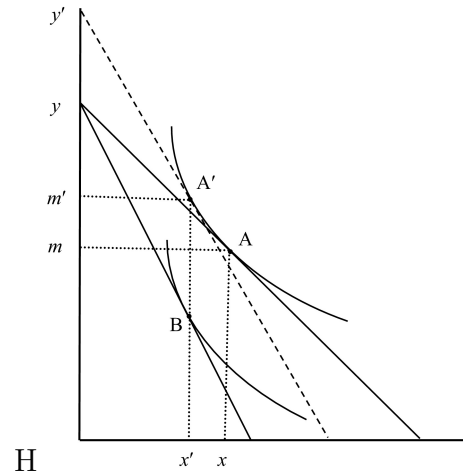


Figure 1 – The compensating variation under quasilinear preferences

Fig.1 demonstrates the concept of CV for a representative consumer, who initially consumes at point A , where the vertical axis measures consumption expenditures on all other goods than x . The price increases for good x and the budget constraint shifts inwards where, without compensation at point B , a lower utility level is reached. The required CV, equal to $y' - y$ then indicates by how much the budget constraint must shift upwards after the price change to reach the initial utility curve. The consumption bundle then changes from point A to point A' . There are two main groups of applied work using the welfare measures to analyse the well-being of individuals. A large group of empirical studies follow Willig (1976) and calculate compensating variations approximated by estimates of consumer surplus⁶. The second group of the researches have followed Hausman (1981) in estimating a single demand equation and calculating the expenditure function through the Roy's identity⁷.

In this thesis, we aim at opening the black box of the household. What is happening in the household? It is since Becker that we are interested in the functioning of the household. Why is understanding of the household important for well-being analysis? In fact, the household plays an essential role in welfare analysis for different reasons:

1. Its formation: the broader conception of utility derived by the formation

6. This approach is more common in industrial economics.

7. This is the approach that is used in this research.

- of a couple requires to understand the determinants of marriage and couple formation. Economic models of marriage originate in Becker's works (1973). The specificity of these models is to emphasize that matching allows parents to generate a joint surplus and thus has strong welfare consequences. For instance, if rich individuals marry together, and the poor together, this will have an influence on inequalities. To partially address this issues, research has examined the statistical association between male and female labour earning within households (Burtless, 1999, Schwartz, 2010, Greenwood et al., 2014).
2. Resource sharing and collective models: collective models of the household assume that each household member has individual preferences and that collective household decisions result from bargaining and/or cooperation between household members. Chiappori and his co-authors⁸ have developed an approach known as "collective" based on the following two postulates: (a) Every individual living in the household has his or her own utility function, (b) The outcome of the decision process is efficient in the Pareto sense. Such models are essential to (a) understand how better outside opportunities for women have changed the balance of power within the household and to (b) measure changes in inequality, at the individual level, that result from recent economic and demographic trends. The analysis of individual welfare has to, however, solve an identification problem that can be summarized as follows: Is it possible to recover individual utility functions and bargaining weights from the observation of household behavior? The response is generally positive. It is thus possible to carry out welfare analysis at the individual level.
 3. Domestic production: Its properties have repercussions on analyses of well-being, particularly, through the cost of time and the substitutability/complementarity of time and money factors. Time is one of the most important assets and yet there is no market where it can be bought or traded; time cannot be saved, stored or invested for expected return. As an input, time is required to produce of any activity but the peculiarity

8. The collective approach was inspired by precursors (McElroy and Horney, 1981, Apps and Rees, 1988). The main contributions include Chiappori (1988); Bourguignon and Chiappori (1992); Browning and Chiappori (1998); Donni and Chiappori (2011).

of this asset makes it difficult to analyze. Indeed, one of the most valuable uses of time is its contribution in domestic production, which is defined as the goods and services produced by households. These goods have the singularity of being the same as those consumed by the household itself. Households are consumers and producers of their own goods. Time, as money, is needed for the domestic production of goods. Therefore, the time dimension is as essential as the monetary expenses for the family's welfare. An important debate in the consumption literature is the analysis of time in the consumer's utility theory. Before the 1960s, the question about the time in economic theory was not usually addressed. After the appearance of some new theories such as [Becker \(1965\)](#)'s theories⁹ in the mid-60's, the household's behavior started to be exuviated. Becker's model¹⁰ affects fundamentally the study of household production and allocation of time within the household. It creates a large literature and continues to affect economics and other social sciences. These new theories started to study households as a whole entity and positioned them not only as consumers but also as producers. From their point of view, a household would be as a small company that produces final products from two inputs: time and purchased commodities. Consequently, each household faces two constraints, a budget constraint as in the classical consumer case, and a time constraint. [DeSerpa \(1971\)](#) and [Evans \(1972\)](#) tried to improve Becker's model by adding extra constraints. Their model is a special case of Becker's model by redefining commodities and introducing new constraints. Further research in the area of time-use modeling can be found in [Juster and Stafford \(1991\)](#)'s survey paper that provides both theoretical and empirical research on the matter. Despite the policy relevance of the Becker model, its empirical applications are rare. Most empirical studies, such as those just cited, rely on simplified or reduced-form equations derived from the model rather than on

9. [Ironmonger \(1972\)](#), [Lancaster \(1966\)](#)

10. However, Becker's paper is not the first to consider time use in the household. [Mincer \(1962\)](#) analyzes the married women's time trade-off between housework and paid work. And [Gorman \(1980\)](#) is one of the earliest papers in which the household production is introduced (The paper is written in 1956 and widely circulated as a working paper for decades).

the model itself in all its complexity.¹¹

4. Economies of scale: the economies of scale is important for the determination of the needed income by households of different sizes and the standard of living. And the “household income equivalence scale” is crucial for measuring the poverty, income distribution, and inequality. Household economics of scale may be explained by different reasons. In the larger household, the cost per person of sustaining the given material standard of living may decrease as the household size increases. For instance, if two adults form different households join as one household, they can share the public good¹² like housing and they will be better off. Accordingly, they can use the released expenses on public for private goods and making each other better off than they were when they lived by themselves (Barten, 1964b). The economies of scale can be important from the allocation of time point of view. If the production of the domestic good has a fixed time cost component (a constant fraction of time is dedicated to household chores such as housing maintenance), then people in a couple will have proportionally more time available for market work and leisure. This may generate inequality between single-headed or divorced families and couples. Bargain and Donni (2012) have suggested a new approach which is consistent with an individualistic representation of children’s welfare and where the cost of children depends on the relative weight of the mother and the father in the decision process¹³.

This thesis locates in the consumer and welfare literature and it shall attempt to take a somewhat broader view and discuss, if only briefly, the time as a contributor of domestic production (3) and economies of scale (4) but also the literature on welfare measuring by compensating method for a developing country in the case of

11. One exception is worth mentioning. Salazar (2015) in her PhD thesis considers a general model of commodity consumption where each commodity is produced by a fixed-coefficient production function.

12. The public good can be “electric light in a room, security provided by locked bolt on the door” (Lazear and Michael, 1980).

13. See also Dunbar et al. (2013). Lewbel et al. (2001) proposed a model of household behavior that permits to address different issue such as how much money does a couple save on consumption goods by living together versus living apart? how much income would a woman living alone require to attain the same standard of living that she would have if she were married?

Iran.

In the first chapter, we focus on a developing country, Iran, and we analyze the welfare changes regarding the recent price shocks in this country using thirteen waves of household income and expenditure survey. Applying the compensating variation method, we study family welfare changes on the distribution of the income. The second chapter presents a literature review concerning the Deaton-Paxson puzzle. Furthermore, it investigates the existence of the puzzle on the Iranian household income and expenditure survey. Also, it studies the effect of additional child or adult's consumption for different types of goods and on the distribution of the income. Finally, the third chapter, written in collaboration with Olivier Donni, offers a consumption model for households based on the Becker theory to explore the role of time in household utility and demand function. Thanks to the three different American databases, Consumer Expenditure Survey (CES), American Time Use Survey (ATUS), Current Population Survey (CPS). This chapter proposes one of the first empirical applications of the Becker model.

Were the economic sanctions targeted against 'ordinary people'? Who loses more welfare because of the economic sanctions, the poor or the rich? Economic sanctions can influence the consumer welfare through increasing the trade cost. In the first chapter, "**Iranian Household Welfare after Recent Economic Sanctions**" we look at the welfare changes related to the recent price shocks coming from the recent economic sanctions in a developing country, Iran. For more than 40 years, Iran has been confronting different sanctions types. After the Iranian revolution in 1979, the US imposed a ban on Iranian imports. Afterwards, in the mid-2000s when Iran started its uranium enrichment the UN Security Council prevented trade in the nuclear trade technology. In 2010 the embargo was expanded to include the US, UK and Canada. This new wave of sanctions targeted the financial and energy sectors of Iran. The UK stopped its business with Iranian banks, while the US and Canada prohibited firms' trades with Iran's energy sectors. In addition, the European Union restricted oil export from Iran to European countries. These recent sanctions led to a significant decline in oil sales (about one million barrels

per day) as well as in currency reserves.

As the Iranian economy is dominated by oil and gas production, it was profoundly impacted by the recent economic sanctions. The combination of macroeconomic disturbance, including import restrictions, a parallel market in foreign exchange, and high inflation led to an economic slowdown and two years of negative GDP growth. At the same time, the Iranian government implemented the subsidy reform to relax energy subsidies to reach the international price for the energy products. To accomplish the subsidy reform and to compensate households for increased prices, the government applied an unconditional cash transfer at the same time. The government stated that the main purpose of the cash transfer policy is to protect the poor, therefore it first targeted low-income households. But as it did not eventually succeed, more than 90 percent of Iranians received the monthly paid amount as a cash transfer to be refunded for the augmented energy prices.

In our research using thirteen waves of household income and expenditure survey of Iran, we aim to investigate the welfare impact of recent price shocks due to the recent economic sanctions. To achieve our objective, we focus on changes in welfare from price changes following the indirect welfare measurement. Employing the 13 waves of micro data of household survey conducted yearly by the Statistical Center of Iran, we estimate the demand system by the Quadratic Almost Ideal Demand System method of [Banks et al. \(1997\)](#) for five main commodity groups (food, energy, housing, clothing and transport). We calculate the welfare loss (gain) by compensating variation (CV) approach ([Friedman and Levinsohn, 2002](#))¹⁴. Using CV, we measure the monetary compensation required to bring the consumer back to the original utility level before the price shocks (year 2010).

Who lost more welfare due to the economic sanctions? The households in the middle of the income distribution in both rural and urban areas were most adversely impacted by the economic sanction. In addition, the families who work in private

14. Research on the the welfare effect of price changes using the CV approach has been conducted for developed and developing countries in the literature, e.g :[Attanasio and Lechene \(2010\)](#), [Osei-Asare et al. \(2013\)](#), [Ferreira et al. \(2013\)](#), [Vu and Glewwe \(2011\)](#), [Alem \(2011\)](#), [Weber et al. \(2015\)](#), [MohammadZadeh \(2011\)](#)

sectors and the households with children are more vulnerable concerning the price shocks. To sum up, the Iran's economic sanctions influenced the welfare of ordinary people, however it is supposed to target more the political government policy than the households. *Did any group of households have a welfare gain despite the price shocks?* The results show that the households with low income (the 2 first deciles) have a positive welfare change, while they are expected to lose more regarding the price shocks (especially the increase in food prices which have an important share in the poor consumption expenditure). Therefore, the cash transfer policy was pro-poor and protected the very poor households as the payed amount was significantly important compared to the total income for the poor families.

Does the share of private goods increase by increasing the family size given the per capita income constant? In the second chapter "**Deaton-Paxson Puzzle: Iran Case Study**" we study one of the important paradoxes about the economies of scale in the consumption literature, namely the Deaton and Paxson puzzle. [Deaton and Paxson \(1998\)](#) raised an important puzzle in economies of scale in household consumption. They derived theoretical model of economies of scale using the [Barten \(1964b\)](#) two-goods model. According to the model if two adults unify to form one household, the couple will be better off at constant per capita income as they share the public good so the couple will devote the released resources to the private good.

They claim that food could be an appropriate example of private goods as its income elasticity usually dominates the own price elasticity, further substitution away from food will be less likely for households close to subsistence. This means that the released resource from decreasing the consumption of public goods would be allocated to food, a necessary which has few substitutes. This is the case at least in developing countries and poor households. But by analyzing household survey data for seven countries, they found that the food share decreases by additional household member, given per capita income constant. Moreover, the correlation between food share and household size is stronger for developing countries. These empirical results of Deaton and Paxson started a puzzle in the consumption literature, and and gave

place to discussion in academic circles. Many studies try to explain the cause of the puzzle through different approaches¹⁵.

In this chapter, we aim at understanding the Deaton and Paxson puzzle by using the Iranian expenditure and income survey. The Iranian household is a good example of a developing country in which the assumption of Deaton-Paxson for private good is fulfilled, i.e., the income elasticity of food is higher than the its own price elasticity. We use four categories of goods such as food, housing, clothing and transport to see the changes of share of each group by family size given per capita income constant. To control for differences between the consumption of adults and children, we also did our estimation for an additional adult and child separately for food share. Finally to understand more about the Deaton-Paxson puzzle on distribution of the income, we run our model on different quantiles of family income and we estimate the relation between food/clothing share and household size on the distribution of income. We used the same method as Deaton-Paxson but estimate our model for clothing (as a private good) and transportation in addition to the food and housing expenditure shares.

Does the share of private goods increase by increasing the family size at constant per capita income? Our results for food share are in line with Deaton-Paxson's paper, this means that by increasing the household size, the food share decreases holding the par-capita income constant. Furthermore, this negative relation remains the same for additional child or additional adult in the family for urban and rural areas. In addition, by studying this relation on the distribution of income, we find that the decrease in the food share by increasing the household size is stronger in poor households than in the rich ones. We examine the relation between the household size and the clothing share (more private good compare to food) holding

15. For example: the role of measurement errors: For larger households is more difficult to remember all the food expenditures by detail compared to the smaller households and it is more likely for them to under-report their food expenditure. In this kind of research, researchers use the dairy data rather than the recall survey, however they found that their results are in line with Deaton and Paxson's results. [Gibson \(2002\)](#), [Gibson and Kim \(2007\)](#), [Gibson et al. \(2015\)](#), [Brzozowski et al. \(2017\)](#). Criticizing and modifying the the Barten model [Horowitz \(2002\)](#), and the role of economies of scale in food preparation and food consumption [Gan and Vernon \(2003\)](#), [Crossley and Lu \(2018\)](#) ,[Gibson and Kim \(2018\)](#)

the per capita income constant. Our result is in line with the theory and the share of clothing increases by increasing the household size. Analyzing the relation on the distribution of income shows a stronger relation for poor families than the rich, as expected in the Barten model. Our findings confirm the Deaton-Paxson puzzle for food. However, clothing as a private good is totally consistent with the Barten theory.

Can Substituting time for expenditure be important to the household welfare? In the third chapter, "**The Becker Model of Time Allocation: Empirical Evidence with US Data**" we aim at answering this question.

We expand the model based on the Backerian unitary model of household to analyze the relation between different goods expenditure and time in the household. We show that under the assumption of no joint production and constant return to scale, preference and technology can be identified provided that the goods and time be allocated to the production and constant returns to scale. In addition, we propose the empirical application of our model using the datasets conducted by the Bureau of Labor Statistics, the American Time Use Survey (ATUS) and the Consumer Expenditure Survey for fifteen waves (CES) (2003-2017).

One of the main problems to estimate this kind of model is that data providing information on both the allocation of time and the allocation of expenditure are rare. To be able to estimate our model, we use three different databases. For the information on the time allocation, we use ATUS. But the non-labor income is not reported in ATUS. Thanks to the fact that the ATUS is extracted from the Current Population Survey, we can match the two databases and add the non-labor income to ATUS. For the information on expenditure allocation, we use CES. We define five commodities around the following activities: eating, housing maintenance, clothing, transport and leisure. We estimate our model on the sub-sample of single-head households of ages between 25 to 60 applying the seemingly unrelated regression (SUR).

Does time allocation play an important role in the demand of households? Yes, the

parameters of our extended model are different from the traditional model, while they have the same order of magnitude. According to the estimated parameters of the production function, the traditional model is rejected. The two main inputs of the production function (time and money) are rather complementary in the production of goods. Additionally, the comparison of the evolution of the shadow prices for the different goods with the evolution of the corresponding current prices shows that the shadow and the market prices increased during the analysis period. However, the rates of increase are different. Consequently, it is important to take into account the full prices of the good for the welfare analysis, especially for the necessary goods, to avoid under-estimating the well-being of the poorest, who devote a large part of their resource to goods like food.

This thesis is thus composed of three distinct chapters on the consumer literature. The first chapter studies the welfare impact of price change due to the recent price shocks for Iranian households. The second chapter addresses the issue of the economies of scale and tries to understand the Deaton-Paxson puzzle using the household expenditure and income survey of a developing country. Finally, the third chapter studies the Becker model and analyzes the producing consumption with time and goods using the three American database.

Bibliography

- Alem, Y. (2011). The impact of food price inflation on consumer welfare in urban ethiopia: A quadratic almost ideal demand system approach. *Economic Studies Department of Economics School of Business, Economics and Law University of Gothenburg*, page 54.
- Apps, P. F. and Rees, R. (1988). Taxation and the household. *Journal of Public Economics*, 35(3):355–369.
- Attanasio, O. and Lechene, V. (2010). Conditional cash transfers, women and the demand for food. Technical report, IFS working papers.
- Banks, J., Blundell, R., and Lewbel, A. (1997). Quadratic engel curves and consumer demand. *The review of economics and statistics*, 79(4):527–539.
- Bargain, O. and Donni, O. (2012). Expenditure on children: a rothbarth-type method consistent with scale economies and parents. *European Economic Review*, 56(4):792–813.
- Barten, A. P. (1964a). Consumer demand functions under conditions of almost additive preferences. *Econometrica: Journal of the Econometric Society*, pages 1–38.
- Barten, A. P. (1964b). Family composition, prices and expenditure patterns.
- Becker, G. S. (1965). A theory of the allocation of time. *The economic journal*, pages 493–517.

- Becker, G. S. (1973). A theory of marriage: Part i. *Journal of Political economy*, 81(4):813–846.
- Blundell, R. and Stoker, T. M. (2005). Heterogeneity and aggregation. *Journal of economic literature*, 43(2):347–391.
- Bourguignon, F. and Chiappori, P.-A. (1992). Collective models of household behavior: an introduction. *European Economic Review*, 36(2-3):355–364.
- Browning, M. and Chiappori, P.-A. (1998). Efficient intra-household allocations: A general characterization and empirical tests. *Econometrica*, pages 1241–1278.
- Brzozowski, M., Crossley, T. F., and Winter, J. K. (2017). Does survey recall error explain the deaton–paxson puzzle? *Economics Letters*, 158:18–20.
- Burtless, G. (1999). Effects of growing wage disparities and changing family composition on the us income distribution. *European Economic Review*, 43(4-6):853–865.
- Chiappori, P.-A. (1988). Rational household labor supply. *Econometrica: Journal of the Econometric Society*, pages 63–90.
- Christensen, L. R., Jorgenson, D. W., and Lau, L. J. (1975). Transcendental logarithmic utility functions. *The American Economic Review*, 65(3):367–383.
- Crossley, T. F. and Lu, Y. (2018). Returns to scale in food preparation and the deaton–paxson puzzle. *Review of Economics of the Household*, 16(1):5–19.
- Deaton, A. (1974a). A reconsideration of the empirical implications of additive preferences. *The Economic Journal*, 84(334):338–348.
- Deaton, A. and Muellbauer, J. (1980). An almost ideal demand system. *The American economic review*, 70(3):312–326.
- Deaton, A. and Paxson, C. (1998). Economies of scale, household size, and the demand for food. *Journal of political economy*, 106(5):897–930.

- Deaton, A. S. (1974b). The analysis of consumer demand in the united kingdom, 1900-1970. *Econometrica: Journal of the Econometric Society*, pages 341–367.
- DeSerpa, A. C. (1971). A theory of the economics of time. *The Economic Journal*, 81(324):828–846.
- Donni, O. and Chiappori, P.-A. (2011). Nonunitary models of household behavior: a survey of the literature. In *Household economic behaviors*, pages 1–40. Springer.
- Dunbar, G. R., Lewbel, A., and Pendakur, K. (2013). Children’s resources in collective households: identification, estimation, and an application to child poverty in malawi. *American Economic Review*, 103(1):438–71.
- Evans, A. W. (1972). On the theory of the valuation and allocation of time. *Scottish Journal of Political Economy*, 19(1):1–17.
- Ferreira, F. H., Fruttero, A., Leite, P. G., and Lucchetti, L. R. (2013). Rising food prices and household welfare: evidence from brazil in 2008. *Journal of Agricultural Economics*, 64(1):151–176.
- Friedman, J. and Levinsohn, J. (2002). The distributional impacts of indonesia’s financial crisis on household welfare: A “rapid response” methodology. *The World Bank Economic Review*, 16(3):397–423.
- Gan, L. and Vernon, V. (2003). Testing the barten model of economies of scale in household consumption: Toward resolving a paradox of deaton and paxson. *Journal of Political Economy*, 111(6):1361–1377.
- Gibson, J. (2002). Why does the engel method work? food demand, economies of size and household survey methods. *Oxford Bulletin of Economics and Statistics*, 64(4):341–359.
- Gibson, J., Beegle, K., De Weerd, J., and Friedman, J. (2015). *What does variation in survey design reveal about the nature of measurement errors in household consumption?* Oxford Bulletin of Economics and Statistics.

- Gibson, J. and Kim, B. (2007). Measurement error in recall surveys and the relationship between household size and food demand. *American Journal of Agricultural Economics*, 89(2):473–489.
- Gibson, J. and Kim, B. (2018). Economies of scale, bulk discounts, and liquidity constraints: comparing unit value and transaction level evidence in a poor country. *Review of Economics of the Household*, 16(1):21–39.
- Gorman, W. M. (1980). A possible procedure for analysing quality differentials in the egg market. *The Review of Economic Studies*, 47(5):843–856.
- Greenwood, J., Guner, N., Kocharkov, G., and Santos, C. (2014). Marry your like: Assortative mating and income inequality. *American Economic Review*, 104(5):348–53.
- Hammond, P. J. (1990). Theoretical progress in public economics: a provocative assessment. *Oxford Economic Papers*, 42(1):6–33.
- Hausman, J. A. (1981). Exact consumer’s surplus and deadweight loss. *The American Economic Review*, 71(4):662–676.
- Henderson, A. (1941). Consumer’s surplus and the compensating variation. *The Review of Economic Studies*, 8(2):117–121.
- Hicks, J. (1956). Jr (1956). a revision of demand theory.
- Hicks, J. R. (1939). From ‘value and capital’. In *Bond Duration and Immunization*, pages 57–61. Routledge.
- Hicks, J. R. (1941). The rehabilitation of consumers’ surplus. *The Review of Economic Studies*, 8(2):108–116.
- Horowitz, A. W. (2002). Household size and the demand for food: a puzzle resolved? *V Unpublished Manuscript, University of Arkansas*.
- Houthakker, H. S. (1960). Additive preferences. *Econometrica: Journal of the Econometric Society*, pages 244–257.

- Ironmonger, D. S. (1972). New commodities and consumer behaviour.
- Juster, F. T. and Stafford, F. P. (1991). The allocation of time: Empirical findings, behavioral models, and problems of measurement. *Journal of Economic literature*, 29(2):471–522.
- Lancaster, K. J. (1966). A new approach to consumer theory. *Journal of political economy*, 74(2):132–157.
- Lazear, E. P. and Michael, R. T. (1980). Real income equivalence among one-earner and two-earner families. *The American Economic Review*, 70(2):203–208.
- Leser, C. E. (1941). Family budget data and price-elasticities of demand. *The Review of Economic Studies*, 9(1):40–57.
- Lewbel, A., Chiappori, P.-A., and Browning, M. (2001). Estimating consumption economies of scale, adult equivalence scales, and household bargaining power. Technical report, Mimeo, Chestnut Hill, Boston College.
- Lewbel, A. and Pendakur, K. (2009). Tricks with hicks: The easi demand system. *American Economic Review*, 99(3):827–63.
- Lluch, C. (1971). Consumer demand functions, spain, 1958–1964. *European Economic Review*, 2(3):277–302.
- McElroy, M. B. and Horney, M. J. (1981). Nash-bargained household decisions: Toward a generalization of the theory of demand. *International economic review*, pages 333–349.
- Mincer, J. (1962). Labor force participation of married women: A study of labor supply. In *Aspects of labor economics*, pages 63–105. Princeton University Press.
- MohammadZadeh, M. (2011). The Impact of subsidies changes on Iranian Hoousehold Food demand.
- Osei-Asare, Y. B., Eghan, M., et al. (2013). Food price inflation and consumer welfare in ghana. *International Journal of Food and Agricultural Economics*, 1(1):27–39.

- Schwartz, C. R. (2010). Earnings inequality and the changing association between spouses' earnings. *American journal of sociology*, 115(5):1524–1557.
- Stone, R. (1954). *The measurement of consumers' expenditure and behaviour in the United Kingdom, 1920-1938*, volume I. Cambridge University Press, Cambridge, UK.
- Theil, H. (1965). The information approach to demand analysis. *Econometrica*, 33(1):67–87.
- Vartia, Y. O. (1983). Efficient methods of measuring welfare change and compensated income in terms of ordinary demand functions. *Econometrica: Journal of the Econometric Society*, pages 79–98.
- Vu, L. and Glewwe, P. (2011). Impacts of rising food prices on poverty and welfare in vietnam. *Journal of Agricultural and Resource Economics*, pages 14–27.
- Weber, R. et al. (2015). Welfare impacts of rising food prices: Evidence from india. In *2015 Conference, August*, pages 9–14.
- Willig, R. D. (1976). Consumer's surplus without apology. *The American Economic Review*, 66(4):589–597.

Chapter 1

Iranian Household Welfare after Recent Economic Sanctions

Abstract

Over the past decade, Iran's economy has been confronted with external and internal shocks: The United States, the United Nations Security Council and the European Union intensified sanctions against Iran in 2011/2012 to stop its nuclear activities. On the other hand, Iran's government decided to implement the subsidy reform and eliminate subsidies on certain products. As a result of all these shocks, Iran has been experiencing price increased shocks. In this paper, we explore how price changes impact the Iranian consumer's welfare. Having estimated the relevant parameters using the Quadratic Almost Ideal Demand System model, we used the indirect utility function to calculate the welfare changes due to the price changes by compensating variation approach. Our results show that Iranian households in the middle of the income distribution were more adversely impacted by the price shocks than the poor and the rich. The families in rural areas need to earn less income to obtain the same consumption level as before the price shocks compared to the families in the urban areas. Additionally, in both urban and rural areas households who work in the private sector were the most impacted by the price change, unlike the agricultural sector. Our research also suggests that families with more children are more affected than the childless families.

Keywords: Sanctions, Welfare, Compensating variation, Iran.

1.1 Introduction

Over the past decade, Iran's economy has been confronted with external and internal shocks: The United States, the United Nations Security Council and the European Union intensified economic sanctions against Iran to stop Iran's nuclear activities. The new wave of sanctions was targeting Iran's energy and financial sectors. On December 2011, the US imposed sanctions on the Central Bank of Iran to cut it from the international fiscal system. A month later, on 23 January 2012, the European Union approved the imposition of the ban on Iranian crude oil¹.

On the other hand, the government decided to implement the subsidy reform and eliminate subsidies on certain products. All these incidents profoundly affected the Iranian economy, growth and income distribution. According to the world bank statistics, Iran GDP growth dropped by 53 percent in 2011 compared to 2010 i.e. from 5.8 percent to 2.6 percent, which became -7 percent in 2012. Figure 1.1 presents the GDP per capita, PPP on US dollar of Iran, Turkey and MENA countries². The decrease of GDP per capita after 2011 is shown compared to the other countries.

As Iran has the world's fourth largest proved crude oil reserves³ and the second largest natural gas reserves, oil and gas revenue is the main source of fiscal revenue and foreign exchange earning. The new waves of sanction profoundly affected the Iranian energy sector by restricting Iran's ability to sell oil. As a result, in 2012, about one million(b/d) crude oil dropped from export compared to the previous year.⁴ Also after EU sanctions, the share of Iran's monthly exports of crude oil and condensate have changed. The share of European countries such as Spain, Italy and Greece decreased sharply. Additionally, the share of Japan and South Korea decreased gradually while China's share increased. Figure 1.2 presents the share of Iran's export of crude oil to different countries. In Figure 1.3, the decrease in the production of petroleum after the sanctions is shown, however there are not any

1. This proposal was led by France, Germany and UK.

2. Countries with similar economic systems.

3. 10 percent of the world's crude oil and 13 percent of OPEC's reserves are supported by Iran

4. U.S. Energy Information Administration based on Trade Information Services.

sharp changes in its consumption.

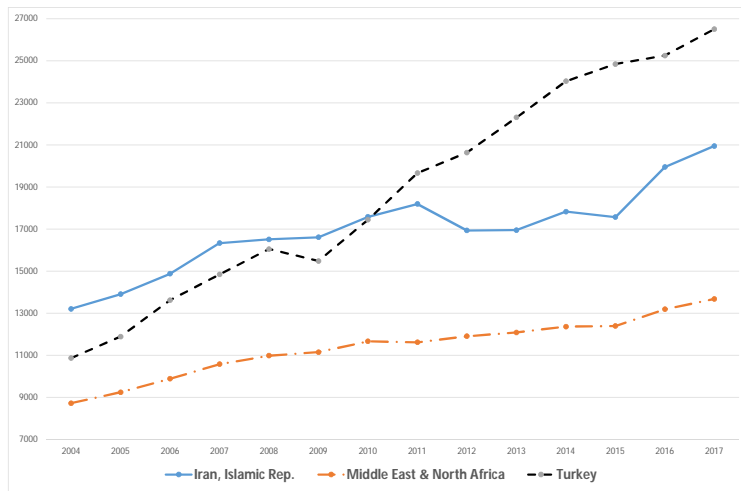


Figure 1.1 – GDP per capita, PPP

Source: World Bank

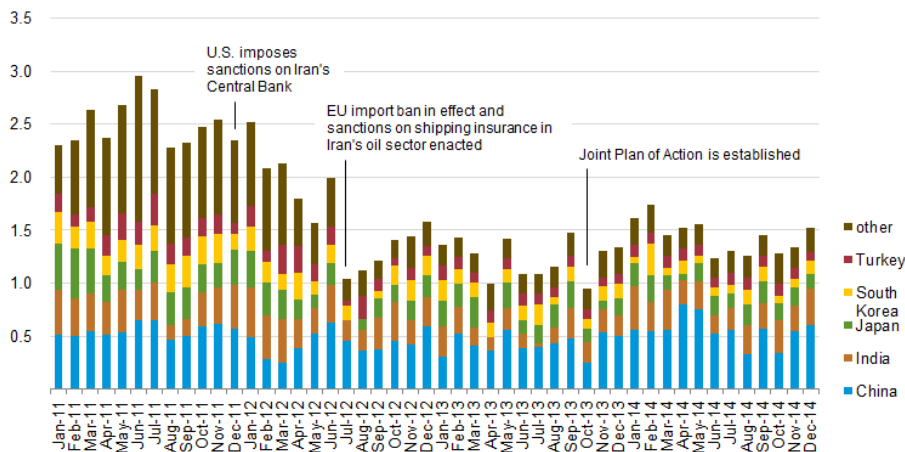


Figure 1.2 – Iran's monthly exports of crude oil and condensate

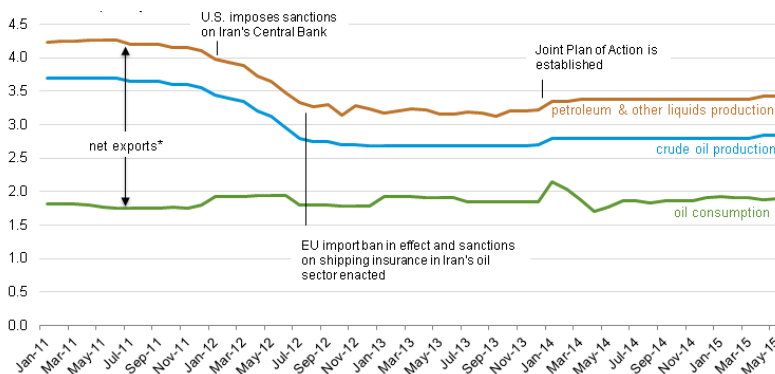


Figure 1.3 – Iranian petroleum and other liquids production and consumption.

Source: The US energy information administration based on the Global Trade Information Services.

Over the same period in December 2010, the Iranian government implemented the subsidy reform to relax subsidies allocated to some products, mainly energy, to offset the reduction of its revenue due to sanctions (Farzanegan et al., 2015). The aim of the program was to increase domestic prices to achieve the international prices, while using some percentage of the revenue to compensate households for increased prices with cash transfer. But the revenue from raising energy prices was not enough to supply the cash transfer program. As a result, the government printed money. Consequently, the subsidy reform became more inflationary than expected. Despite the new inflation, the amount of cash transfer stayed fixed in local currency: 45 dollars per person per month at the beginning of the reform. The value decreased to 17 US dollars in 2014 based on the official exchange rate announced by the Central Bank of Iran.

As a result of all these shocks, Iran has been experiencing price increases. The prices of commodities have increased by more than 20 percent since 2010/2011⁵. Figure 1.4 presents the consumer price index of Iran and the Turkey (We compare Iran's CPI with the CPI of Turkey as Turkey has the most similar economy indexes with Iran in the region before 2010). We can see also the inflation rate of consumer price for these two countries and MENA countries in Figure 1.5. Iran's CPI before 2010 has a similar trend as Turkey, but after 2010 the raise of Iran's CPI is striking. Figure 1.6 shows the price indexes for 5 main commodities groups. The horizontal axis presents the equivalent Gregorian years of Persian calendar. For example, the year 1383 corresponds to 2004/05 and the quarter is based on the Persian calendar⁶. The vertical axis shows the price indexes for 5 groups. There is a sharp increase by more than 50 percent in the price of energy and gradual augmentation in other prices.

In this paper, we aim to measure how the welfare of Iranian households has changed in recent years after the new wave of sanctions and price changes in 2010/2011. To achieve our goal, we focus on changes in welfare induced by the

5. The statistical center of Iran's reports.

6. Persian year begins on 21 Mars, first day of Spring. For the sake of accuracy I did not convert the quarter.

price following the indirect welfare measurement. We use thirteen waves of the micro data of household survey conducted yearly by Statistical Center of Iran, and we estimate a demand system in which demand depends on income and prices, but also on household characteristics using the Quadratic Almost Ideal Demand System (QUAIDS) by [Banks et al. \(1997\)](#) for urban and rural areas. Then, with respect to the estimated parameters, we calculate the welfare loss (gain) by compensating variation (CV) approach ([Friedman and Levinsohn, 2002](#))⁷. The CV is the monetary compensation required to bring the consumer back to the original utility level before the price shocks. Distinguishing the impact of sanctions from subsidy reform on the welfare changes is not the goal of this paper.

Having estimated the relevant parameters using QUAIDS model, we used the indirect utility function to calculate the welfare changes due to change in price by the compensating variation approach. Our results show that the Iranian household in the middle of the income distribution were the most adversely impacted by the price shock in both urban and rural areas. The families in rural areas need to earn less income to obtain the same consumption level as before the price shock compared to the families in urban areas. Additionally, classifying households by activity of the household head, we find that the families in which the household head is working in the private sector are more affected by the price shock, however the agricultural sector is less vulnerable in both urban and rural areas. Our research also suggests that families with children are more affected by the price shock compared to those without children in both urban and rural area.

Our contribution to the existing literature is multi-sided. Studies of the demand system in developing countries over the several periods are rare. To the best of my knowledge, this is the first paper using the micro data of 13 years of household expenditure and income survey to explain the welfare changes on income distribution after the price shocks related to the economics sanctions and subsidy reform in

7. Studies on the welfare effect of price changes using the CV approach have been conducted for developed and developing countries in the literature, e.g :[Attanasio and Lechene \(2010\)](#), [Osei-Asare et al. \(2013\)](#), [Ferreira et al. \(2013\)](#), [Vu and Glewwe \(2011\)](#), [Alem \(2011\)](#), [Weber et al. \(2015\)](#), [MohammadZadeh \(2011\)](#)

Iran. Thanks to the available price variation in our data, we estimate the elasticity of the price and income precisely, which is not frequent because of lack of data. We also analyze the relation between price variation and the households' welfare. Additionally, it is important to measure how sanction can influence the welfare of ordinary people, despite the fact that the sanctions are supposed to target the political government rather than the households.

The rest of this paper is structured as follows: Section two explains the theoretical model which is used in this research. Section three introduces the data. Section four presents and discusses the study's result and section five concludes the paper.

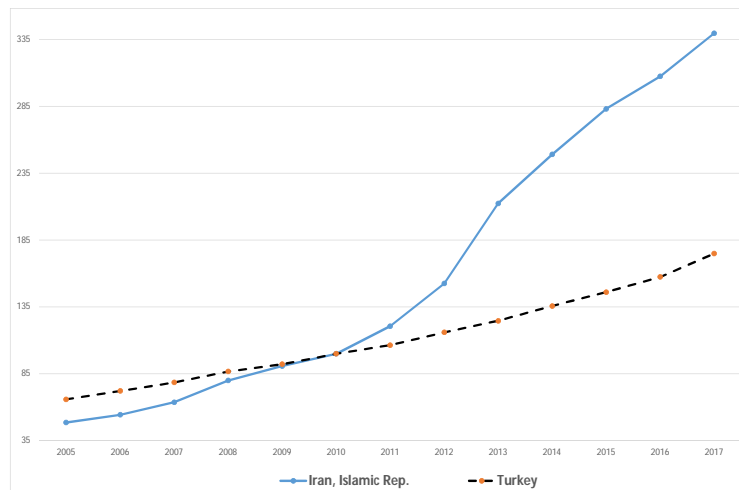


Figure 1.4 – Consumer price index

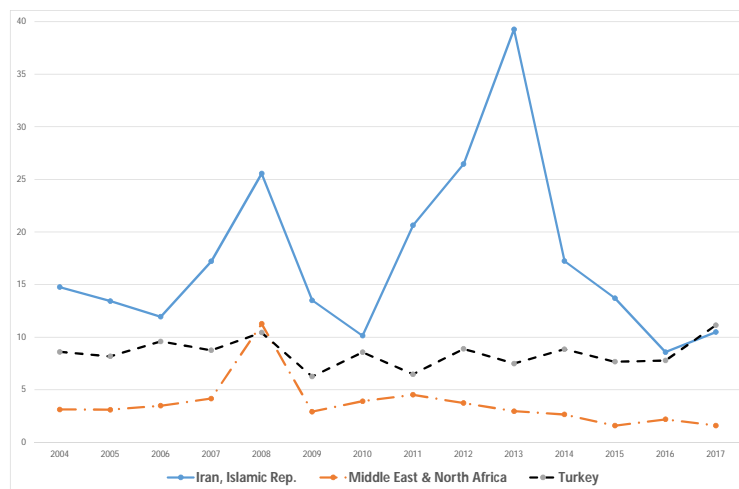


Figure 1.5 – Inflation of consumer price

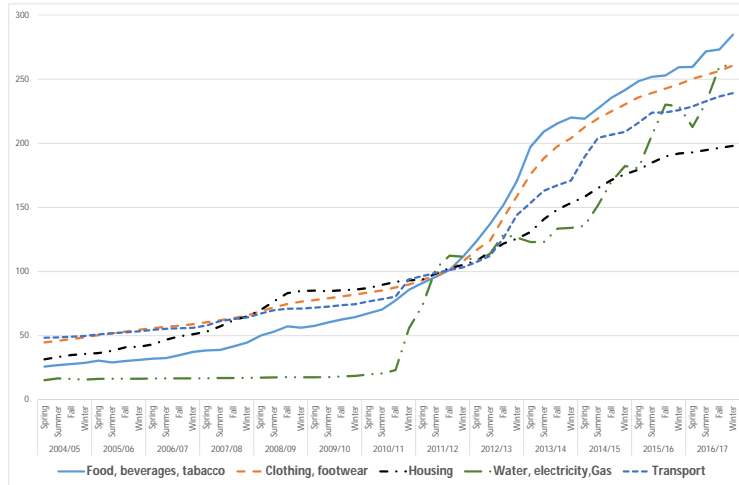


Figure 1.6 – Price indexes for 5 selected groups

1.2 Theoretical model

1.2.1 Demand system equation and elasticity

To calculate the impact of price changes on the household welfare, we start by estimating a demand system for Iranian households which allows us to calculate income elasticity and (un)compensated own and cross price elasticity. We estimate the Quadratic Almost Ideal Demand System proposed by [Banks et al. \(1997\)](#) which is a flexible functional form that incorporates nonlinear effects and interactions between prices and expenditures in the demand relationships.

QUAIDS is an extension of the Almost Ideal Demand System. The Almost Ideal demand system was developed by [Deaton and Muellbauer \(1980\)](#). The quadratic almost ideal demand system adds the quadratic term of log income to the AIDS and allows a more flexible relationship between budget share and total expenditure while being consistent with the theory. This means that goods can be basic or luxury in different levels of income.

Following [Banks et al. \(1997\)](#), the general QUAIDS model is derived from an indirect

utility function of the following form:

$$\ln V(\mathbf{p}, x) = \left\{ \left[\frac{\ln x - \ln a(\mathbf{p})}{b(\mathbf{p})} \right]^{-1} + \sum_{i=1}^n \lambda_i \ln p_i \right\}^{-1} \quad (1.2.1)$$

where x is the total expenditure and \mathbf{p} is the vector of prices. Applying Roy's identity to the indirect utility function, equation 1.2.1 yields:

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{x}{a(\mathbf{p})}\right) + \frac{\lambda_i}{b(\mathbf{p})} \left(\ln\left(\frac{x}{a(\mathbf{p})}\right)\right)^2 \quad (1.2.2)$$

where w_i is the expenditure share of commodity groups i in total expenditure, x . p_j is price of goods j and $b(\mathbf{p})$, $\alpha(\mathbf{p})$ are the price indexes calculated by the following equations:

$$\begin{aligned} \ln a(\mathbf{p}) &= \alpha_0 + \sum_k \alpha_k \ln(p_k) + \frac{1}{2} \sum_k \sum_l \gamma_{kl} \ln(p_k) \ln(p_l) \\ b(\mathbf{p}) &= \prod_{i=1}^n p_i^{\beta_i} \end{aligned} \quad (1.2.3)$$

To satisfy the adding up, homogeneity and symmetry which derived from the standard demand theory, the following parameter restriction must hold: Adding-up, expenditure shares must sum up to one:

$$\sum_{i=1}^n \alpha_i = 1 \quad \sum_{i=1}^n \beta_i = 0 \quad \sum_{i=1}^n \gamma_{ij} = 0 \quad \forall_j \quad \sum_{i=1}^n \lambda_{ij} = 0$$

homogeneity:

$$\sum_{j=1}^n \gamma_{ij} = 0 \quad \forall_i$$

as well as Slutsky symmetry: $\lambda_{ij} = \lambda_{ji} \quad \forall_{i,j}$

Differentiating the equation (1.2.2) with respect to $\ln(p_j)$ and $\ln(x)$, we obtain the expressions (1.6.1) and (1.6.2) in appendix (1.6.1) which are used afterward to compute income elasticity and compensated and uncompensated elasticity.

1.2.2 Measuring the Welfare Effect of Price Changes

After estimating the (un)compensated own and cross price elasticity, we calculate the welfare impact of the increase in commodity prices. To measure the impact of price changes on the household welfare, we look at the changes in the consumer surplus due to the changes in prices. One should note that we do not consider any potential changes in the demand curve of goods related to the economic sanctions other than relative price changes. Also, we do not take into account any impacts of economic sanctions on economy or on the absolute level of income due to, for example changes of the employment rate. We only focus on the nominal price effect of these events.

We consider the minimum expenditure function $e(p, u)$ needed to attain utility level u for a given household at the price level p . We compute compensating variation using the indirect utility function to measure the household welfare changes. The compensating variation (CV) is the amount of money needed to keep the household utility level equal to its previous level of utility before the changes in the commodity prices.

$$\begin{aligned} CV(p^0, p^1, x^0) &= e(p^1, u^0) - e(p^0, u^0) \\ &= e(p^1, u^0) - x^0 \end{aligned} \tag{1.2.4}$$

where $e(p^1, u^0)$ and $e(p^0, u^0)$ is the minimum expenditure needed to reach the utility u^0 at price p^1 and p^0 , and $x^0 = e(p^0, u^0)$ from the indirect utility function. CV will be positive if welfare after the price change is lower than the initial level, and negative in the opposite case.

After calculating the CV -the amount of money that one household has to earn to reach the initial consumption level, we measure the relative changes in the expenditure function: between 2 targeted years $((x^t - x^0)/x^0)$ and compensating variation value relative to the baseline expenditure (x^0) , $\frac{CV}{x^0} = \frac{e(p^t, u^0)}{x^0} - 1$. Finally, we compare the relative changes in the expenditure and the relative CV to find the

welfare loss (gain)⁸. In other words, we compare the increase in the total expenditure with the increase in the prices during two targeted periods.

1.3 Data

In this research, we use the Household Expenditure and Income Survey data (HEIS) which have been published annually by the Statistical Center of Iran since 1968 for urban and rural areas. The surveys are nationally and regionally representative, and include both demographic and income information but their main focus is on expenditures. They collect expenditure information on more than 1,000 items for each household as follows:

- Demographics information such as; age, sex, marital status, relationship to the head of the household, education, and employment status of individuals.
- Detailed information on food expenditures.
- Reports on non-food expenditures, including non-durable and semi-durable goods such as clothing and other household goods, as well as rent and utilities.
- Expenditures on durable goods.
- Household ownership of assets and amenities.
- Information on wage and salary income, self-employment income, and other income from retirement, rent, or other sources.

The recall period for these expenditures is the last 30 days, which is rather long for consumption. For durable, some educational expenses, insurance expenditures, investment in housing and farms, and income components, the recall period is the last 12 months. Like in most surveys of such type, income and expenditure data are self-reported. HEIS does not distinguish between how much is spent and how much is consumed and reports only expenditures on a particular item. For items, which were not purchased, an estimated value is provided. Gregorian notations for years are used in this report, but the actual survey period is left as it is shown in the HEIS: from March to March. For example, year 2010 means the survey period between

8. For more explanation you can see Appendix [1.6.2](#)

March 2010 and March 2011. It is important to note that HEIS does not contain information on prices for all goods. Therefore, the second data-set used in this paper includes price level from the Statistical Center of Iran. These prices are available quarterly for desegregated⁹ commodities in urban and rural areas over the study period. This time period began 6 years before the sanctions and continued 6 years after the high inflation, i.e. from 2004 to 2017. We use the year 2004 as the beginning year, because of the questionnaire design. The format of the questionnaire is not the same before and after 2004. Therefore to avoid the problem of homogenization of two different questionnaires, we used the data from 2004 to 2017.

1.4 Results and discussion

To estimate the demand system, we use the HEIS data and price indexes published by the Statistical Center of Iran. The model is estimated on 211,237 (213,548) households for urban (rural) over 13 waves by using the demographic, expenditure and consumption data. The main variables of the model are budget shares of the particular goods. We focus on six groups of commodities: food and beverage, housing¹⁰, water-gas-electricity¹¹, transport, clothing and footwear, and other, as the changes in their prices are more important in these main groups compared to the other. We suppose the aggregation of the goods such as; restaurants and hotels, furniture, health, communication, and recreation and culture as other. The family expenditure is adjusted by equivalence scale for difference in family size by using OECD equivalence scale. In OECD equivalence scale, the total expenditure of the family is divided by the square root of the household size¹².

The demand system is augmented with the demographic variables such as age and

9. Food and Beverages, Tobacco, Clothing and Footwear, Housing, Water, Electricity Gas, Furnishings Household Equipment, Health, Transport, Communication, Recreation and Culture, Education, Restaurants and Hotels, Goods Services

10. The actual payment of the rent or the imputed rate.

11. The monthly payment of the energy for the household.

12. [OECD \(2013\)](#)

education of the household head. Moreover, to avoid the heterogeneity problem across the urban and rural households, we report separate results for rural and urban areas. The heterogeneity problem concerns the self-produced agriculture and owner-occupied housing in rural areas that could change the consumption pattern of the household related to the price changes compared to urban areas.

Summary statistics of the main variables are shown in Tables 1.1 and 1.2 for rural and urban areas. First, we can see the expenditure share of the main commodities used in this research. According to the Engel's second law, food share correctly indicates welfare across households of different sizes and compositions, so lower food share implies higher welfare. It is important to notice that the share of the food and beverage on the total expenditure has a decreasing pattern until 2009/2010, after that it increases with the total expenditure. It is also greater for rural areas than urban ones. Second, there are the summary statistics of real total family income, family size, age of household head and price index for 13 years.

We estimate the quadratic almost ideal demand system equation (1.2.2) imposing all of the restrictions from theory using the iterated linear least-squares approach proposed by [Blundell and Robin \(1999\)](#), with six different commodities and demographic characteristics of the household. The estimated parameters for price (γ_s), total expenditure (β_s), square of total expenditure (λ_s) and constant (α_s), and the demographic variables (age), education of the household head ($eduHH$) are provided in appendix Tables A2 and A3 for urban and rural areas. All parameters are statistically significant at one percent levels. λ_s are statically significant for all six goods and are statistically different from zero, which confirms the appropriate usage of the quadratic demand system instead of the linear one.

To estimate the demand system, it is important to take into account the endogeneity of total expenditure and possible presence of measurement errors ([Attanasio and Lechene, 2010](#)). Endogeneity may arise as the result of defining total expenditure (an explanatory variable) as the sum of expenditures on individual components, which are endogenous to the decision-making problem, or as the result of measuring

Table 1.1 – Descriptive statistics of the variables for urban areas

Year	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
	Urban												
Food	0.35	0.34	0.33	0.32	0.31	0.31	0.32	0.34	0.35	0.36	0.34	0.33	0.34
(sd)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.14)	(0.14)	(0.13)	(0.13)	(0.13)
WGE	0.05	0.05	0.04	0.04	0.03	0.03	0.04	0.07	0.05	0.04	0.05	0.05	0.06
(sd)	(0.05)	(0.04)	(0.04)	(0.04)	(0.03)	(0.03)	(0.04)	(0.06)	(0.04)	(0.03)	(0.04)	(0.04)	(0.04)
House	0.33	0.34	0.36	0.38	0.40	0.39	0.39	0.34	0.36	0.35	0.36	0.36	0.37
(sd)	(0.16)	(0.16)	(0.17)	(0.17)	(0.18)	(0.18)	(0.18)	(0.17)	(0.18)	(0.18)	(0.17)	(0.16)	(0.16)
Cloth	0.07	0.07	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.05	0.05	0.05	0.05
(sd)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)	(0.07)
Trans	0.05	0.06	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.07
(sd)	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
RFln	1176472	1216448	1279962	1267428	1108604	1137386	1088061	1188620	1234812	1115779	1127828	1147512	1226481
(sd)	(1605733)	(1271947)	(1576656)	(1341726)	(1341197)	(1052873)	(927403)	870911	1569113	902603	922406	958491	1116363
Size	4.19	4.13	4.04	3.93	3.89	3.86	3.79	3.75	3.61	3.55	3.53	3.54	3.50
(sd)	(1.80)	(1.69)	(1.66)	(1.64)	(1.58)	(1.61)	(1.53)	(1.48)	(1.51)	(1.37)	(1.35)	(1.32)	(1.33)
AgeH	45.16	44.85	45.29	45.40	45.94	46.13	46.99	47.91	52.74	46.43	47.26	47.98	48.38
(sd)	(13.30)	(13.20)	(13.22)	(13.36)	(13.09)	(13.03)	(13.04)	(12.75)	(12.40)	(13.17)	(13.03)	(13.01)	(12.97)
CPI	33.80	37.90	43.10	50.54	63.53	69.49	79.06	99.94	128.49	169.74	194.90	216.93	231.59
(sd)	(1.26)	(1.10)	(1.85)	(2.76)	(3.34)	(1.50)	(5.09)	(5.82)	(12.16)	(8.02)	(7.85)	(5.19)	(5.56)
N	11,195	12,449	13,648	14,389	18,504	17,696	17,682	17,589	17,288	17,875	17,721	17,662	17,539

Food: Food share, House: Housing share, Clothing: Clothing and footwear share, Trans: Transport share

WGE: Water , gas and electricity, RFln: Real Family Income, AgeH: Age Household Head

Year 1383=2004/05... 1395=2016/2017

Table 1.2 – Descriptive statistics of the variables for rural areas

Year	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17
	Rural												
Food	0.49	0.49	0.48	0.48	0.48	0.47	0.48	0.48	0.52	0.52	0.50	0.49	0.49
(sd)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.15)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
WGE	0.07	0.07	0.06	0.06	0.05	0.05	0.05	0.09	0.07	0.06	0.07	0.08	0.08
(sd)	(0.07)	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.07)	(0.06)	(0.05)	(0.06)	(0.06)	(0.06)
House	0.13	0.14	0.15	0.16	0.18	0.19	0.18	0.15	0.13	0.14	0.15	0.16	0.17
(sd)	(0.11)	(0.11)	(0.12)	(0.13)	(0.13)	(0.13)	(0.13)	(0.11)	(0.10)	(0.11)	(0.11)	(0.11)	(0.12)
Cloth	0.09	0.09	0.09	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.05	0.05	(0.06)
(sd)	(0.10)	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)	(0.09)	(0.09)	(0.08)	(0.09)
Trans	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.07	0.07	0.08
(sd)	(0.06)	(0.06)	(0.05)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.05)	(0.05)	(0.06)	(0.06)	(0.06)
RFInc	978937	1014214	1017784	1042179	839328	915565	846126	696555	787790	670410	669112	693762	705536
(sd)	(1096516)	(1346335)	(1057917)	(1156790)	(920461)	(839177)	(770718)	(646425)	(709052)	(499191)	(541553)	(622623)	(574929)
Size	4.91	4.85	4.75	4.62	4.38	4.37	4.23	4.17	3.98	3.88	3.86	3.81	3.79
(sd)	(2.25)	(2.25)	(2.17)	(2.07)	(2.00)	(1.94)	(1.86)	(1.82)	(1.88)	(1.64)	(1.61)	(1.60)	(1.61)
AgeH	46.18	46.76	47.10	47.16	45.99	46.43	47.34	47.82	51.89	46.16	46.94	47.78	48.47
(sd)	(14.24)	(14.17)	(14.07)	(13.88)	(14.14)	(13.69)	(13.59)	(13.38)	(12.95)	(13.64)	(13.55)	(13.29)	(13.15)
CPI	29.64	33.21	37.31	43.71	55.39	61.08	73.26	99.95	132.58	180.62	205.30	226.94	243.37
(sd)	(1.05)	(0.83)	(1.56)	(2.19)	(2.21)	(2.14)	(7.96)	(5.63)	(13.85)	(8.02)	(7.72)	(4.35)	(6.02)
N	12132	13009	15538	15036	18234	16579	17814	17824	17616	17750	17467	17309	17240

Food: Food share, House: Housing share, Clothing: Clothing and footwear share, Trans: Transport share

WGE: Water , gas and electricity, RFIn: Real Family Income, AgeH: Age Household Head

Year 1383=2004/05... 1395=2016/2017

the total expenditure (even if it is exogenous) with an error which is correlated with the equation error. Measurement error in total expenditure is a likely cause of endogeneity. To deal with this issue, we used the log income of the household as an instrumental variable. High partial F statistics for instrumental variable shows that our instrument is a good explanatory variable for total expenditure. In Table A1, we see the first stage estimation of instrumental variable. All the coefficients are statically significant at the one percent level.

Interpreting the coefficient of the demand system is not so straightforward, so we focus on the income elasticity and the price elasticity in the next subsection to explain the results.

1.4.1 Price and income elasticity of demand

Estimated income elasticity for urban and rural areas at the mean value of the sample is shown in Table A1. Food and beverage, water, gas, electricity and housing for rural areas are necessary goods as the elasticity value are positive and less than one. On the contrary, clothing and transport are luxuries goods. In urban areas the income elasticity of food is less than rural areas. This is consistent with Engel's second law: food share correctly indicates welfare across households of different sizes and composition, so lower food share implies higher welfare. As income rises, the proportion of income spent on food falls, even if absolute expenditure on food rises. In other words, the income elasticity of demand of food is between 0 and 1. The results for urban areas are in line with the research of Goudarzi et al. (2007) and Tash et al. (2012) on estimating the income elasticity for six groups of commodities: food, clothing, transportation, housing, health, and furniture in urban areas. We can also find the own-price (un)compensated elasticity for different commodities in the second and third columns of Table A1.

Almost all of them are negative and statistically significant, which is consistent with the demand theory. The positive own-price elasticity for transport in rural areas may be due to the fewer positive consumption values than the other goods, so it is

Table 1.3 – Income and (un)compensated own-price elasticity

	Income	u_price	c_price	Income	u_price	c_price
	Urban			Rural		
Food	0.839*** (0.003)	-0.593*** (0.017)	-0.281*** (0.017)	0.955*** (0.002)	-0.773*** (0.009)	-0.293*** (0.009)
WGE	0.572*** (0.013)	-0.522*** (0.011)	-0.493*** (0.011)	0.566*** (0.010)	-0.284*** (0.011)	-0.245*** (0.011)
Housing	1.034*** (0.004)	-0.774*** (0.017)	-0.447*** (0.017)	0.866*** (0.006)	-0.842*** (0.033)	-0.710*** (0.033)
Clothing	1.348*** (0.010)	-1.041*** (0.198)	-0.954*** (0.198)	1.400*** (0.010)	-2.064*** (0.189)	-1.967*** (0.189)
Transport	1.289*** (0.007)	-0.711*** (0.077)	-0.634*** (0.077)	1.230*** (0.007)	0.012 (0.068)	0.095 (0.068)
Other	1.227*** (0.008)	-1.441*** (0.129)	-1.274*** (0.129)	1.213*** (0.008)	-2.200*** (0.139)	-2.031*** (0.139)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

WGE: Water, gas, electricity

Author calculation using Household Expenditure and Income Survey

not likely to be precisely estimated. Table A4 and Table A5 in appendix show the cross price compensated and uncompensated elasticity for six commodities in urban and rural areas respectively. This result could be affected by changing the degree of aggregation into the commodity bundles. Nonetheless, the use of more aggregate good bundle could be useful for dealing with the zero expenditure problem.

Table 1.4 indicates the distribution of the income elasticity for six bundles of commodities in urban areas. We notice that the poor households are more sensitive to changes in the income than the rich for the goods such as food and energy of the house. Income elasticity for food has a decreasing pattern across the income distribution. This can be explained by the fact that in the very poor families food has an important share of the total expenditure. Thus by increasing the income they have more demand for the food. For clothing and transport, there is no difference in the income elasticity on the distribution of the income. For both, increasing the income leads to increasing their budget share. Finally, the rich are more income-sensitive for housing than the poor households. And by increasing income they have more tendency to increase their share of housing compared to the low income families. We see the same story for the rural areas in Table 1.5.

Table 1.4 – Income elasticity across distribution of expenditure - urban areas

	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.90	0.86	0.84	0.83	0.83	0.83	0.83	0.82	0.81	0.73
(sd)	(0.04)	(0.04)	(0.05)	(0.06)	(0.07)	(0.07)	(0.08)	(0.08)	(0.08)	(0.19)
WGE	0.63	0.56	0.52	0.50	0.50	0.51	0.52	0.51	0.49	0.43
(sd)	(0.05)	(0.06)	(0.10)	(0.14)	(0.18)	(0.22)	(0.21)	(0.25)	(0.30)	(0.35)
Housing	1.02	1.03	1.03	1.03	1.03	1.03	1.03	1.04	1.04	1.05
(sd)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Clothing	1.64	1.47	1.44	1.46	1.47	1.47	1.45	1.40	1.33	1.19
(sd)	(0.64)	(0.43)	(0.48)	(0.44)	(0.42)	(0.37)	(0.30)	(0.21)	(0.15)	(0.14)
Transport	1.68	1.45	1.39	1.34	1.32	1.31	1.29	1.26	1.23	1.15
(sd)	(0.58)	(0.25)	(0.22)	(0.18)	(0.16)	(0.14)	(0.12)	(0.09)	(0.07)	(0.07)
Other	1.01	1.15	1.19	1.20	1.20	1.19	1.19	1.22	1.26	1.35
(sd)	(0.15)	(0.14)	(0.15)	(0.16)	(0.17)	(0.16)	(0.14)	(0.11)	(0.08)	(0.06)

Author calculation using Household Expenditure and Income Survey

Table 1.5 – Income elasticity across distribution of expenditure - rural areas

	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.98	0.97	0.96	0.95	0.95	0.95	0.95	0.95	0.94	0.90
(sd)	(0.03)	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.06)
WGE	0.68	0.59	0.53	0.48	0.46	0.45	0.46	0.45	0.48	0.39
(sd)	(0.05)	(0.06)	(0.10)	(0.15)	(0.22)	(0.29)	(0.36)	(0.44)	(0.35)	(0.25)
Housing	0.83	0.86	0.87	0.88	0.88	0.87	0.87	0.87	0.88	0.91
(sd)	(0.02)	(0.02)	(0.03)	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)
Clothing	1.50	1.42	1.39	1.39	1.42	1.46	1.48	1.47	1.41	1.32
(sd)	(0.29)	(0.21)	(0.18)	(0.17)	(0.21)	(0.21)	(0.19)	(0.16)	(0.12)	(0.09)
Transport	1.48	1.33	1.28	1.26	1.26	1.25	1.25	1.22	1.19	1.12
(sd)	(0.21)	(0.13)	(0.14)	(0.16)	(0.16)	(0.15)	(0.12)	(0.09)	(0.07)	(0.08)
Other	0.99	1.14	1.19	1.20	1.20	1.18	1.18	1.19	1.23	1.31
(sd)	(0.14)	(0.13)	(0.14)	(0.16)	(0.18)	(0.17)	(0.15)	(0.11)	(0.08)	(0.06)

Author calculation from Household Income and Expenditure Survey

1.4.2 Welfare changes

As mentioned in the previous section, the price increase shocks occurred in 2011 and 2012, so for our welfare study, we used year 2010 (before the shock) as a base line. And then, we focus on six price increments to analyze the welfare loss (gain), that is, we study the welfare changes for 6 years after the price shocks compared to 2010. Table 1.6 presents the price changes compared to year 2010/2011 for the six following years after. The energy price (WGE) increased by 100 percent, and the other indexes raised gradually each year. First, we focus on the relative differences in the

Table 1.6 – Price changes compared to 2010/2011 (percent)

	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17
Food	28.50	65.76	103.11	112.35	121.63	128.87
Clothing	14.21	43.93	79.17	93.96	102.28	108.00
Housing	9.91	26.20	45.85	61.58	72.30	77.02
WGE	129.57	148.50	155.91	177.31	207.07	218.67
Transport	19.60	39.24	68.85	90.01	99.59	104.76

compensating variation measure across the log of income distribution. The relative differences are shown in Table 1.7 for urban and rural areas and are calculated as follows: $Rcv = \frac{CV}{x^0} = \frac{e(p^1, u^0)}{x^0} - 1$. Rcv is the compensating variation value relative to the baseline expenditure(x^0). It is interpreted as the amount of money relative to the baseline expenditure that one household has to earn to reach the initial consumption level or growth of expenditure if we keep the household utility at the same level as the baseline. Additionally, Rcv could be interpreted as the price index¹³. While $Rex (\frac{x^t}{x^0} - 1)$ is the changes between expenditure of targeted year and the baseline relative to the baseline expenditure. For each year the mean value of Rcv and Rex is reported in the table on the income distribution.

By comparing the two values, we can find the welfare gain(loss) for the Iranian family on distribution of log income. For example, in 2012/13 in the third bottom decile, the household needs a 43 percentage increase of expenditure to reach their initial utility at the new price, while the percentage increase of expenditure (Rex) is about 55, i.e. more than 43 percent. Therefore, the increase in the household

13. For further explanation refer to Appendix 1.6.3.

expenditure is enough to compensate the potential welfare loss of household related to the price change and there is no welfare loss for the household in the third decile. As presented in the table, the household in the middle of the income distribution needs more expenditure to have the same utility as before the price changes with the new price, compared to the household in the top and bottom deciles. However, in all income distribution, the relative changes in the expenditure (Rex) is more than the relative compensating variation (Rcv) in year 2012/2013. To sum up, the price shock affected more the households in the middle of the income distribution than the poor and the rich in year 2012/2013 in urban areas.

The strength of the welfare changes is increasing year after year. This can be explained by the long-term impact of economic sanctions on the economy and the yearly increase in the prices (Table 1.6). For example, for year 2015/16 the household in the second decile of distribution of income needed 1.50 percent of their expenditure to stay at the initial utility by the new prices, while the expenditure increased by 1.81 percent compared to the initial one, therefore the households are enough compensated to tolerate the shocks. As shown in the table, there is a welfare loss for the rest of the deciles except for the household in the top decile. This means that the relative changes in expenditure are less than the needed minimum expenditure to compensate the family for the changes in the price. The Iranian households in the top and bottom of the income distribution were less adversely impacted by the price shock. Therefore the family in the middle of the income distribution needs to earn more income than the poor and the rich households in order to reach the initial consumption level as before the shocks.

In the bottom of Table 1.7 the changes in the welfare for rural areas are presented. Relative compensating variation for rural area is greater than for urban areas. The household needs more consumption to reach the initial utility in the new price compared to the urban area. In addition, we observe that the household in the middle of the income distribution and the rich are more adversely affected by the price shock compared to the poor family. Figure 1.7 and 1.8 show the differences between relative compensating variation (Rcv) and relative expenditure differences

(Rex). For urban areas we see that the households in the middle of the income distribution lose more welfare compared to the rich and poor families. In rural areas the poor households are less affected by the price changes compared to the other households.

In general, the rural poor require the least amount of consumption to obtain the pre-crisis utility, and urban households in the middle of the income distribution are the most affected by the price shock. This result could be explained by different channels. By the fact that the rural households probably grow their own food compared to urban households. Therefore, rural households are less affected by the price changes compared to the urban area. Additionally, we found that the poor families are generally less influenced by the shock compared to the other households. To have a better understanding of this finding, we check out the expenditure's share of different commodities on the distribution of income from 2010 to 2017. As presented in Table A6, food and housing have the largest expenditure shares of the income compared to the other goods (transport, clothing and water, gas, electricity). Additionally, the expenditure share of food and gas, water, electricity is descending on the income distribution. Poor households have more food share than the rich ones. When we look at the housing expenditure share on the income distribution for these seven years, it has a U shape. It means the housing share for the poor family is more than the family in the middle of the income distribution. In Table 1.6 we see that the food (housing) price increased by more than hundred (seventy) percent in seven years. This augmentation is more than 200 percent for the price of energy (gas, water, electricity). Subsequently, considering the high share of food, housing, and energy expenditure of the poor family total expenditure, the poor households seem more vulnerable compared to the other households. But our results show the opposite. How can we explain this fact!

As explained in the introduction, the Iranian government implemented the subsidy reform in December 2010 and started to pay the cash transfer to almost all the Iranian households (more than 85%). The cash transfer was based on the household size and was unconditional. The amount of the cash transfer was about 26 percent

of the household income for the households in the first decile of income distribution, this percentage decreased to 1 percent for the top decile of income in 2011 (Salehi-Isfahani et al., 2015). As a result, the cash transfer became a pro-poor program and helped the poor to be less influenced by the shock.

Table 1.7 – Welfare loss (gain) as a proportion of 2010/11 total expenditure across income distribution - urban and rural areas

Urban Area												
	2011/12		2012/13		2013/14		2014/15		2015/16		2016/17	
	Rcv	Rex	Rcv	Rex	Rcv	Rex	Rcv	Rex	Rcv	Rex	Rcv	Rex
1	0.09	0.27	0.41	1.06	0.89	1.47	1.16	1.79	1.42	2.01	1.58	1.96
2	0.14	0.32	0.48	0.90	0.98	1.38	1.26	1.58	1.52	1.75	1.69	1.96
3	0.12	0.25	0.45	0.55	0.94	0.97	1.21	1.20	1.47	1.35	1.64	1.45
4	0.14	0.25	0.47	0.55	0.96	0.92	1.24	1.16	1.51	1.30	1.67	1.37
5	0.13	0.26	0.46	0.51	0.95	0.93	1.24	1.14	1.49	1.25	1.65	1.34
6	0.12	0.22	0.46	0.48	0.94	0.85	1.22	1.04	1.47	1.22	1.63	1.33
7	0.11	0.19	0.43	0.42	0.91	0.81	1.19	0.96	1.43	1.15	1.59	1.27
8	0.09	0.25	0.42	0.48	0.89	0.81	1.16	0.98	1.40	1.19	1.55	1.32
9	0.10	0.28	0.43	0.49	0.91	0.86	1.18	1.08	1.42	1.25	1.58	1.34
10	0.02	0.27	0.32	0.63	0.74	0.92	1.01	1.18	1.22	1.36	1.36	1.59
Rural Area												
	2011/12		2012/13		2013/14		2014/15		2015/16		2016/17	
	Rcv	Rex	Rcv	Rex	Rcv	Rex	Rcv	Rex	Rcv	Rex	Rcv	Rex
1	0.13	0.55	0.47	1.10	1.01	1.62	1.28	1.76	1.53	1.90	1.70	1.84
2	0.19	0.39	0.56	0.91	1.13	1.40	1.40	1.61	1.67	1.67	1.85	1.78
3	0.21	0.44	0.58	0.83	1.17	1.27	1.46	1.42	1.73	1.58	1.91	1.63
4	0.19	0.36	0.56	0.74	1.13	1.18	1.42	1.26	1.68	1.47	1.86	1.55
5	0.19	0.34	0.56	0.70	1.13	1.20	1.42	1.27	1.67	1.43	1.86	1.45
6	0.18	0.31	0.57	0.68	1.12	1.11	1.40	1.26	1.66	1.43	1.84	1.47
7	0.20	0.34	0.59	0.73	1.15	1.12	1.44	1.35	1.70	1.45	1.88	1.53
8	0.17	0.31	0.56	0.66	1.11	1.07	1.40	1.31	1.65	1.43	1.83	1.42
9	0.16	0.29	0.55	0.72	1.10	0.99	1.39	1.24	1.63	1.43	1.81	1.41
10	0.10	0.24	0.48	0.62	1.00	0.94	1.27	1.22	1.50	1.22	1.67	1.30

Source: Author calculation using Household Income and Expenditure Survey Iran.

$$Rcv = e(p^1, u^0)/x^0 - 1$$

$$Rex = x_t/x^0 - 1$$

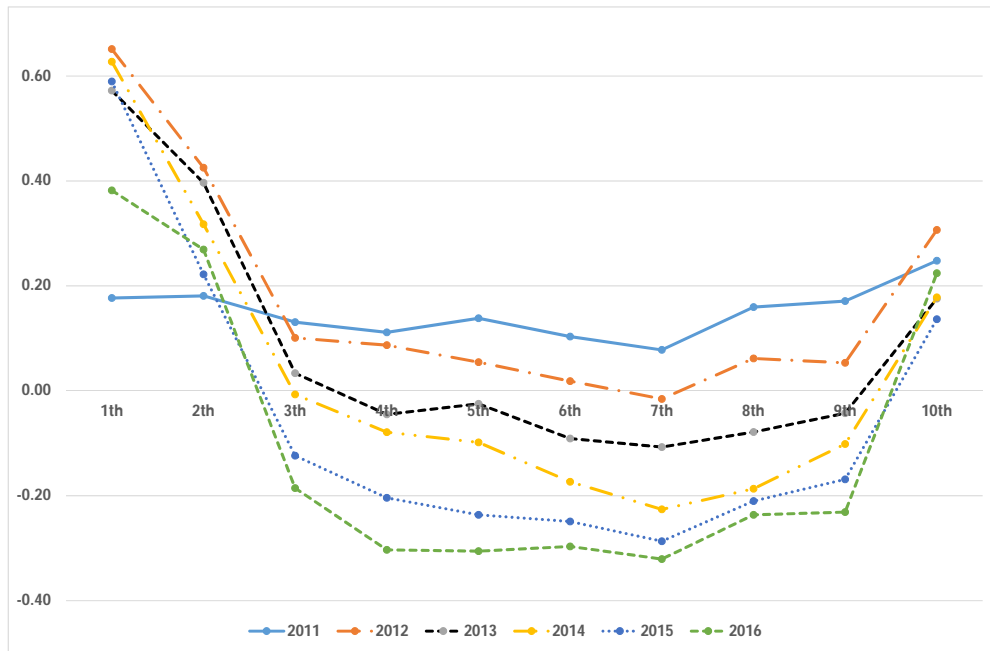


Figure 1.7 – Differences between relative expenditure changes (Rex) compensating variation (Rcv) - urban areas

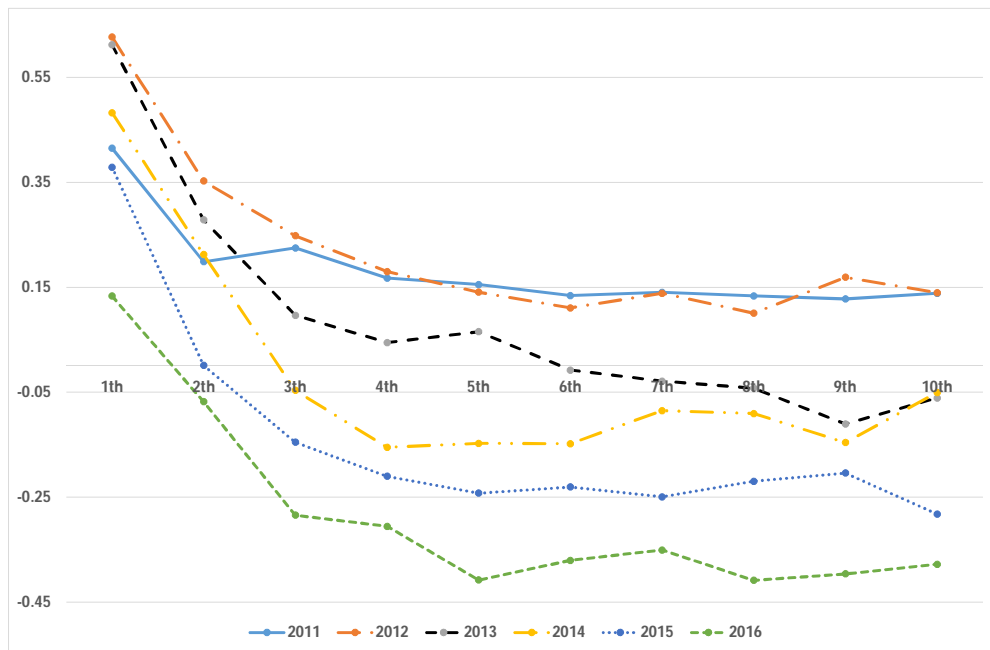


Figure 1.8 – Differences between relative expenditure changes (Rex) compensating variation (Rcv) - rural areas

Now we explore how the CV measure may be changed by the number of children and the household head’s job. Table 1.8 shows the changes in the relative compensating variation for the household heads who work in public, private and agriculture sectors by year. In both urban and rural areas the households who work in the private sector were most impacted by the price changes, contrary to the agriculture and

public sectors. The public sector was protected by the government program of yearly revenue increase. In addition, the agricultural households can benefit from their production compared to the other households. On the bottom of the table, the CV for families with different number of children are presented. The families with children are more affected by the price shock compared to those without children in both urban and rural areas. That can be explained while the fact of more consumption by having more children, being thus more vulnerable by changes in prices.

Table 1.8 – Compensating variation measured as a proportion of 2010/11 household’s expenditure for different household characteristics - urban and rural areas

	Urban					
	11/12	12/13	13/14	14/15	15/16	16/17
W&S, public	0.06	0.37	0.83	1.10	1.33	1.48
W&S, private	0.07	0.39	0.86	1.12	1.36	1.51
Agriculture	0.05	0.36	0.80	1.07	1.30	1.45
Zero Child	0.01	0.30	0.73	0.98	1.21	1.35
1 or 2 child	0.04	0.35	0.81	1.06	1.30	1.44
More than 2	0.08	0.40	0.87	1.14	1.39	1.54
	Rural Area					
	11/12	12/13	13/14	14/15	15/16	16/17
	2011	2012	2013	2014	2015	2016
W&S, public	0.17	0.55	1.11	1.40	1.65	1.83
W&S, private	0.16	0.53	1.09	1.37	1.62	1.80
Agriculture	0.11	0.47	1.00	1.27	1.52	1.69
Zero Child	0.06	0.40	0.90	1.15	1.38	1.55
1 or 2 child	0.12	0.48	1.02	1.29	1.53	1.70
More than 2	0.14	0.50	1.05	1.32	1.57	1.74

Source: Author calculation with Household expenditure and income survey Iran.

1.5 Conclusion

The analysis of welfare impacts of economic shocks is important for policy-makers. By identifying the most vulnerable households in the distribution of the income, policy-makers could decide for targeted intervention plans to help the most adversely impacted groups. In this paper, we exploit how the welfare of Iranian consumers changed during the new wave of economic sanctions after 2010/2011.

Using the QUAIDS, we estimated the demand system on micro data of households in Iran. Thanks to the estimated parameters, we calculated the income and price elasticity. The income elasticity show that food, beverage and water, gas, electricity and housing for the rural areas are necessary goods as the elasticity value are positive and less than one. On the contrary, clothing and transport are luxuries goods within total demand. By looking at the income elasticity on income distribution, we found that poor household, are more sensitive to income changes than rich for the food, beverage and water-gas-electricity.

Having estimated the relevant parameters, we used the indirect utility function to calculate the welfare changes regarding the changes in the prices. We focused on six price changes to analyze the welfare loss (gain), that is, we studied the welfare changes for 6 years following the price shocks.

Looking at the distribution of income, the welfare loss is more for the family in the middle of the income distribution compared to the poor and rich family. This means that Iranian households in the middle of the income distribution were more adversely impacted by the price shock, however all the households on different distributions of income are influenced. It is important to note that the families in rural areas are less influenced by the price shocked and need to earn less income to obtain the same consumption level as before the price shock compared to the families in urban areas. This phenomenon can be explained by the self-production in the rural areas. In addition, the amount of cash transfer by the government is relatively important for the poor family and helps the household to compensate their loss of consumption.

Classifying the households by the activity of the household head, we found that the families with the household head working in the private sector are more affected by the price shock, while the agricultural sector is less vulnerable for urban and rural areas. The public sector was protected by the government program of yearly revenue increase. In addition, the agricultural households can benefit from their self-production compared to the other households. Our research also suggests that the families with children are more affected by the price shock compared to families without children in both urban and rural areas. That can be explained by the fact of more consumption while having more children, being thus more influenced by changing the price.

Our work is not perfect and issues are left for future research. It is important to note that at the same period, there were other economic policies that could affect the economic environment. Therefore, the changes in prices could be the result of all the incidents at that period in Iran. In this paper, we did not try to separate the price changes due to different causes and we calculate the net price changes related to different occurrences. Also, we did not study the role of cash transfer on the welfare changes of household does not study in this research. Moreover, as we have no data on changes of income and wages of households in this period, we focused on the nominal changes rather than the real impact of the price shock. Finally it would be ideal to find the causal effect of economic sanctions on Iranian households due to lack of panel data we could not find the counter-factual in our study.

Bibliography

- Alem, Y. (2011). The impact of food price inflation on consumer welfare in urban ethiopia: A quadratic almost ideal demand system approach. *Economic Studies Department of Economics School of Business, Economics and Law University of Gothenburg*, page 54.
- Attanasio, O. and Lechene, V. (2010). Conditional cash transfers, women and the demand for food. Technical report, IFS working papers.
- Banks, J., Blundell, R., and Lewbel, A. (1997). Quadratic engel curves and consumer demand. *The review of economics and statistics*, 79(4):527–539.
- Blundell, R. and Robin, J. M. (1999). Estimation in large and disaggregated demand systems: An estimator for conditionally linear systems. *Journal of Applied Econometrics*, 14(3):209–232.
- Deaton, A. and Muellbauer, J. (1980). An almost ideal demand system. *The American economic review*, 70(3):312–326.
- Farzanegan, M. R., Mohammadikhabbazan, M., and Sadeghi, H. (2015). Effect of oil sanctions on the macroeconomic and household welfare in iran: New evidence from a cge model. Technical report, Joint Discussion Paper Series in Economics.
- Ferreira, F. H., Fruttero, A., Leite, P. G., and Lucchetti, L. R. (2013). Rising food prices and household welfare: evidence from brazil in 2008. *Journal of Agricultural Economics*, 64(1):151–176.
- Friedman, J. and Levinsohn, J. (2002). The distributional impacts of indonesia’s

- financial crisis on household welfare: A “rapid response” methodology. *The World Bank Economic Review*, 16(3):397–423.
- Goudarzi, M., MORTAZAVI, S. A. A., and PEYKANI, M. G. R. (2007). Survey on iranian’s urban households commodity and food demand, using two-stage budgeting.
- MohammadZadeh, M. (2011). The Impact of subsidies changes on Iranian Hoousehold Food demand.
- OECD (2013). Oecd frameworkfor statistics on the distribution of household income, consumption and wealth.
- Osei-Asare, Y. B., Eghan, M., et al. (2013). Food price inflation and consumer welfare in ghana. *International Journal of Food and Agricultural Economics*, 1(1):27–39.
- Salehi-Isfahani, D., Wilson Stucki, B., and Deutschmann, J. (2015). The reform of energy subsidies in iran: The role of cash transfers. *Emerging Markets Finance and Trade*, 51(6):1144–1162.
- Tash, M. N. S., Shahraki, J., and Jangi, S. N. (2012). Estimating the almost ideal demand system model for rural households in iran. *International Journal of Academic Research in Business and Social Sciences*, 2(8):281.
- Vu, L. and Glewwe, P. (2011). Impacts of rising food prices on poverty and welfare in vietnam. *Journal of Agricultural and Resource Economics*, pages 14–27.
- Weber, R. et al. (2015). Welfare impacts of rising food prices: Evidence from india. In *2015 Conference, August*, pages 9–14.

1.6 Appendix

1.6.1 Elasticity Calculation

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln x} = \beta_i + \frac{2\lambda_i}{b(p)} \left\{ \ln\left(\frac{x}{a(p)}\right) \right\} \quad (1.6.1)$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij}(\alpha_j + \sum_{k=1}^n \gamma_{jk} \ln p_k) - \frac{\lambda_i \beta_j}{b(p)} \left\{ \left(\ln\left(\frac{x}{a(p)}\right) \right)^2 \right\} \quad (1.6.2)$$

$$\mu_i = \frac{\partial w_i}{\partial x} x$$

$$\begin{aligned} \frac{\partial w_i}{\partial x} &= \frac{\partial \frac{p_i q_i}{x}}{\partial x} = -\frac{p_i q_i}{x^2} + \frac{p_i}{x} \frac{\partial q_i}{\partial x} \\ &= -\frac{w_i}{x} + \frac{w_i}{q_i} \frac{\partial q_i}{\partial x} \end{aligned}$$

$$\mu_i = \frac{\partial w_i}{\partial x} x = -w_i + w_i \frac{x}{q_i} \frac{\partial q_i}{\partial x} = -w_i(1 - \epsilon_i^{14})$$

The income elasticity is $\epsilon_i = \frac{\mu_i}{w_i} + 1$ and the uncompensated price elasticity is as follows: $\epsilon_{ij}^u = \frac{\mu_{ij}}{w_i} - \delta_{ij}$, where δ_{ij} is the Kronecker delta. Using the Slutsky equation, we calculate the compensated elasticity: $\epsilon_{ij}^c = \epsilon_{ij}^u + \epsilon_i w_i$. Moreover, we can use the matrix with entries $\{\epsilon_{ij}^c w_i\}_{i,j}$ to check for the negativity condition. This matrix should be negative semi-definitive.

1.6.2 Welfare Calculation

We can calculate the cost function using the indirect utility function like (1.6.4). Using the indirect utility function for u^0 and p^0 , we have the indirect utility function

14. ϵ_i is the income elasticity of demand for i th commodity.

$\ln V^0$, equation 1.2.1. Then, using the price after the shock p^1 , and utility before the shock u^0 , we can calculate $e(p^1, u^0)$ as you find in equation 1.6.7.

Having the $e(p^1, u^0)$, it is easy to calculate the CV and relative CV using the equation 1.2.4 and 1.6.3.

$$\begin{aligned} CV(p^0, p^1, x^0)/x^0 &= e(p^1, u^0)/x^0 - e(p^0, u^0)/x^0 \\ &= e(p^1, u^0)/x^0 - x^0/x^0 \\ &= e(p^1, u^0)/x^0 - 1 \end{aligned} \quad (1.6.3)$$

$$\ln(e(p, u)) = \ln x = b(p) \left[(\ln V)^{-1} - \sum_{i=1}^n \lambda_i \ln p_i \right] + \ln a(p) \quad (1.6.4)$$

$$\ln V^0 = \ln V(p^0, x^0) = \left\{ \left[\frac{\ln x^0 - \ln a(p^0)}{b(p^0)} \right]^{-1} + \sum_{i=1}^n \lambda_i \ln p_i \right\}^{-1} \quad (1.6.5)$$

$$\ln V^0 = \left\{ \left[\frac{\ln x^* - \ln a(p^1)}{b(p^1)} \right]^{-1} + \lambda \ln p^1 \right\}^{-1} \quad (1.6.6)$$

$$\ln(e(p^1, u^0)) = \ln x^* = b(p^1) \left[(\ln V^0)^{-1} - \sum_{i=1}^n \lambda_i \ln(p^1)_i \right] + \ln a(p^1) \quad (1.6.7)$$

$$e(p^1, u^1) = EXP(\ln x^1)$$

$$e(p^0, u^0) = EXP(\ln x^0)$$

$$e(p^1, u^0) = EXP(\ln x^*)$$

1.6.3 Calculating indices from expenditure data

Sometimes, especially for aggregate data, expenditure data are more readily available than quantity data. For these cases, the indices can be formulated in

terms of relative prices and base year expenditures, rather than quantities. Let E_{c,t_0} be the total expenditure on good c in the base period, then (by definition) we have $E_{c,t_0} = p_{c,t_0} \cdot q_{c,t_0}$ and therefore also $\frac{E_{c,t_0}}{p_{c,t_0}} = q_{c,t_0}$. We can substitute these values into our index price.

1.6.4 Estimation Results

Table A1 – First stage instrumental variable estimation

	Expenditure	
	Rural	Urban
lnp_food	0.542*** (43.43)	0.455 (21.47)
lnp_WGE	0.045*** (5.64)	-0.003 (-0.48)
lnp_House	-0.089* (-2.94)	0.054** (3.41)
lnp_Clothing	0.085 (0.90)	-0.028 (-0.32)
lnp_Transport	0.056 (1.34)	0.299*** (7.51)
lnp_other	-0.388* (-3.02)	-0.428*** (-3.86)
ln_income	0.384*** (255.56)	0.379*** (255.00)
ageHH	0.022*** (39.89)	0.013*** (23.51)
ageHH2	-0.0002*** (-29.88)	-0.00004*** (-7.57)
eduHH1	-0.135*** (-49.53)	-0.207*** (-67.85)
eduHH3	0.059*** (12.84)	0.144*** (51.07)
_cons	8.862*** (120.48)	8.789*** (124.82)
Number Ob:	213548	211,237
R-squared:	0.6741	0.6760

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A2 – Estimation results - urban areas

	Food,Bev	Water,Gas,El	House	Clothing,Footw	Transport	Other
γ_{Food}	0.0944*** (16.63)	-0.0284*** (-14.80)	-0.0785*** (-11.26)	-0.0316*** (-8.82)	-0.00763** (-3.16)	0.0518*** (10.64)
γ_{WGE}	-0.0284*** (-18.91)	0.0214*** (40.84)	0.00592** (3.20)	-0.000505 (-0.53)	0.00904*** (14.11)	-0.00742*** (-5.72)
γ_{House}	-0.0785*** (-19.68)	0.00592*** (4.41)	0.0899*** (18.33)	0.000726 (0.29)	0.00989*** (5.83)	-0.0279*** (-8.17)
γ_{Cloth}	-0.0316* (-2.23)	-0.000505 (-0.10)	0.000726 (0.04)	0.0560*** (6.27)	0.0174** (2.89)	-0.0419*** (-3.45)
γ_{Tran}	-0.00763 (-0.75)	0.00904** (2.67)	0.00989 (0.79)	0.0174** (2.71)	0.0337*** (7.81)	-0.0624*** (-7.22)
γ_{Othr}	0.0518*** (4.35)	-0.00742 (-1.81)	-0.0279 (-1.90)	-0.0419*** (-5.55)	-0.0624*** (-12.27)	0.0879*** (8.54)
β_{Inx}	0.0287*** (9.11)	-0.0238*** (-7.21)	-0.00526 (-1.39)	0.0686*** (35.48)	0.0464*** (35.30)	-0.115*** (-21.12)
λ_{Inx2}	-0.0153*** (-31.45)	0.000428 (0.82)	0.00286*** (4.79)	-0.00768*** (-25.39)	-0.00479*** (-23.26)	0.0245*** (28.75)
α_{ageHH}	0.00484*** (32.77)	0.000723*** (13.99)	-0.00852*** (-47.27)	0.00107*** (11.57)	0.00134*** (21.51)	0.000537*** (4.20)
α_{ageHH2}	-0.000053*** (-34.50)	-0.0000045*** (-8.47)	0.0001*** (54.31)	-0.000021*** (-21.17)	-0.000018*** (-28.00)	-0.000006*** (-4.33)
α_{eduHH1}	0.0184*** (20.39)	0.000903* (2.57)	-0.0206*** (-18.77)	0.00677*** (11.96)	-0.00563*** (-14.78)	0.000222 (0.27)
α_{eduHH3}	-0.00844*** (-10.41)	-0.00147*** (-4.84)	-0.00103 (-1.04)	0.00558*** (10.92)	0.00643*** (18.71)	-0.00106 (-1.46)
α_{cons}	0.301*** (50.72)	0.106*** (21.29)	0.478*** (66.88)	-0.0828*** (-22.60)	-0.0503*** (-20.25)	0.248*** (28.98)

N: 213548

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A3 – Estimation results - rural areas

	Food, Bev	Water, Gas, EI	House	Cloth, Footwear	Transport	Other
γ_{Food}	0.0591*** (15.83)	-0.0376*** (-24.50)	0.0322*** (10.84)	-0.0523*** (-23.96)	-0.0203*** (-13.68)	0.0190*** (6.48)
γ_{WGE}	-0.0376*** (-20.02)	0.0439*** (58.34)	-0.0179*** (-11.88)	0.00799*** (7.20)	0.00168* (2.22)	0.00195 (1.36)
γ_{House}	0.0322*** (3.61)	-0.0179*** (-5.01)	0.0321*** (4.48)	-0.0187*** (-3.56)	-0.00482 (-1.35)	-0.0229*** (-3.34)
γ_{Cloth}	-0.0523*** (-2.93)	0.00799 (1.11)	-0.0187 (-1.31)	0.0234* (2.23)	0.0209** (2.92)	0.0187 (1.36)
γ_{Tran}	-0.0203 (-1.88)	0.00168 (0.39)	-0.00482 (-0.55)	0.0209** (3.28)	0.0682*** (15.69)	-0.0656*** (-7.94)
γ_{Other}	0.019 (0.86)	0.00195 (0.22)	-0.0229 (-1.29)	0.0187 (1.43)	-0.0656*** (-7.39)	0.0489** (2.89)
β_{Inx}	0.0709*** (21.82)	-0.0191*** (-6.87)	-0.0535*** (-22.72)	0.0486*** (27.71)	0.0463*** (35.93)	-0.0931*** (-17.86)
λ_{Inx2}	-0.0180*** (-32.58)	-0.00205*** (-4.43)	0.00638*** (15.53)	-0.00395*** (-12.91)	-0.00581*** (-25.97)	0.0234*** (27.27)
α_{AgeHH}	0.00312*** (18.43)	0.000566*** (8.07)	-0.00473*** (-34.92)	0.000706*** (7.10)	0.000965*** (14.26)	-0.000623*** (-4.66)
α_{AgeHH2}	-0.00003*** (-18.34)	-0.000003*** (-3.63)	0.00005*** (39.06)	-0.00002*** (-15.00)	-0.00002*** (-18.85)	0.0000086*** (6.23)
α_{eduHH1}	0.0286*** (33.80)	0.00167*** (4.67)	-0.0190*** (-28.04)	0.00484*** (9.74)	-0.00746*** (-22.08)	-0.00866*** (-12.70)
α_{eduHH3}	-0.00336* (-2.46)	-0.000428 (-0.78)	-0.00109 (-1.00)	0.00137 (1.71)	0.00505*** (9.27)	-0.00154 (-1.47)
α_{cons}	0.352*** (60.72)	0.124*** (31.33)	0.351*** (79.92)	-0.0362*** (-11.14)	-0.0232*** (-10.08)	0.232*** (31.17)

N: 213548

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A4 – Cross-price elasticity - urban areas

	Uncompensated cross-price elasticity					
	p_Efood s	p_water s	p_rent	p_cloth r	p_trans t	p_other_5
	b/se	b/se	b/se	b/se	b/se	b/se
sha_food	-0.59*** (0.02)	-0.04*** (0.00)	-0.06*** (0.01)	-0.03 (0.05)	0.02 (0.03)	0.11* (0.06)
sha_wate	-0.41*** (0.05)	-0.52*** (0.01)	0.23*** (0.03)	-0.04 (0.14)	0.15* (0.07)	-0.03 (0.14)
sha_hous	-0.27*** (0.03)	0.01 (0.01)	-0.77*** (0.02)	-0.05 (0.08)	-0.01 (0.04)	-0.01 (0.08)
sha_clot	0.03 (0.06)	0.01 (0.02)	-0.13** (0.04)	-1.04** (0.20)	-0.17 (0.11)	0.66** (0.20)
sha_tran	0.23*** (0.05)	0.15*** (0.01)	0.01 (0.03)	-0.19 (0.14)	-0.71*** (0.08)	-0.30* (0.15)
sha_othe	-0.46*** (0.04)	-0.16*** (0.01)	-0.38*** (0.03)	0.31* (0.13)	-0.15* (0.07)	-1.44*** (0.13)
	Compensated cross-price elasticity					
sha_food	-0.281*** (0.02)	0.01 (0.00)	0.204*** (0.01)	0.03 (0.05)	0.075** (0.03)	0.223*** (0.06)
sha_wate	-0.194*** (0.05)	-0.493*** (0.01)	0.416*** (0.04)	(0.01) (0.14)	0.189** (0.07)	0.05 (0.14)
sha_hous	0.120*** (0.03)	0.060*** (0.01)	-0.447*** (0.02)	0.02 (0.08)	0.05 (0.04)	0.13 (0.08)
sha_clot	0.533*** (0.06)	0.074*** (0.02)	0.294*** (0.04)	-0.954*** (0.20)	(0.09) (0.11)	0.848*** (0.20)
sha_tran	0.711*** (0.05)	0.210*** (0.01)	0.418*** (0.03)	(0.11) (0.14)	-0.634*** (0.08)	(0.13) (0.15)
sha_othe	(0.01) (0.04)	-0.102*** (0.01)	0.01 (0.03)	0.391** (0.13)	(0.07) (0.07)	-1.274*** (0.13)

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A5 – Cross-price elasticity - rural areas

Uncompensated cross-price elasticity						
	p_Efood s	p_water s	p_rent	p_cloth r	p_trans t	p_other_5
	b/se	b/se	b/se	b/se	b/se	b/se
sha_food	-0.773*** (0.01)	-0.049*** (0.00)	0.119*** (0.01)	-0.060 (0.04)	-0.021 (0.02)	0.016 (0.05)
sha_wate	-0.272*** (0.03)	-0.284*** (0.01)	-0.091* (0.04)	0.143 (0.13)	0.020 (0.07)	0.075 (0.15)
sha_hous	0.187*** (0.02)	-0.108*** (0.01)	-0.842*** (0.03)	-0.255* (0.12)	-0.189** (0.06)	0.122 (0.14)
sha_clot	-0.490*** (0.04)	0.128*** (0.02)	-0.583*** (0.05)	-2.064*** (0.19)	-0.198* (0.10)	2.104*** (0.22)
sha_tran	-0.083** (0.03)	0.035** (0.01)	-0.379*** (0.04)	-0.202 (0.13)	0.012 (0.07)	-0.166 (0.15)
sha_othe	-0.609*** (0.03)	-0.140*** (0.01)	-0.084* (0.03)	1.058*** (0.12)	-0.117 (0.06)	-2.200*** (0.14)
Compensated cross-price elasticity						
sha_food	-0.293*** (0.01)	0.017*** (0.00)	0.265*** (0.01)	0.01 (0.04)	0.04 (0.02)	0.148** (0.05)
sha_wate	0.01 (0.03)	-0.245*** (0.01)	(0.01) (0.04)	0.18 (0.13)	0.06 (0.07)	0.15 (0.15)
sha_hous	0.623*** (0.02)	-0.048*** (0.01)	-0.710*** (0.03)	(0.20) (0.12)	-0.131* (0.06)	0.24 (0.14)
sha_clot	0.214*** (0.04)	0.224*** (0.02)	-0.369*** (0.05)	-1.967*** (0.19)	(0.10) (0.10)	2.299*** (0.22)
sha_tran	0.536*** (0.03)	0.119*** (0.01)	-0.191*** (0.04)	(0.12) (0.13)	0.10 (0.07)	0.01 (0.15)
sha_othe	0.00 (0.03)	-0.057*** (0.01)	0.101** (0.03)	1.143*** (0.12)	(0.04) (0.06)	-2.031*** (0.14)

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6 – Share of five commodities on distribution of income for seven years

	2010/2011									
	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.361	0.371	0.357	0.349	0.353	0.355	0.350	0.350	0.344	0.329

WGE	0.043	0.045	0.041	0.042	0.039	0.037	0.038	0.036	0.035	0.033
Housi	0.385	0.349	0.360	0.362	0.357	0.341	0.329	0.322	0.316	0.306
Clothing	0.040	0.050	0.053	0.052	0.058	0.060	0.067	0.068	0.072	0.081
Trans	0.041	0.048	0.050	0.053	0.056	0.061	0.063	0.067	0.068	0.073
Other	0.131	0.137	0.138	0.143	0.137	0.145	0.154	0.157	0.164	0.179
2011/2012										
	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.401	0.386	0.382	0.371	0.369	0.369	0.358	0.355	0.341	0.314
WGE	0.080	0.074	0.078	0.076	0.072	0.067	0.066	0.063	0.058	0.055
Housing	0.303	0.299	0.293	0.303	0.304	0.297	0.301	0.296	0.310	0.327
Clothing	0.043	0.048	0.054	0.051	0.051	0.058	0.057	0.062	0.061	0.065
Transport	0.044	0.053	0.057	0.058	0.063	0.063	0.070	0.074	0.073	0.076
Other	0.130	0.140	0.136	0.141	0.141	0.145	0.148	0.151	0.157	0.162
2012/2013										
	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.414	0.409	0.414	0.411	0.405	0.396	0.394	0.385	0.372	0.338
WGE	0.063	0.058	0.059	0.053	0.053	0.053	0.051	0.046	0.044	0.040
Housing	0.294	0.287	0.291	0.285	0.289	0.290	0.289	0.300	0.312	0.336
Clothing	0.042	0.054	0.050	0.054	0.058	0.054	0.059	0.057	0.059	0.067
Transport	0.047	0.053	0.052	0.058	0.059	0.064	0.064	0.069	0.068	0.067
Other	0.141	0.139	0.135	0.140	0.136	0.142	0.143	0.144	0.146	0.152
2013/2014										
	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.440	0.424	0.424	0.420	0.412	0.408	0.397	0.389	0.373	0.352
WGE	0.056	0.054	0.052	0.051	0.048	0.047	0.044	0.041	0.040	0.036
Housing	0.280	0.278	0.273	0.284	0.275	0.275	0.284	0.293	0.292	0.315
Clothing	0.043	0.051	0.055	0.053	0.062	0.061	0.065	0.066	0.069	0.072
Transport	0.041	0.051	0.052	0.055	0.057	0.059	0.062	0.063	0.064	0.065
Other	0.141	0.142	0.144	0.137	0.146	0.149	0.149	0.147	0.162	0.160
2014/2015										

	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.410	0.398	0.400	0.400	0.389	0.388	0.382	0.368	0.356	0.323
WGE	0.068	0.062	0.061	0.058	0.056	0.055	0.051	0.048	0.046	0.040
Housing	0.301	0.301	0.295	0.294	0.292	0.286	0.289	0.302	0.305	0.330
Clothing	0.037	0.041	0.047	0.050	0.059	0.059	0.059	0.062	0.066	0.071
Transport	0.046	0.054	0.057	0.058	0.063	0.067	0.069	0.071	0.073	0.075
Other	0.138	0.144	0.140	0.139	0.141	0.144	0.150	0.148	0.154	0.162
2015/2016										
	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.396	0.387	0.385	0.382	0.385	0.377	0.372	0.361	0.346	0.324
WGE	0.070	0.066	0.066	0.064	0.060	0.057	0.056	0.052	0.048	0.043
Housing	0.317	0.312	0.311	0.300	0.293	0.300	0.296	0.305	0.311	0.325
Clothing	0.034	0.038	0.045	0.050	0.056	0.054	0.056	0.059	0.064	0.070
Transport	0.046	0.054	0.058	0.061	0.064	0.068	0.073	0.077	0.077	0.077
Other	0.136	0.142	0.136	0.143	0.143	0.143	0.146	0.146	0.153	0.161
2016/2017										
	1th	2th	3th	4th	5th	6th	7th	8th	9th	10th
Food	0.394	0.388	0.393	0.391	0.384	0.377	0.372	0.366	0.358	0.331
WGE	0.080	0.075	0.071	0.068	0.066	0.064	0.060	0.056	0.052	0.044
Housing	0.335	0.318	0.309	0.311	0.308	0.304	0.310	0.316	0.314	0.334
Clothing	0.035	0.044	0.045	0.046	0.054	0.059	0.056	0.055	0.060	0.072
Transport	0.047	0.060	0.063	0.064	0.069	0.073	0.078	0.079	0.085	0.081
Other	0.109	0.115	0.118	0.120	0.119	0.123	0.125	0.128	0.131	0.138

Source: Author calculation using Household Expenditure and Income Survey

1.6.5 Data and variables

We had two main samples of urban and rural areas. Each sample is limited to the family with the household age between 18 and 75, and the family with one household

head.

We used five main commodity groups of food and beverage, clothing and footwear, housing, gas-water-electricity and transport. In addition, we assume the possibility of aggregation of the expenditure of health, communication, cultural and recreation, fast food, hotel and restaurant and household furniture and home appliances and we put them on the other categories. We did not take into account the durable good given to the different consumption behavior towards durable and non durable goods.

For dummy variables we used age and age squared of household head and the education of household. The education has three categories: The first group is: illiterate, the second: primary, middle and high school, and the third is college and higher degree. We used the second group as a baseline group in our demand system model. We also used other different dummy variables such as seasonal dummy and gender of the household head, but they were not significant.

Chapter 2

Deaton-Paxson Puzzle: Iran Case Study

abstract

Deaton and Paxson (1998) raised an important puzzle in the economies scale of the household consumption. According to the Barten model, increasing the household size at constant per capita income, there is an economies of scale in the public good and the additional resource will be directed toward private good such as food (the income elasticity dominates the own price elasticity for food). Deaton-Paxson analyzed household survey data from seven countries, and on the contrary, found that the food share decreases by additional household member. In this research we use four categories of goods, namely food, housing, clothing and transport, to understand more about the puzzle using the Iranian household expenditure and income survey. To control for differences between the consumption of adults and children, we also do our estimation for food share for each group separately. Finally to examine the puzzle on distribution of the income, we run our model on different quantiles of family income and we estimate the relation between food/clothing share and household size on the distribution of income for the Iranian household. Our results for food share are in line with the Deaton-Paxson finding and contrary the Barten theory, it means by increasing the household size, the food share decreases holding the per-capita income constant. Furthermore, this negative relation remains the same for each additional child or additional adult in the family for urban and rural areas. In addition, by studying this relation on the income distribution, we find that the decrease in the food share in larger households is stronger in the poor households than in the rich ones. We examine the relation between the household size and the clothing share (the more private goods compared to food) holding the per capita income constant. Our result is in line with the theory and the share of the clothing increases by increasing the household size. Also analyzing the relation on the distribution of the income shows the stronger relation for the poor family than for the rich, as expected in the Barten model.

Keywords: economies of scale, Welfare, Deaton-paxson paradox, Iran.

2.1 Introduction

Deaton and Paxson (1998) raised an important puzzle in the economies of scale of the household consumption. They derived the theoretical model of economies of scale using the Barten (1964) two-goods model. According to this model, they assume that by increasing the household size at constant per capita income (expenditure), return to scale (in at least some goods) implies that households are better off. It means that when the family size increases at constant per capita income, additional resource will be directed toward private good.

If two adults unify to form a couple, they will be better off as they can share public goods thus lowering per capita expenditure on public goods. Both the income and substitution effects imply increment of public goods. But for the private goods the income and substitution effects work in the opposite direction and in general, it is not possible to know which effect will dominate, except if we know more about characteristics of the private goods. For example, the consumption of private goods with large income elasticity and low own price elasticity will tend to increase with household size.

Deaton and Paxson (1998) claim that food could be an appropriate example of private goods as its income elasticity usually dominates its own price elasticity. Furthermore, substituting food with other goods will be less likely for households close to subsistence. It means that the released resource from the decrease in consumption of public goods would be allocated to food, a necessary which has few substitutes, and it is the case at least in developing countries. But by analyzing seven different household survey data, they found that the food share decreases by additional household member. Moreover the correlation between food share and household size is stronger for developing countries than for the developed ones. This empirical result of Deaton and Paxson starts a puzzle in the consumption literature.

The Deaton and Paxson puzzle gave place to discussion in the academic circles. Many studies try to explain the cause of the puzzle through different channels. For example there are some researches about the role of measurement error in explaining

the puzzle. They suggest that one reason of the puzzle can be measurement error in recall food expenditure data. For the larger household it is more difficult to remember all the food expenditure in details compared to the smaller household and it is more likely to under-report food expenditure. To deal with the measurement error issue they use the dairy data rather than the recall survey. However, the results of these kind of researches are in line with Deaton and Paxson empirical paper outcomes.¹ Another group of researches focus on the Barten model. For instance, they try to use the Barten model with n goods instead of two goods to resolve the puzzle.² Finally, there are studies about the role of economies of scale in food preparation and food consumption on resolving the puzzle³. However [Deaton and Paxson \(2003\)](#) believe that the return to scale in food preparation strengthens the puzzle rather than explaining it. Despite all these researches, the puzzle remains the puzzle and none of the analyses could find an explanation for it.

In this study we aim to understanding the Deaton and Paxson puzzle using the Iranian expenditure and income survey. The Iranian household is an appropriate example of a developing country in which the assumption of Deaton-Paxson for private goods is fulfilled. The income elasticity of food is higher than the its own price elasticity as it is shown in table [A1](#). We use four categories of goods such as food, housing, clothing and transport to see the variation of each category's share by family size, given per capita income constant. To control for differences between the impact of additional adult or additional child to the household on the food share, we calculated the relation of the additional adult and child on the food share separately. Finally, to understand more about the Deaton-Paxson puzzle on distribution of the income, we run our model on different quantiles of family income and we estimate the relation between food/clothing share and household size on the distribution of income. To be fair to Deaton-Paxson's paper, we use the same method as theirs but we estimate our model for clothing (as another private good) and transportation in addition to the food and housing expenditure share.

1. [Gibson \(2002\)](#), [Gibson and Kim \(2007\)](#), [Gibson et al. \(2015\)](#), [Brzozowski et al. \(2017\)](#)

2. [Horowitz \(2002\)](#)

3. [Gan and Vernon \(2003\)](#), [Crossley and Lu \(2018\)](#), [Gibson and Kim \(2018\)](#)

Our results for food share are in line with the Deaton-Paxson paper. It means that increasing the household size, the food share decreases holding the per-capita income constant. Furthermore, this negative relation remains the same for additional child or additional adult in the family for urban and rural areas. In addition, by studying this relation on the distribution of the income, we find that the decrease in the food share in larger household is stronger in the poor household than the rich ones. We examine the relation between the household size and the clothing share (the more private good compared to food) holding the per capita income constant. Our result is in line with the theory and the share of the clothing increases by increasing the household size. Also analysing the relation on the distribution of the income shows stronger relation for the poor family compared to the rich as expected in the Barten model.

Our findings confirm the Deaton-Paxson puzzle for food. However, clothing as private goods are totally consistent with the Barten theory. Our contribution to this literature is further explaining and understanding the Deaton-Paxson puzzle and providing literature review of studies devoted to the puzzle. Moreover we investigate the existence of the puzzle by using the rich Iranian expenditure and income survey. Finally, we study the presence of the puzzle for other private goods than food.

The study is organised as follows: section 2 presents the puzzle in details and the review of the main studies and channels which attempt to explain and solve the puzzle. Section 3 provides the theoretical framework using Barten's model. Section 4 describe the databases used in the research and the results of the analysis, and the final section concludes.

2.2 Literature review

[Deaton and Paxson \(1998\)](#) discuss a possible contradiction between the anticipation of economic theory and the empirical evidence. They use the [Barten \(1964\)](#) model to

explain the relation between the share of the private and public goods with increase in the family size when controlling for the per capita income. It is supposed that one family consumes public and private goods. Keeping the per capita expenditure constant, if the family size increases, the public goods become cheaper for the family member, because they do not need to increase their demand for public goods the same proportion as the number of the family members. Therefore, larger household has lower per capita expenditure on public goods. This lower expenditure leads to the two different effects toward the private goods, substitution and income effects with different directions.

According to the income effect, when the per-capita expenditure on public goods decreases in the larger family, the resource becomes more available to spend on private goods. As a result, the income effect leads to the increase of consumption of private goods. On the contrary, the substitution effect makes the private goods relatively more expensive when the public goods become cheaper by increasing the family size. Therefore the substitution effects goes in the opposite direction, the consumption of private goods decreases and individuals substitute private goods by public goods. But which effect will dominate depends on the household preferences.

[Deaton and Paxson \(1998\)](#) claim that as the price elasticity of food (as a private goods) is low, it is not easily sustainable. As a result, income effect dominates the substitution effect and, by increasing the household size, the expenditure on the food will increase holding the per capita income constant. Furthermore, as the food is a necessary goods, for the a low-income country, the positive effect of household size on food expenditure will be larger, while individual needs for food are not necessarily satisfied and food is usually close to subsistence.

After analyzing the data for seven different countries, the results were not in line with the theory. This means that, increasing the family size, controlling for the per capita income, the food expenditure decreases and this result has a larger magnitude for the low-income countries than the high-income ones. These contradictory results

between economic theory and empirical evidence became well-known in the literature as the Deaton-Paxson puzzle. After Deaton and Paxson the puzzle has been confirmed by [Gardes et al. \(2000\)](#), [Gan and Vernon \(2003\)](#), [Abdulai \(2003\)](#), [Parpiev and Yusupov \(2011\)](#), [Logan \(2011\)](#), and [Crossley and Lu \(2018\)](#).

[Deaton and Paxson \(1998\)](#), in the same paper, tried to explain the puzzle through the different channels such as direct economies of scale in food consumption, economies of scale in food preparation, wastage, collective models, price elasticity of food, measurement error, calorie overheads, and, intrahousehold inequality. But none of these was satisfying enough to solve the problem.

Following Deaton-Paxson's paper there are many researches trying to explain the puzzle. One of the possible explanation is based on the measurement error in household expenditure and income survey which recall food consumption. For larger households it is more difficult to remember all the food expenditure in detail compared to the smaller households and it is thus more likely for them under-report their food expenditure. As Deaton claims, this measurement error might occur for other goods as well. But the understatement for food may be greater due to its purchase frequency. [Gibson \(2002\)](#) examines the effect of measurement errors using Monte Carlo methods. He finds that food expenditure data collected with the recall method contain measurement errors that are correlated with household size. These measurement errors in expenditure data cause a negative bias in the estimated relation between household size and food demand. This can be one of the explanations to the puzzle. [Gibson and Kim \(2007\)](#) attempt to examine measurement error in food expenditure data in developing countries using the data from Cambodia and Indonesia. They provide evidence for measurement errors caused by different design and implementation strategies and conclude that the measurement errors can only partially explain the puzzle. On the other hand, [Brzozowski et al. \(2017\)](#) using the Canadian recall and diary data find a negative relation between household size and food expenditure, which rules out the hypothesis of measurement error being the explanation to the puzzle.

In a different direction, [Gan and Vernon \(2003\)](#) consider two different measures of food shares: food as a share of food plus a goods to be more private than food, and food as a share of food plus other goods known to be more public than food. In the first case the food share decreases with the family size as predicted by Barten model. However, for the second case the food share increases with the household size. They discuss the behavior of food as a consumption goods and the possibility of economies of scale in food consumption by increasing the household size. [Deaton and Paxson \(2003\)](#) claim that although meaningful economies of scale in food consumption in comparison to clothing and transport would solve the puzzle, [Gan and Vernon \(2003\)](#) did not generate the adequate empirical evidence to prove their discussion. [Horowitz \(2002\)](#) develops the Barten model to the N-goods world model and demonstrates that their model does not predict a positive relation between food expenditure and household size. He also argues that the food income elasticity does not necessarily exceeds own-price elasticity. In the same direction of economies of scale, [Logan \(2011\)](#) estimates the economies of scale for different goods such as food, clothing, entertainment and housing for three different period using the American Household Expenditure Survey. He finds that there is no contradiction between Barten model and empirical results in the share of other non-food private goods such as entertainment and clothing. He suggests that food might have a fundamentally different behavior. Also [Parpiev and Yusupov \(2011\)](#) using the household survey of Uzbekistan, estimate the economies of scale for different goods (food, meals out, clothing, education, health, transportation and shelter). Their results show that there is a positive household economies of scale for the private goods but not for food.

[Crossley and Lu \(2018\)](#) modify the Barten model to add heterogeneity in time cost for food. They classify food in two groups of time-intensive home product food and ready-to-eat food and using the Canadian data on food expenditure and time use. They assume that unlike ready food, home production is subject to economies of scale in preparation time and ingredients might be subject to economies of scale from bulk buying. As a result, larger households have to shift away from ready food

towards ingredients. According to their empirical results of analyzing the effect of household size on the budget share of food, larger households tend to shift towards home production of food when analysing. Nevertheless, the Deaton-Paxson puzzle still holds.

In spite of all the researches following Deaton-Paxson, the puzzle still remains unsolved as none of the researches could uncover the main reason behind the problem. In the next section we explain the Barten model and attempt to understand the puzzle for different shares of goods for the Iranian household survey.

2.3 Food consumption and family size

2.3.1 Parametric specification of the Barten model

In this section, we present [Barten \(1964\)](#)'s model which is used in [Deaton and Paxson \(1998\)](#) and the economies of scale literature. Suppose that there are two groups of goods, private and public (food and housing). One household with n members allocates its total expenditure on food and housing. In this model, the household maximizes the following utility function subject to his budget constraint.

$$\begin{aligned} \underset{u}{\text{maximize}} \quad & nv \left(\frac{q_f}{\phi_f(n)}, \frac{q_h}{\phi_h(n)} \right) \\ \text{s.t.} \quad & p_f \left(\frac{q_f}{n} \right) + \left(\frac{p_h}{n} \right) q_h = \frac{x}{n}. \end{aligned} \tag{2.3.1}$$

$\phi_f(n)$ and $\phi_h(n)$ are the scaling functions for food (f) and goods broadly interpreted to be nonfood such as housing (h), respectively, q_f and q_h represent the household consumption of food and housing. $\phi_i(n) = n^{1-\sigma_i}$ for $i = f, h$, where σ_i is the commodity specific economy of scale measure for goods i . this means that if the goods is private $\sigma_i = 0$ and $\phi_i = n$, and for the public goods $\sigma_i = 1$ and $\phi_i = 1$. If we consider food as a private and housing as a public goods, the utility function can be written as: $nv(\frac{q_f}{n}, q_h)$. If household size increases by one percent, then the consumption of goods i must go up by $1 - \sigma_i$ percent to keep the household at the

same level of consumption as before, meaning that the per capita consumption of household will not change. If goods i is private, there is no economies of scale in consumption of goods i and the increase in the household size has to be compensated by the same rate of increase in goods i to make the household member as well off as they were. On the other hand, if $\sigma = 1$ (for the public goods), there are economies of scale in goods i , implying that the one percent increase in household size can be compensated by less than one percent increase in goods i .

Solving the maximization problem (2.3.1), we obtain the following food demand function.

$$\frac{q_f}{n} = \frac{\phi_f(n)}{n} g_f \left(\frac{x}{n}, \frac{p_f \phi_f(n)}{n}, \frac{p_h \phi_h(n)}{n} \right) \quad (2.3.2)$$

Where $g_f(x, p_f, p_h)$ is the demand function of food for the single-person household. To see the relation of household size with the demand function, we take logs of the both sides of (2.3.2) and differentiate with respect to $\ln n$, then we have:

$$\frac{\partial \ln(q_f/n)}{\partial \ln n} = \sigma_h(\epsilon_{fx} + \epsilon_{ff}) - \sigma_f(1 + \epsilon_{ff}) \quad (2.3.3)$$

where ϵ_{fx} and ϵ_{ff} are the income elasticity and the own-price elasticity of food. The expression (2.3.3) shows the effect of additional members in the household on food consumption. We see that per capita food expenditure will increase by additional person in the family at the constant $\frac{x}{n}$ if and only if

$$\sigma_h(\epsilon_{fx} + \epsilon_{ff}) - \sigma_f(1 + \epsilon_{ff}) > 0 \quad (2.3.4)$$

Deaton and Paxson show that Barten's model predicts that the demand curve shifts to the right by increasing the size of the household at constant per capita expenditure if the elasticity of income for food as a private goods is high and the price elasticity of food is low in absolute value ($\epsilon_{fx} > -\epsilon_{ff}$) as we have ($\sigma_f = 0$) and ($\sigma_h = 1$). This is prone to be satisfied for developing countries as the food share is high and food is a necessity. Intuitively, the resource which is liberated by sharing the public goods, like housing, can be used for both public and private goods. If the income

effect dominates the substitution effect, then the per capita expenditure of food as a private goods is expected to rise.

2.3.2 Non-parametric specification

We make a non-parametric analysis, using non-parametric locally weighted regression⁴ in order to compare the relationship between food and household size conditioning on per capita income. Therefore, we are interested in analyzing the following inequality:

$$E\left(\frac{p_f \cdot q_f}{n} \mid i, \frac{x}{n}\right) > E\left(\frac{p_f \cdot q_f}{n} \mid j, \frac{x}{n}\right) \quad (2.3.5)$$

where i and j refer to the two households with different size and demographic composition. (p_f, q_f) is the food expenditure and n is the household size.

To estimate the local smoother regression, we fit Engel curves on interval of $\ln(x/n)$. Then we divide the interval by 50 to obtain the grid of equally-spaced 51 points (thanks to the sufficient number of observations) as done by Deaton and Paxson. Then for each grid we estimate weighted regression of the food (housing) share on the $\ln(x/n)$. The weight which is assigned to each point is calculated by:

$$\omega_{im} = \frac{1}{h} \kappa\left(\frac{z_i - g_m}{h}\right) \quad i = 1, \dots, N; \quad m = 1, \dots, N * bw \quad (2.3.6)$$

Where h is a bandwidth, and $\kappa(t)$ is a Biweight kernel function as follows:

$$\kappa(t) = \frac{15}{16} (1 - t^2)^2 1(|t| \leq 1), \quad (2.3.7)$$

The choice of a bandwidth is crucial for many smoothing techniques. In general, using a large bandwidth gives smooths with a large bias, whereas a small bandwidth may result in highly variable smoothed values. Various techniques exist for optimal bandwidth selection. Here, we use the Rule-of-Thumb (ROT) method to estimate

4. Jianqing and Gijbels (1996), Fan (1992)

the bandwidth used for the smoothing technique (Jianqing and Gijbels, 1996).

After estimating the expected food shares for all values of z in our grid, we calculate the weighted average of expected food share as follows:

$$\int_{z_0}^{z_1} E\left(\frac{p_f \cdot q_f}{n} \mid i, z\right) f(z) dz \quad (2.3.8)$$

where $f(z)$ is the kernel density function. We compute the weighted average for each household(i), and the density function is the same for all household types, as it is estimated by using all observations. The average expected food shares provide the summary measure for all households of the same type and it is helpful to compare. In the next sections we report the results of non-parametric and parametric estimation for Engel curves on Iranian household survey to understand the relation between food share expenditure and household size.

2.4 Empirical evidence

2.4.1 Data

In this research, we use the Household Expenditure and Income Survey data (HEIS) which have been published annually by the Statistical Center of Iran since 1968 for urban and rural areas. The surveys are nationally representative, and contain detailed information for each household as follows:

- Demographics information such as: age, sex, marital status, relationship to the head of the household, education, and employment status of individuals.
- Detailed information on food expenditures.
- Reports on non-food expenditures, including non-durable and semi-durable goods such as clothing and other household goods, as well as rent and utilities.
- Expenditures on durable goods.
- Household ownership of assets and amenities.
- Information on wage and salary income, self-employment income, and other

income from retirement, rent, or other sources.

The recall period for these expenditures is the last 30 days, which is rather long for consumption. For durable goods, some educational expenses, insurance expenditures, investment in housing and farms, and income components, the recall period is the last 12 months. Like in most surveys of this type, income and expenditure data are self-reported. HEIS does not distinguish between how much is spent and how much is consumed and reports only expenditures. For items that are not purchased, an estimated value is provided. Gregorian notations for years are used in this report, but the actual survey period is left as it is shown in the HEIS: March to March. For example, year 2010 means the survey period between March 2010 and March 2011. We use a single cross-sectional household survey of year 2010/2011 (1389), the year before economic sanctions and energy subsidy reform.

We examine the economies of scales on the Iranian household survey using both non-parametric and parametric approaches. We adopt the same econometric techniques used in Deaton and Paxson's research and also the same age and sex categories to permit the comparability of the results.

We exclude household heads with age less than 18 and households with size more than 15 from our sample. Household with no adults members (4 observations in 2010/2011) are excluded as well. In this research children are defined as people of less than 18 years of age and adults are the family members who are more than 17 years old.

As we use logarithm of income per capita as an instrumental variable for logarithm of per capita expenditure, we exclude families with zero or negative income after tax from our sample for both OLS and IV models to have a comparable model. The family income is defined as the total income of household. The total expenditure is the expenditure of household except expenditure on purchased durable goods and insurance, and the food expenditure includes the household expenditure on food, restaurant and fast food, i.e. food eaten at home and away from home. Thanks to the large survey, we do our analysis in urban and rural areas separately to control

for the differences in the urban and rural areas. Furthermore, food is not the only private goods that can be tested against the prediction of the Barten model. So it is useful to estimate our model for other household expenditure categories. In this research we study the existence of the Deaton-Paxson puzzle for share of food, housing and also clothing and transport for different Iranian households. Clothing and food considered as private goods in the literature, although the extent to which each is private is subject to debate. In our estimation, we used the survey weight which is published by the statistical center of Iran. Finally, our sample size was reduced from 40,171 families to 38,038 households. Table 2.1 presents the descriptive statistics of our variables of interest. As it is shown, the food share has

Table 2.1 – Descriptive statistics

Variables of interest	Average	Standard Deviation
Share of Food	0.349	0.151
Share of Housing	0.230	0.140
Share of Clothing	0.052	0.069
Share of Transportation	0.047	0.042
Ln(Total Expenditure)	16.595	0.739
Gender	0.499	0.500
Age	30.45	19.860
Family Size	4.775	1.936
Urban	0.676	0.499
Job Position	Freq.	Percent
W&S, public	5,423	11.96
W&S, private	19,216	42.37
Agriculture	10,907	24.05
NoAgriculture	9,715	21.42

Author calculation from Household Expenditure and Income Survey

an important role compared to the other commodities in the total expenditure of Iranian households. After food share, housing has the second place. Regarding the demographic characteristics of our sample, the ratio of male to female is about 50 percent, the average age is about 30 years old, the average of family size is about 5 persons, and 67 percent of the households in our sample live in urban areas.

2.4.2 Non-parametric Engel curves

We first study the Engel curves using non-parametric locally weighted regression model. Figures 2.1 - 2.4 display the results of non-parametric regression. To control for differences in consumption between additional child and additional adult, we present the Engel curves for couples living with adults and couples with different number of children (assuming that there are different needs for adults and children). We estimate the Engel curves for different goods categories such as: food (figure 2.1), clothing (figure 2.3), transport (figure 2.4) and public goods like housing (figure 2.2) by non-parametric model. As we see in each figure, the first and second column present the changes in the Engel curve by additional child and additional adult; The solid line refers to the married couple without children (family with two adults), the dash line assigns to the family with one child (three adults), the short-dash line points out to the couple with two children (family with four adults) and the long-dash line refers to the couple with 3 children. To control for the differences between the consumption for urban and rural households, we separate urban and rural areas in our estimation. In each figure, the first row presents the Engel curves for the whole sample, the second row shows the Engel curves for urban areas and the third row for rural areas.

As shown in figure 2.1, the evidence supports the Deaton-Paxson paradox. The additional child/adult in the household decreases the food share holding the per capita expenditure constant. This relation is not clear for the family with more than one child as the Engel curves cross and also the Engel curves do not move so much, especially for food share. We can say that there is some fixed cost of having the first child which is not the case for the next children, and having the next children does not change the food share expenditure much, per capita expenditure holding constant. In the second column, with an additional adult to the family, the Engel curves move to the left. As we present, in figure 2.1, there is not any clear evidence of rising the food share by additional adult keeping expenditure per capita constant and the evidence is supporting the existence of the Deaton and Paxson puzzle on the Iranian data for food. Interestingly, comparing the two columns reveals that the

estimated curves are more similar in the case of households with children. Figure 2.2 presents the estimated Engel curves for share of housing expenditure. Decreases in the housing share by increasing the household size is obvious in the two columns (either an additional adult or child) for urban and rural areas. There is an economy of scale in housing share by adding the household size as it is predicted in the theory.

Figure 2.3 displays the Engel curves for another private goods, clothing. With an additional child/adult to the household, the Engel curves move to the right so that the share of clothing increase, with the household size growing. The primitive results of the non-parametric method declare that clothing behaves as a private goods more than the food share does. Finally, figure 2.4 shows the estimated Engel curve for transport. The transportation here can be considered as a private goods because the value of the purchased vehicle is not included inside⁵. The changes in the share of transport expenditure related to the household size, per capita expenditure constant, are not clear compared to the clothing share. But we can see the increases in the transportation share by increasing the size of the family from two to three members.

The non-parametric Engel curves are useful to provide a general overview of the commodities' behaviour but in some instances, they are not clear to interpret because of the crossing of Engel curves. Therefore table 2.2 reports the summary statistics for each of the Engel curves we estimated. Each number shows the weighted averages of the expected food shares conditional on different levels of per capita expenditure, with weights given by the kernel estimate of the density of per capita total household expenditure. The weights are common across household types, so per capita expenditure is held constant as one moves in each row which are calculated by expression (2.3.8). The number in parentheses is the standard error. The first third columns show the results for childless households with different number of adults, and the third last columns present the couples with different number of children. We did our calculation for the whole sample and for urban and rural areas separately.

5. To see more information on the detailed item you can refer to the Appendix (2.6.2)

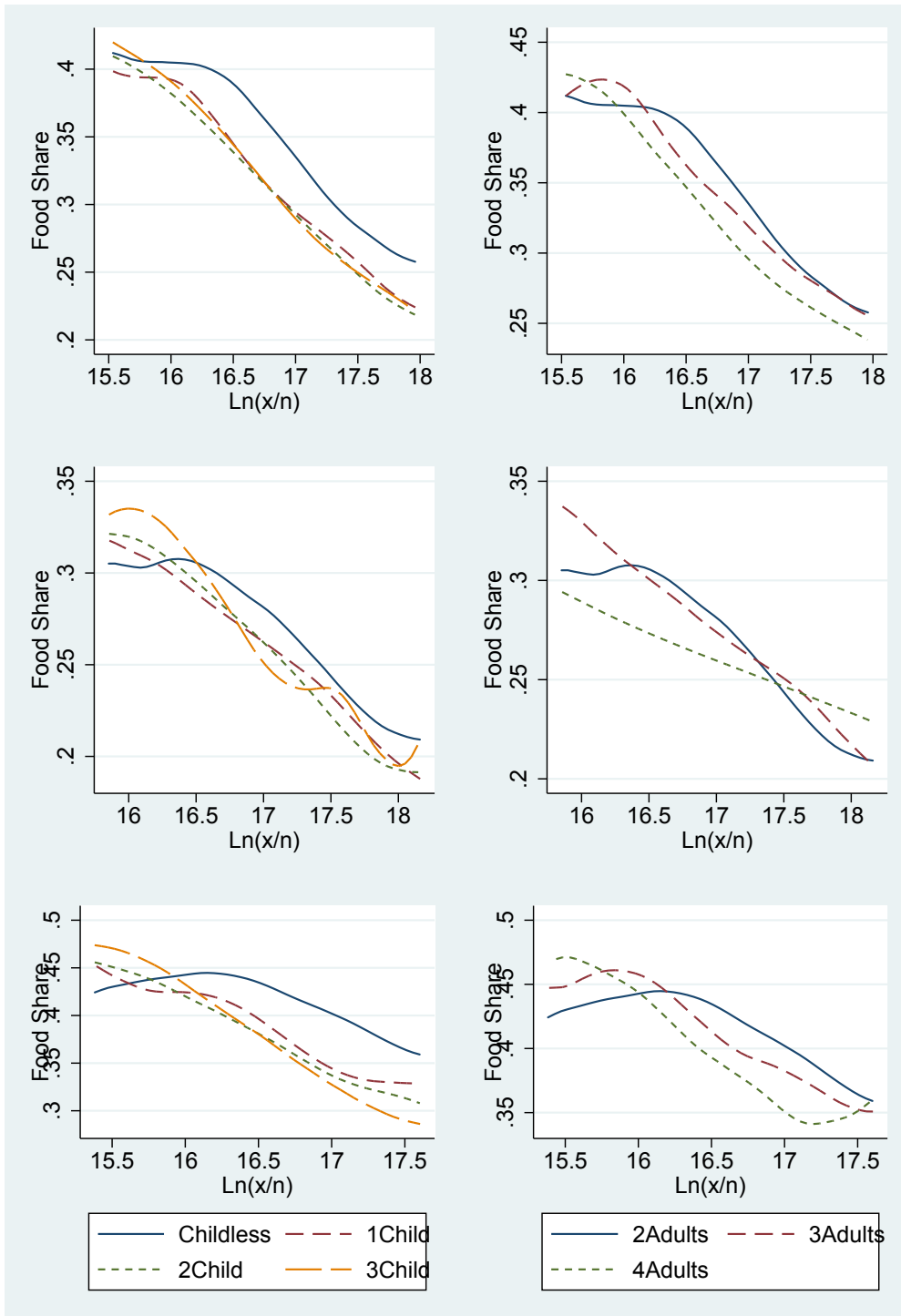


Figure 2.1 – Engel curves for food share by household type and by per capita expenditure.

Note: The first row is the whole sample, the second row is for urban area and the third row is for rural area.

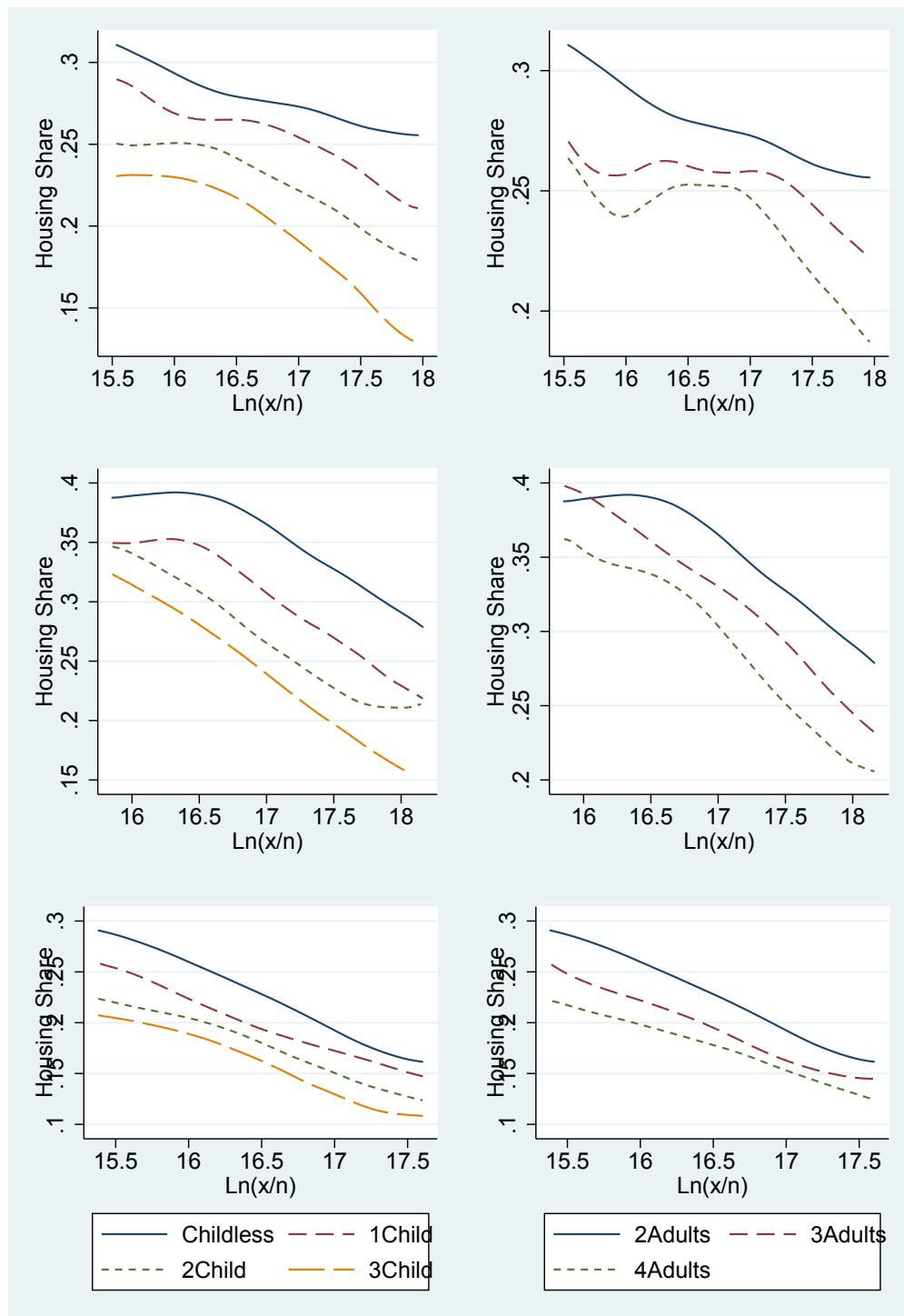


Figure 2.2 – Engel curves for housing share by household type and by per capita expenditure.

Note: The first row is the whole sample, the second row is for urban area and the third row is for rural area.

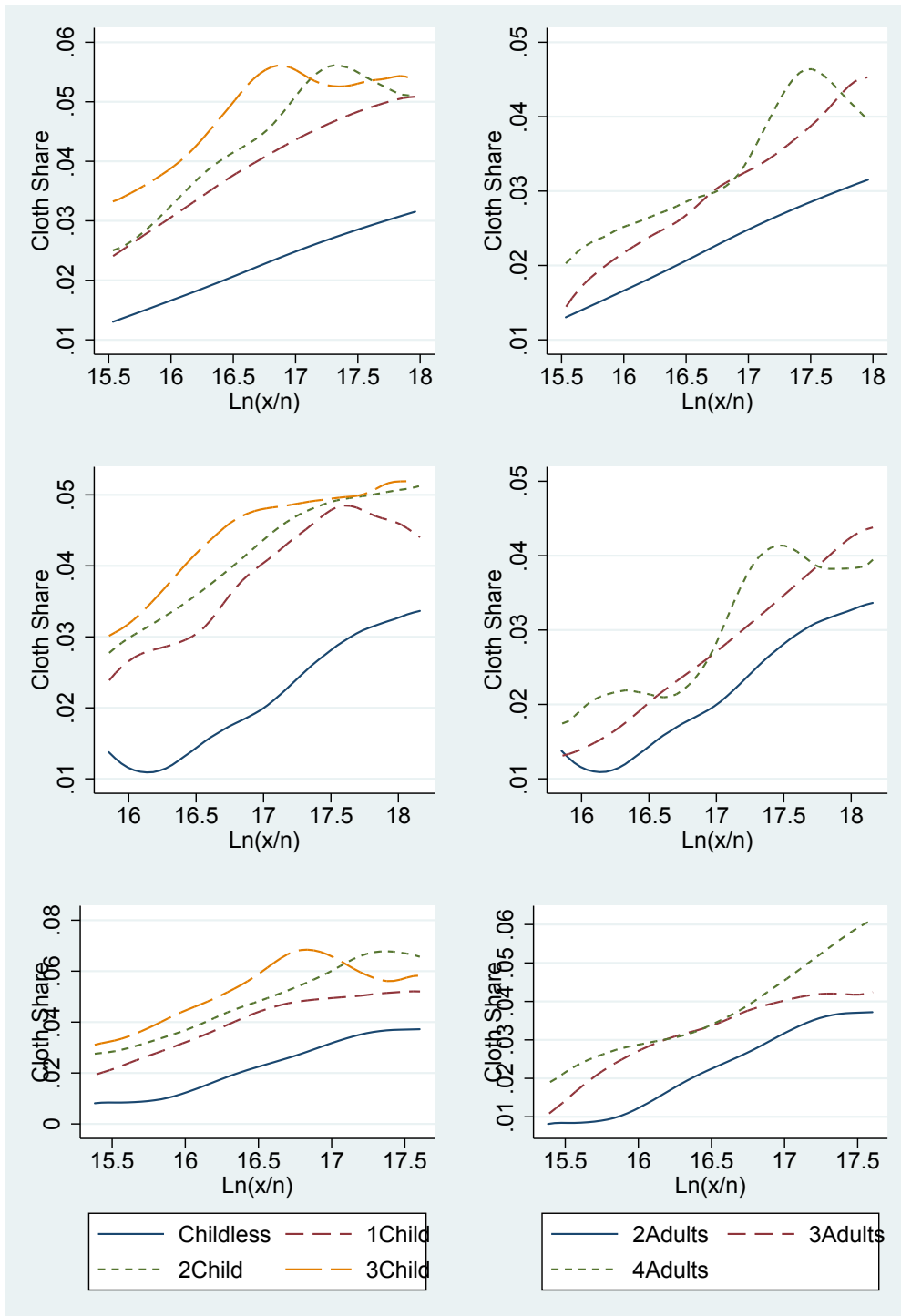


Figure 2.3 – Engel curves for clothing share by household type and by per capita expenditure.

Note: The first row is the all sample, the second row is the urban area and the third row is the rural area.

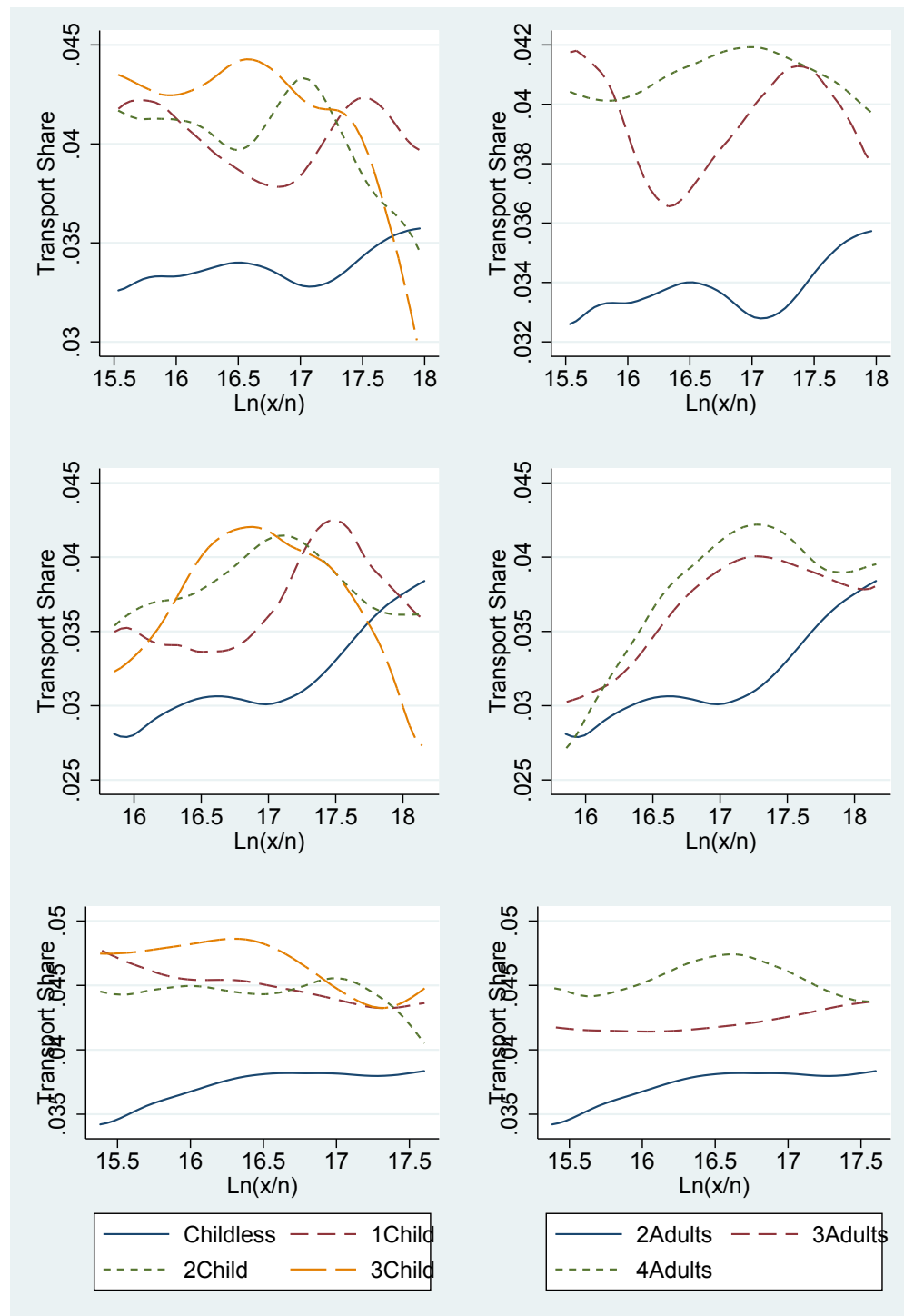


Figure 2.4 – Engel curves for transport share by household type and by per capita expenditure.

Note: The first row is the whole sample, the second row is for urban area and the third row is for rural area.

Table 2.2 – Food share: summary statistics for each of the Engel curves

(Adult,Child)	(2,0)	(3,0)	(4,0)	(2,1)	(2,2)	(2,3)
All	0.350 (0.055)	0.344 (0.058)	0.328 (0.062)	0.321 (0.062)	0.318 (0.064)	0.323 (0.066)
Urban	0.270 (0.026)	0.274 (0.038)	0.260 (0.046)	0.290 (0.053)	0.288 (0.054)	0.295 (0.062)
Rural	0.417 (0.035)	0.413 (0.037)	0.399 (0.028)	0.354 (0.044)	0.350 (0.052)	0.350 (0.052)

The weighted averages of the expected food shares conditional on different levels of per capita expenditure, with weights given by the kernel estimate of the density of per capita total household expenditure. The numbers in the parentheses are the standard error.

To sum up, the results do not show any uniform increase in the food share with the number of adults or children in the household. For the additional number of children in the household by adding the first and second child to the couple, the food share decreases, however we cannot see the same direction by adding the third child to the family neither in urban nor in rural areas. In the next section we estimate the Engel curve using the parametric model to take into account the differences in the household characteristics.

2.4.3 Parametric Engel curves

In the previous section, we reported the results of non-parametric method in which we did not control for the differences across household which are correlated with the household size and can affect the food, housing, clothing and transportation expenditure. For example, differences in consumption by gender, age of the household head and number of money earners in the household. In this section, we used the Working-Leser consumption function to estimate the demand function for food, housing, clothing and transportation share expenditure. According to this function, the budget shares are explained by per capita expenditure $\frac{x}{n}$, logarithm of household size $\ln n$, the proportion of various types of individuals $\frac{n_k}{n}$ and different

socio-economic variables V .

$$w_i^6 = \alpha + \beta \ln \frac{x}{n} + \gamma \ln n + \sum_{k=1}^{K-1} \eta_k \frac{n_k}{n} + \zeta \cdot V + u \quad (2.4.1)$$

for $i = \text{food, housing, clothing, and transportation}$

For the proportion of various types of individuals we examine k age-sex group defined by Deaton and Paxson⁷ and other categories explained in Appendix (2.6.3). For the vector V different variables such as the ratio of the members with income in the family, job categories of the household head, and dummies variables for urban, rural areas and season are taken into account. Finally according to the estimated parameters, we used seasonal dummies, household age and job categories, and geographical dummies.

The empirical model (2.4.1) is estimated by two methods: Ordinary Least Square (OLS) and instrumental variable (IV) method. We use the IV method because the budget shares and per capita expenditures are produced from the same information and the errors of both might be correlated, so it would lead to a biased estimate of β . In addition, since per capita expenditure and household size are also correlated, this error would lead to a biased estimate of γ , the coefficient of interest. Furthermore, we do not know the the direction of the bias. Therefore, we use the logarithm of family per capita income as an instrumental variable for the log of per capita expenditure.

The regression coefficient for non-public goods (food, clothing, transport share) and housing (public goods) on the logarithm of household size and the other explanatory variables for the whole sample are reported in table 2.3. Columns (1) and (2) and (3) present the result of estimation for food, clothing, and transport shares with OLS and IV model and column (4) reports the result with the same method for the share of the housing expenditure.

The effect of household size on the budget share devoted to food (γ) is negative

7. The age between 0-5, 6-11, 12-17, 18-64 and 65 and over for men and women separately, there is further explanation in the appendix.

and significant. This means that a 100% change in the household size leads to a reduction of the food share by 1.5 percentage change. We see that this parameter is negative for the both methods of estimation (OLS and IV). This mirrors the results found in Deaton and Paxson: food does not behave in the consistent way as a private goods in the Barten model.

Supposing clothing as a private goods, we expect an increase of clothing expenditure share by household size given constant the per capita income. Column (2) shows the estimated parameters for the clothing expenditures share. 100 percent changes in the household size leads to the increase of the clothing share by 2.3 percentage points. Therefore, unlike the food scale economy, the clothing scale economy is always positive and consistent with the prediction of the Barten model for private economy. In the third column we see the results for transport category. If we double the household size, the transportation expenditure share increases significantly by 0.5 percentage point. Therefore, it behaves like the private goods in our estimation.

Housing is a public goods. Thus the estimate of scale economy for housing should be negative if housing is consistent with the Barten model. Column (4) reports the estimated results for housing. By doubling the household size the housing share expenditure decreases by 8.6 percentage point if the expenditure per capita and household composition hold constant. Our estimations provide an outcome which is in line with Deaton-Paxson's paper and against the Barten theory for food as a private goods. But the results for clothing and transport show that the share of clothing and transport increase by rising the household size, which is consistent with the Barten model for private goods. It is important to note that the results from instrumental variable estimation are not really different from OLS estimation.

Table 2.3 – Estimation coefficient on the logarithm of household size in budget share regression (OLS and IV)

	(Food)		(clothing)		(Transport)		(Housing)	
	(1)		(2)		(3)		(4)	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Ln(PCX)	-0.083*** (0.002)	-0.091*** (0.003)	0.019*** (0.001)	0.008*** (0.002)	-0.000 (0.003)	0.001 (0.001)	-0.070*** (0.002)	-0.060*** (0.003)
Ln(size)	-0.015*** (0.002)	-0.019*** (0.002)	0.023*** (0.002)	0.019*** (0.001)	0.005*** (0.002)	0.005*** (0.001)	-0.086*** (0.002)	-0.082*** (0.002)
N.Obs	23347	23347	23939	23939	23954	23954	23260	23260
adj. R^2	0.298	0.297	0.070	0.058	0.027	0.027	0.304	0.302

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Because of the unexpected behavior of food, in the rest of our estimations we focus on the food share to have a better understanding of its behaviour. First of all, to control for the distinct behavior among urban and rural areas, the Engel curves for food share are estimated independently for urban and rural areas. The two first columns of the table 2.4 report the coefficient of our IV estimation for urban and rural areas. Increasing the household size by 100 percent decreases the share of the food by 1.6 percentage point in urban areas and by 2 percentage points for rural areas. For the two regions, we observe the same pattern for the food share by increasing the family size given the per capita expenditure constant.

Regarding our non-parametric estimation, the relation between food share expenditure and the additional adult or additional child is not clear. Thanks to our large sample, we estimate the parameters for two sub-sample: the household without children (married couples living with adults), and the married couple with different numbers of children. Using two different samples, we can isolate the role of additional adult from additional child, thereby controlling for differences in the consumption and behaviours of the additional adult and child.

Table 2.4 – IV estimation for urban, rural and number of adults and children

	Urban	Rural	No.of Adults	No.of Children
Ln(PCX)	-0.0891*** (0.00365)	-0.0917*** (0.00433)	-0.106*** (0.00428)	-0.0742*** (0.00621)
Ln(size)	-0.0159*** (0.00325)	-0.0203*** (0.00294)	-0.0154** (0.00555)	-0.0295*** (0.00403)
N	11078	12269	10721	5819
adj. R^2	0.195	0.178	0.298	0.286

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

In table 2.4, in two last columns, the results of the estimation for the two subsamples are presented. Additional children in the household decrease the food more than additional adult do. It means that an additional child to the family decreases the food share consumption by 2.9 percentage points, whereas, an additional adult decreases the food share by 1.5 percentage point. As pointed out by ? a family with many children would benefit most from economies of scales compare a family with adults, which can explain the difference in the results for additional adult compared to additional child.

As expected by Barten's model, the effect of household size on food expenditure is larger for poor families than for rich ones. Because the elasticity of income for food in poor households is higher than in rich family and the elasticity of price is relatively low, it is more likely to see a rise in food expenditure share with increase of household size at the constant PCE for poor families compared to the rich ones. Moreover, food is usually close to subsistence for poor families and substitution away from food is less likely for poor households. However, by comparing the results between poor and rich countries, Deaton and Paxson find that the food share decreases more in the poorer countries in comparison to the rich ones holding the per capita expenditure constant.

To understand more about the Deaton and Paxson puzzle on distribution of

the income, we run our model on different quantiles of family income and estimate the relation between food share and household size on the distribution of income. Table 2.5 shows the results of instrumental variable estimation on different quantiles of the family income. In line with the previous studies, the coefficient of household size is larger for the lowest quantiles compared to the highest one. However, the coefficients are not significant for the two highest quantiles. The bottom of the table 2.5 presents the same results for the clothing share as another private goods. As shown in the table, the increase in the clothing share is larger for the poor households compared to the rich households and all the estimated coefficients are significant on 0.1 percent. Thus, the result is perfectly consistent with the Barten model for clothing expenditure as a private goods.

Table 2.5 – IV estimation coefficient for quantiles of household income

	Food share				
	Whole sample	Qtile(1)	Qtile(2)	Qtile(3)	Qtile(4)
Ln(PCX)	-0.0905*** (0.003)	0.0715* (0.035)	-0.177*** (0.021)	-0.0731*** (0.021)	-0.0754*** (0.0105)
Ln(size)	-0.0187*** (0.002)	0.0421** (0.015)	-0.0761*** (0.015)	-0.00218 (0.015)	-0.00495 (0.008)
<i>N</i>	23347	5479	6529	6148	5191
adj. <i>R</i> ²	0.297	0.122	0.163	0.282	0.307
clothing share					
Ln(PCX)	0.00308 (0.00185)	0.0187 (0.0126)	0.00945 (0.00921)	0.00849 (0.00895)	0.00368 (0.00488)
Ln(size)	0.0232*** (0.00141)	0.0212*** (0.00545)	0.0210*** (0.00638)	0.0186** (0.00668)	0.0173*** (0.00369)
<i>N</i>	23347	5714	6603	6256	5366
adj. <i>R</i> ²	0.050	0.083	0.053	0.055	0.041

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

2.5 Concluding remarks

In this study, we address the [Deaton and Paxson \(1998\)](#) puzzle and estimate the relationship between household size and the demand for food, housing, clothing, and transport share using the Iranian Expenditure and Income Household survey. We used the cross sectional data of 2010/2011 to understand the paradox more profoundly. We used the same method as [Deaton and Paxson \(1998\)](#) but we estimate our model for clothing and transportation share (as a private goods) in addition to the food and housing expenditure share. We also isolate the effect of additional adult from additional child to take into account the possible differences between child and adult consumption patterns. Finally, to understand more about the Deaton and Paxson puzzle on distribution of the income, we run our model on different quantiles of family income and we estimate the relation between food and clothing share with the household size on the distribution of income.

Applying the non-parametric and parametric Engel model, we investigate the relation between household size and food, clothing, transport, and housing share in the Iranian household. Our experiment reproduces the same empirical analysis conducted by Deaton and Paxson in terms of per capita incomes obtaining equivalent results for food and housing.

According to the parametric results, food share behaves against the Barten theory's prediction. But clothing and transport shares (as private goods) rise by increasing the household size given the per capita expenditure constant. Finally, to examine the relation of the food share and household size between the poor and rich households, we generate our results in the distribution of income for food share and for the clothing share. In line with Deaton and Paxson's research, we find that the decrease in the food share by household size is larger for poor families than the rich ones, which is in contrast with the Barten theory. However, for clothing share, the increase of the share by family size is stronger for poor households as expected in the Barten model.

Our findings confirm the Deaton-Paxson puzzle for food. Nonetheless, clothing

as a private goods is totally consistent with the Barten theory. Therefore the results cast doubt on whether food should be considered as a private goods for the measure of household economies of scale or if it has special characteristics as a private goods. In addition, this should make us rethink the theoretical model to measure household economies of scale. For further research, it would be interesting to study the household production function and time approach to calculate the household economies scale.

Bibliography

- Abdulai, A. (2003). Economies of scale and the demand for food in switzerland: Parametric and non-parametric analysis. *Journal of Agricultural Economics*, 54(2):247–267.
- Barten, A. P. (1964). Family composition, prices and expenditure patterns.
- Brzozowski, M., Crossley, T. F., and Winter, J. K. (2017). Does survey recall error explain the deaton–paxson puzzle? *Economics Letters*, 158:18–20.
- Crossley, T. F. and Lu, Y. (2018). Returns to scale in food preparation and the deaton–paxson puzzle. *Review of Economics of the Household*, 16(1):5–19.
- Deaton, A. and Paxson, C. (1998). Economies of scale, household size, and the demand for food. *Journal of political economy*, 106(5):897–930.
- Deaton, A. and Paxson, C. (2003). Engel’s what? a response to gan and vernon. *Journal of Political Economy*, 111(6):1378–1381.
- Fan, J. (1992). Design-adaptive nonparametric regression. *Journal of the American statistical Association*, 87(420):998–1004.
- Gan, L. and Vernon, V. (2003). Testing the barten model of economies of scale in household consumption: Toward resolving a paradox of deaton and paxson. *Journal of Political Economy*, 111(6):1361–1377.
- Gardes, F., Starzec, C., et al. (2000). Economies of scale and food consumption: a reappraisal of the deaton-paxson paradox. Technical report, Universit  Panth  on-Sorbonne (Paris 1).

- Gibson, J. (2002). Why does the engel method work? food demand, economies of size and household survey methods. *Oxford Bulletin of Economics and Statistics*, 64(4):341–359.
- Gibson, J., Beegle, K., De Weerd, J., and Friedman, J. (2015). *What does variation in survey design reveal about the nature of measurement errors in household consumption?* Oxford Bulletin of Economics and Statistics.
- Gibson, J. and Kim, B. (2007). Measurement error in recall surveys and the relationship between household size and food demand. *American Journal of Agricultural Economics*, 89(2):473–489.
- Gibson, J. and Kim, B. (2018). Economies of scale, bulk discounts, and liquidity constraints: comparing unit value and transaction level evidence in a poor country. *Review of Economics of the Household*, 16(1):21–39.
- Horowitz, A. W. (2002). Household size and the demand for food: a puzzle resolved? *V Unpublished Manuscript, University of Arkansas*.
- Jianqing, F. and Gijbels, I. (1996). Local polynomial modelling and its applications. *Monographs on Statistics and Applied Probability. Chapman & Hall/CRC*.
- Logan, T. D. (2011). Economies of scale in the household: Puzzles and patterns from the american past. *Economic Inquiry*, 49(4):1008–1028.
- Parpiev, Z. and Yusupov, K. (2011). Testing household economies of scale in uzbekistan. *Eurasian Journal of Business and Economics*, 4(7):25–51.

2.6 Appendix

2.6.1 Income and Own-price Elasticity

Table A1 – Income and uncompensated own-price elasticity

	Urban		Rural	
	Income	u_price	Income	u_price
Food	0.839***	-0.593***	0.955***	-0.773***
(T value)	(0.003)	(0.017)	(0.002)	(0.009)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Author calculation using Household Expenditure and Income Survey

2.6.2 Variables Explanation

Food and beverage

Monetary expenditure in food is calculated as a sum of purchased food and beverage items in the last month. It contains all the detailed expenses on meats, cereals, bread, dairy, fruits, vegetables, food, oil, dessert, pots, pans, trays, cutlery and crockery. In addition the expenditure of all different kinds of soft drinks is taken into account.

Housing

The expenses on housing comprises the value of housing which is calculated in the following way. For the household living in a rented housing, the amount of monthly rent is used and for the household owners, the imaginary rent is used. The rest of the housing expenditures consists of water, gas, electricity and energy cost, but also all the expenses on house and garden decoration and cleaning items such as brushes, soaps, gloves, brooms, mops and detergents. Finally, housing expenses for matches, light bulbs, sheets and towels are also integrated into this category.

Clothing

The clothing category contains all the cost on apparel purchasing for family members including clothes, shoes, tissue for men, women and children. Also all the charges on repairing, cleaning, ironing, fabrication and maintenance of the clothing inside and outside of the home are taken into account.

Transportation

The expenditures on transportation consist of all the expenses on public and private transportation. The public transportation contains expenditure on taxi, urban and regional buses, train, truck, and boat services. Private transportation includes oil, gas, gasoline, the charges of vehicle repair and maintenance, insurance, tolls, parking fees, driving licence and fines. It is important to notice that the expenses for purchasing vehicles are not included in the transportation expenses.

2.6.3 Parametric Model and Demographic Variables

To select the explanatory variables related to the sex and age for OLS and IV models, we tested different categories; such as those mentioned in Deaton and Paxson (Five age categories of 0-5, 6-11, 12-17, 18-64, and more than 65 for males and females). Then we tried other categories; 0-2, 3-11, 12-17, 18-64, and more than 65. We separated the children before 3 years to control for the differences in the expenditure of breast feeding and formula as breast feeding is popular among Iranians and about 60% of infants are breastfed at 2 years of age (?). However, the coefficients were not statistically significant. Further, we take into account the number of workers in the household and the sex of the household head. After analyzing the results of different estimations, we decided to use seasonal dummies, household age, urban dummy and household head job categories.

Table A2 – OLS results for different explanatory variables

	(1)	(2)	(3)
	share_food	share_food	share_food
lnPCX	-0.0830*** (0.00138)	-0.0831*** (0.00139)	-0.0831*** (0.00137)
lnsize	-0.0167***	-0.0153***	-0.0155***

	(0.00214)	(0.00206)	(0.00187)
Season=2	0.0149***	0.0149***	0.0149***
	(0.00191)	(0.00191)	(0.00191)
Season=3	0.0180***	0.0181***	0.0181***
	(0.00191)	(0.00191)	(0.00191)
Season=4	0.0319***	0.0319***	0.0320***
	(0.00192)	(0.00192)	(0.00192)
Urban/Rural=1	-0.0500***	-0.0500***	-0.0500***
	(0.00153)	(0.00153)	(0.00153)
WS, cooperative	0.0143	0.0142	0.0142
	(0.0147)	(0.0147)	(0.0147)
WS, private	0.0199***	0.0198***	0.0198***
	(0.00233)	(0.00233)	(0.00233)
Agriculture	0.0636***	0.0635***	0.0635***
	(0.00274)	(0.00276)	(0.00274)
NoAgriculture	0.0309***	0.0308***	0.0308***
	(0.00240)	(0.00240)	(0.00240)
age	0.000377***	0.000300	0.000364***
	(0.0000595)	(0.000356)	(0.0000586)
rat_fNoWorkers	-0.00504		
	(0.00416)		
age^2		0.000000643	
		(0.00000356)	
_cons	1.706***	1.705***	1.705***
	(0.0241)	(0.0244)	(0.0241)
N	23347	23347	23347
adj. R^2	0.298	0.298	0.298

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A3 – IV results for additional adult/Child in urban and rural areas

	Urban	Rural	No.of Adults	No of Children
Ln(PCX)	-0.0891***	-0.0917***	-0.106***	-0.0742***
	(0.00365)	(0.00433)	(0.00428)	(0.00621)
Ln(size)	-0.0159***	-0.0203***	-0.0154**	-0.0295***
	(0.00325)	(0.00294)	(0.00555)	(0.00403)

Season=2	0.0149*** (0.00254)	0.0161*** (0.00284)	0.0158*** (0.00282)	0.0131*** (0.00394)
Season=3	0.0217*** (0.00254)	0.0159*** (0.00286)	0.0186*** (0.00283)	0.0211*** (0.00394)
Season=4	0.0365*** (0.00265)	0.0307*** (0.00292)	0.0366*** (0.00292)	0.0295*** (0.00414)
WS, cooperative	0.00991 (0.0198)	0.0224 (0.0216)	-0.00973 (0.0197)	0.0169 (0.0382)
WS, private	0.0121*** (0.00304)	0.0277*** (0.00484)	0.00704 (0.00368)	0.0145* (0.00630)
Agriculture	0.0497*** (0.00464)	0.0731*** (0.00476)	0.0600*** (0.00459)	0.0569*** (0.00649)
NoAgriculture	0.0239*** (0.00285)	0.0413*** (0.00484)	0.0212*** (0.00358)	0.0310*** (0.00600)
Age	0.000327*** (0.0000851)	0.000397*** (0.0000829)	0.000460*** (0.000138)	0.000573*** (0.000112)
Urban/Rural=1			-0.0418*** (0.00232)	-0.0554*** (0.00374)
Constant	1.762*** (0.0645)	1.844*** (0.0752)	2.078*** (0.0753)	1.568*** (0.109)
Observations	11078	12269	10721	5819
Adjusted R^2	0.195	0.178	0.298	0.286

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A5 – IV results for food share on quantile of income

	All sample	Qtile(1)	Qtile(2)	Qtile(3)	Qtile(4)
Ln(PCX)	-0.0905*** (0.00283)	0.0715* (0.0354)	-0.177*** (0.0216)	-0.0731*** (0.0204)	-0.0754*** (0.0105)
Ln(size)	-0.0187*** (0.00215)	0.0421** (0.0153)	-0.0761*** (0.0147)	-0.00218 (0.0150)	-0.00495 (0.00773)
Season=2	0.0154*** (0.00192)	0.00188 (0.00519)	0.0167*** (0.00407)	0.0209*** (0.00373)	0.0168*** (0.00399)
Season=3	0.0187*** (0.00192)	0.0134** (0.00481)	0.0222*** (0.00429)	0.0194*** (0.00397)	0.0214*** (0.00394)
Season=4	0.0334***	0.0151*	0.0466***	0.0354***	0.0264***

	(0.00199)	(0.00697)	(0.00528)	(0.00497)	(0.00402)
Urban/Rural=1	-0.0481***	-0.0808***	-0.0365***	-0.0471***	-0.0424***
	(0.00166)	(0.00773)	(0.00531)	(0.00499)	(0.00382)
WS, cooperative	0.0122	0.0715	-0.0237	0.0127	0.0381
	(0.0147)	(0.0602)	(0.0288)	(0.0258)	(0.0258)
WS, private	0.0161***	0.0612**	0.00870	0.0110*	0.00622
	(0.00263)	(0.0202)	(0.00847)	(0.00541)	(0.00445)
Agriculture	0.0608***	0.0666***	0.0584***	0.0609***	0.0709***
	(0.00289)	(0.0189)	(0.00838)	(0.00564)	(0.00471)
NoAgriculture	0.0285***	0.0333	0.0264***	0.0329***	0.0316***
	(0.00252)	(0.0188)	(0.00777)	(0.00495)	(0.00393)
Age	0.000380***	0.0000425	0.000675***	0.000590***	0.000459***
	(0.0000588)	(0.000134)	(0.000132)	(0.000124)	(0.000136)
Constant	1.833***	-0.878	3.331***	1.502***	1.547***
	(0.0491)	(0.599)	(0.375)	(0.361)	(0.188)
Observations	23347	5479	6529	6148	5191
Adjusted R^2	0.297	0.122	0.163	0.282	0.307

Table A6 – IV results for clothing share on quantile of income

	All sample	Qtile(1)	Qtile(2)	Qtile(3)	Qtile(4)
Ln(PCX)	0.00308	0.0187	0.00945	0.00849	0.00368
	(0.00185)	(0.0126)	(0.00921)	(0.00895)	(0.00488)
Ln(size)	0.0232***	0.0212***	0.0210***	0.0186**	0.0173***
	(0.00141)	(0.00545)	(0.00638)	(0.00668)	(0.00369)
Season=2	0.0146***	0.0102***	0.00906***	0.0102***	0.0120***
	(0.00126)	(0.00185)	(0.00177)	(0.00174)	(0.00192)
Season=3	0.0116***	0.00657***	0.00976***	0.00905***	0.00784***
	(0.00126)	(0.00173)	(0.00186)	(0.00182)	(0.00190)
Season=4	0.0235***	0.00830***	0.0109***	0.0146***	0.0150***
	(0.00130)	(0.00241)	(0.00219)	(0.00213)	(0.00193)
Urban/Rural=1	-0.00910***	-0.00664*	-0.00800**	-0.00449	-0.00358
	(0.00109)	(0.00301)	(0.00249)	(0.00236)	(0.00186)
WS, cooperative	0.00535	-0.0172	0.0169	0.000382	0.00140
	(0.00966)	(0.0206)	(0.0124)	(0.0125)	(0.0124)
WS, private	0.00240	-0.000211	0.00515	0.0000186	-0.00328
	(0.00172)	(0.00750)	(0.00370)	(0.00248)	(0.00212)

Agriculture	0.0135*** (0.00189)	0.00517 (0.00703)	0.0102** (0.00367)	0.0131*** (0.00268)	0.00590* (0.00232)
NoAgriculture	0.00576*** (0.00165)	-0.00340 (0.00695)	0.00737* (0.00339)	0.00205 (0.00241)	-0.0000206 (0.00192)
Age	-0.000503*** (0.0000386)	-0.000419*** (0.0000478)	-0.000293*** (0.0000595)	-0.000463*** (0.0000586)	-0.000357*** (0.0000664)
Constant	-0.0198 (0.0322)	-0.281 (0.213)	-0.141 (0.159)	-0.115 (0.158)	-0.0345 (0.0875)
Observations	23347	5714	6603	6256	5366
Adjusted R^2	0.050	0.083	0.053	0.055	0.041

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A4 – OLS and IV results for all the expenditure categories using the parametric model

	(Food)		(clothing)		(Transport)		(Housing)	
	(1)	IV	(2)	IV	(3)	IV	(4)	IV
Ln(PCX)	-0.0831*** (0.00137)	-0.0905*** (0.00283)	0.0187*** (0.000617)	0.00801*** (0.00126)	-0.00000888 (0.000354)	0.00111 (0.000713)	-0.0698*** (0.00129)	-0.0606*** (0.00265)
Ln(size)	-0.0155*** (0.00187)	-0.0187*** (0.00215)	0.0233*** (0.000847)	0.0188*** (0.000972)	0.00480*** (0.000486)	0.00528*** (0.000552)	-0.0865*** (0.00175)	-0.0821*** (0.00207)
Season=2	0.0149*** (0.00191)	0.0154*** (0.00192)	0.00973*** (0.000866)	0.0104*** (0.000874)	-0.00207*** (0.000502)	-0.00213*** (0.000503)	-0.00287 (0.00176)	-0.00336 (0.00176)
Season=3	0.0181*** (0.00191)	0.0187*** (0.00192)	0.00750*** (0.000865)	0.00834*** (0.000875)	-0.000870 (0.000502)	-0.000963 (0.000505)	0.00361* (0.00175)	0.00292 (0.00176)
Season=4	0.0320*** (0.00192)	0.0334*** (0.00199)	0.0108*** (0.000883)	0.0126*** (0.000909)	0.00326*** (0.000508)	0.00306*** (0.000521)	0.0153*** (0.00177)	0.0135*** (0.00183)
Urban	-0.0500*** (0.00153)	-0.0481*** (0.00166)	-0.00846*** (0.000707)	-0.00540*** (0.000777)	-0.00572*** (0.000406)	-0.00603*** (0.000441)	0.109*** (0.00143)	0.106*** (0.00162)
Cooperative	0.0142 (0.0147)	0.0122 (0.0147)	0.00602 (0.00664)	0.00307 (0.00668)	0.00387 (0.00379)	0.00417 (0.00379)	-0.0116 (0.0133)	-0.00913 (0.0133)
private	0.0198*** (0.00233)	0.0161*** (0.00263)	0.00564*** (0.00106)	0.000324 (0.00120)	-0.00236*** (0.000615)	-0.00181** (0.000687)	0.0178*** (0.00213)	0.0223*** (0.00241)
Agriculture	0.0635*** (0.00274)	0.0608*** (0.00289)	0.0124*** (0.00125)	0.00832*** (0.00133)	-0.000992 (0.000724)	-0.000570 (0.000761)	-0.00850*** (0.00255)	-0.00475 (0.00272)
NoAgricul	0.0308*** (0.00240)	0.0285*** (0.00252)	0.00523*** (0.00110)	0.00173 (0.00116)	-0.00538*** (0.000635)	-0.00503*** (0.000665)	0.0343*** (0.00220)	0.0371*** (0.00232)
Age	0.000364*** (0.0000586)	0.000380*** (0.0000588)	-0.000408*** (0.0000266)	-0.000385*** (0.0000268)	-0.000123*** (0.0000153)	-0.000125*** (0.0000153)	0.000336*** (0.0000539)	0.000313*** (0.0000543)
Constant	1.705*** (0.0241)	1.833*** (0.0491)	-0.293*** (0.0108)	-0.109*** (0.0219)	0.0455*** (0.00624)	0.0260* (0.0124)	1.423*** (0.0226)	1.264*** (0.0461)
No.Obs	23347	23347	23339	23339	23954	23954	23260	23260
Adj. R ²	0.298	0.297	0.070	0.058	0.027	0.027	0.304	0.302

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 3

The Becker Model of Time Allocation: Empirical Evidence with the US Data

joint work with Olivier Donni, Professor at Université de Cergy-Pontoise.

Abstract

Time is a particular resource and should be studied as such. It is the only wealth equally distributed among the population. For a long time, economists would not address time allocation issues. Things changed in the 60s after the remarkable contribution by [Becker \(1965\)](#) in “A Theory of the Allocation of the Time”. Despite the policy relevance of the Becker model, its empirical applications are rare. In the present paper, we propose one of the first empirical applications of the Becker model. To simplify, we consider a single individual whose utility is a function of commodities in Becker's sense. These commodities are themselves produced using time and goods according to some technology. We show that under the assumption of no joint production and constant returns to scale, preferences and technologies can be identified provided that the goods and time allocated to the production of each commodity are observed. We then present an empirical application. We estimate our theoretical model by using the American Time Use Survey and Consumer Expenditure survey for fifteen waves (2003-2017). The outcome of our work confirms the importance of taking into account time allocation to estimate the parameters of the demand system. The two main inputs of the domestic production (time and money) are rather complementary in the production of goods. The estimated parameters in the extended model are different from the traditional AIDS model (which only considers the expenditure in the demand function). In addition, the estimated shadow prices for the commodities (food, housing, clothing, transport, leisure) have an increasing trend as the commodity price but the rates of increase are not the same. There are differences between the estimated shadow prices and the market prices. The found discrepancy between shadow prices and the market prices emphasizes the potential effect in terms of well-being analysis of taking into account the full price of goods.

Keywords: Becker's model, Time allocation, Household economics

3.1 Introduction

Time is a particular resource and should be studied as such. It is the only wealth equally distributed among the population; it is one of the most important assets and yet there is no market where it can be bought or traded; time cannot be saved or stored nor invested for expected return. As an input, time is required for the production of any activity but the peculiarity of this asset makes it difficult to analyze. For a long time, economists would not address time allocation issues. Things changed in the 60s after the remarkable contribution by [Becker \(1965\)](#) in “A Theory of the Allocation of the Time”. In this paper, Becker claims that consumers maximize their utility by choosing so-called commodities that are produced by market goods and time, therefore they face both budget and time constraints in their optimization problem. This model lays the foundation for studying the allocation of time within the household. It has generated a lot of literature and continues to affect economics and other social sciences. Becker was not the first to analyze the allocation of time in the household,¹ but his contribution was to merge consumption with the use of time in household production. [DeSerpa \(1971\)](#) and [Evans \(1972\)](#) have improved the Becker model by adding extra constraints to it. Further research in the area of time-use modeling can be found in [Juster and Stafford \(1991\)](#)’s survey that provides both theoretical and empirical research on the matter.²

Taking account of the distribution of time and consumption expenditure into a unified model of household behavior is crucial and may have significant welfare implications. If it is possible, individuals will optimally substitute time for expenditures in response to fluctuations in the relative cost of time. For example, [Aguiar and Hurst \(2005\)](#) find that the large fall in consumption expenditures at retirement is accompanied by a large increase in time spent on food production. Similarly, [Aguiar et al. \(2013\)](#) and [Nevo and Wong \(2019\)](#) show that macroeconomic

1. For instance, [Gorman \(1980\)](#) wrote one of the earliest papers in which the household production is introduced. The paper was written in 1956 and circulated as a working paper for decades. [Mincer \(1962\)](#) analyzed the married women’s time trade-off between housework and paid work.

2. See also [Hamermesh et al. \(2005\)](#).

shocks, as shown during the recent Great Recession, may change the allocation of time. Examining the incidence of taxation, [Gelber and Mitchell \(2012\)](#) show that home production decreases substantially when market hours of work increase in response to policy changes.

Despite the policy relevance of the Becker model, its empirical applications are rare. Most empirical studies, such as those just cited, rely on simplified or reduced-form equations derived from the model rather than on the model itself in all its complexity.³ In the present paper, we propose one of the first empirical applications of the Becker model. To simplify, we consider a single individual whose utility is a function of commodities in Becker's sense. These commodities are themselves produced using time and goods according to some technology. We show that under the assumption of no joint production and constant returns to scale, preferences and technologies can be identified provided that the goods and time allocated to the production of each commodity are observed. We then present an empirical application.

Applying the iterated seemingly unrelated regression (SUR) method of [Zellner and Theil \(1992\)](#), we estimate our theoretical model by using the American Time Use Survey and Consumer Expenditure survey for fifteen waves (2003-2017). The outcome of our work confirms the importance of taking into account time allocation to estimate the parameters of the demand system. The two main inputs of the domestic production (time and money) are rather complementary in the production of goods. The estimated parameters in the extended model are different from the traditional AIDS model (which only considers the expenditure in the demand function). In addition, the estimated shadow prices for the commodities (food, housing, clothing, transport, leisure) have an increasing trend as the commodity price but the rates of increase are not the same. There are differences between the estimated shadow prices and the market prices. Finally, we calculate the Laspeyres index (PL) for both shadow and market prices. The PL is calculated for each year

3. One exception is worth mentioning. [Salazar \(2015\)](#) in her PhD thesis considers a general model of commodity consumption where each commodity is produced by a fixed-coefficient production function.

compared to the basket of goods of the base year 2003. We see that both increase during the period and are not considerably different. The found discrepancy between shadow prices and market prices emphasize the potential effect in terms of well-being analysis of taking into account the full price of goods. For instance, if we do not consider the full price for food which is a necessary commodity, we might underestimate the well-being of the poorest, who devote a large part of their resource to food.

The rest of this research is structured as follows. In section 2, we present the household maximization problem, the Becker model and our model. The empirical issue and the functional form of the model are described in section 3. Then in section 4, we explain the data and the variables. Section 5 presents the results and interpretation, and finally section 6 concludes the results and the research.

3.2 The Model and its Empirical Implementation

The model used in this research is directly based on the Beckerian model, where family maximizes utility from the consumption of final goods – the so-called commodities – produced with money and time. A commodity is generally the result of a set of small heterogeneous activities sharing the same goal of final consumption. For example, a commodity may include all activities related to the act of eating, such as preparing meals, shopping, washing the dishes, spending time on meals, etc. The various commodities can be related to the acts of eating, housekeeping, child care and rearing, entertaining, etc.

3.2.1 Theory

To keep things as simple as possible, we focus on the behavior of a single individual that has to decide on the allocation of his/her time and money to the production of commodities.⁴ We suppose that his/her preferences are described by a well-behaved

4. The extension of the model to a couple poses no theoretical difficulty. In that case, however, its empirical implementation can be troublesome. Indeed the time of each individual can contribute

utility function as:

$$U = F(Z_1, \dots, Z_K) \quad (3.2.1)$$

where Z_k for $k = 1, \dots, K$ denotes the various commodities. Each commodity Z_i is associated to a specific production function as:

$$Z_k = f^k(X_k, T_k), \quad k = 1, \dots, K \quad (3.2.2)$$

where X_k and T_k are the market good and the time used in the production process. Therefore, the individual faces traditional budget and time constraints and a set of technology constraints. The budget constraint can be written as:

$$\sum_{k=1}^K P_k X_k = V + WL, \quad (3.2.3)$$

where P_k is the price of market good k , V is the amount of non-labor income, W is the wage rate and L is the time devoted to market labor. Similarly, the allocated time constraint can be written as:

$$T = L + \sum_{k=1}^K T_k, \quad (3.2.4)$$

where T is the total time endowment (it can be, for example, equal to 16 hours a day if 8 hours are supposed to be necessary for sleep and personal care). The individual maximises his/her utility function (3.2.1) subject to constraints (3.2.2) to (3.2.4).

The optimization problem can be written as:

$$\max F(f_1(X_1, T_1), \dots, f_K(X_K, T_K)) \quad (3.2.5)$$

subject to

$$\sum_{k=1}^K P_k X_k + W \sum_{k=1}^K T_k = WT + V = Y \quad (3.2.6)$$

where $Y = WT + V$ is the full income. In this expression, the wage rate plays the role of the price of time.

to the production of each commodity, multiplying the possibility of substitution between factors of production and multiplying the probability of corner solutions.

The optimization problem is similar to the maximization of a separable utility function and can be decomposed in two stages. To obtain a simple representation of the behavior, we assume that the production functions $f_k(X_k, T_k)$ are linearly homogeneous so that the corresponding expenditure function can be written as:

$$E_k(W, P_k, Z_k) = \Pi_k(W, P_k)Z_k$$

where $E_k(W, P_k, Y_k)$ represents the total level of expenditure (taking into account the price of goods and the price of time) necessary to produce the amount Z_k of commodity k , and $\Pi_k(W, P_k)$ is some linearly homogeneous function that can be interpreted as the price of commodity k . Because of the assumption made on the production function, this price is independent of the level of production. The optimization problem can then be written as a two-stage one. In the first stage, the individual minimizes the expenditure necessary to produce some amount Z_k of commodity k , that is,

$$E_k(W, P_k, Z_k) = \min X_k P_k + T_k W \text{ subject to } Z_k = f_k(X_k, T_k).$$

In the second stage, he/she chooses the optimal level of E_k , budget devoted to each activity, to maximize his/her utility:

$$\max_{E_1, \dots, E_K} U \left(\frac{E_1}{\Pi_1(W, P_1)}, \dots, \frac{E_K}{\Pi_K(W, P_K)} \right) \text{ subject to } \sum_{k=1}^K E_k = Y. \quad (3.2.7)$$

If each E_k is replaced by $Z_k \Pi_k(W, P_k)$, the optimization problem can equivalently be written as:

$$\max_{Z_1, \dots, Z_K} U(Z_1, \dots, Z_K) \text{ subject to } \sum_k Z_k \Pi_k(W, P_k) = Y. \quad (3.2.8)$$

Under our assumption, the demand for commodities can be written as:

$$Z_k = Z_k(\Pi_1(W, P_1), \dots, \Pi_K(W, P_K), Y)$$

where Z_k is a traditional Marshallian demand function satisfying the Slutsky

condition, and Π are shadow prices.

3.2.2 Empirical Content

The question of identification, hitherto ignored, is as follows: is it possible to find the structural components of the model, namely the utility function and the production functions, from the behavior observed by the economist ? The answer to this question depends on what is actually observed. We assume here that neither the quantity Z_k nor the price Π_k of the consumed commodities can be observed. In contrast, the total expenses E_k for each product are observed because they are the sum of the expenses in time WT_k and the expenses in money P_kX_k . As previously said, the total expenses satisfy the following condition:

$$E_k(W, P_k, Z_k) = \Pi_k(W, P_k)Z_k$$

By application of the Sheppard Lemma, we obtain demand functions:

$$\frac{WT_k}{E_k} = \frac{\partial \log \Pi_k}{\partial \log W}(W, P_k) \quad \text{and} \quad \frac{P_kX_k}{E_k} = \frac{\partial \log \Pi_k}{\partial \log P_k}(W, P_k)$$

where the left-hand side of the equations represents the share, respectively, of the time cost and the money cost in total cost that are observed. These equations constitute a system of partial differential equations that can be solved up to a multiplicative constant. That is, if $\Pi_k^*(W, P_k)$ is a particular solution of this system, then the general solution is of the form:

$$\Pi_k(W, P_k) = \Pi_k^*(W, P_k) \times \kappa_k$$

where κ is an unknown. Once this constant is fixed, the price of commodities is well defined and, therefore, the amount of commodities consumed by individuals can be recovered as: $Z_k = E_k/\Pi_k$. If we consider the demand equations:

$$S_k = \frac{\Pi_k Z_k}{Y} = S_k(\Pi_1(W, P_1), \dots, \Pi_K(W, P_K), Y)$$

where S_k is the budget share of commodity k . The budget share equations are identifiable if the K shadow prices are functionally independent, that is, if the rank of the Jacobian matrix

$$J = \begin{pmatrix} \frac{\partial \Pi_1}{\partial W}(W, P_1) & \frac{\partial \Pi_1}{\partial P_1}(W, P_1) & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ \frac{\partial \Pi_K}{\partial W}(W, P_1) & 0 & \cdots & \frac{\partial \Pi_K}{\partial P_K}(W, P_K) \end{pmatrix}$$

is equal to K . A sufficient condition is that each term $\partial \Pi_1 \partial W$ be different from zero. In that case, there exists a vector $dP = (dW, dP_1, \dots, dP_K)$ for any $k = 1, \dots, K$ such that $Jdp = (0 \dots 1 \dots 0)$. The function S_k can then be identified.

3.3 Data and Estimation Method

One of the main problems with estimating this model is the lack of data providing information on both the allocation of time and the allocation of money.⁵ To deal with this difficulty, we will simultaneously use two databases: The American Consumer Expenditure Survey (CES) and The American Time Use Survey (ATUS) (including its connection with the Current Population Survey (CPS)) from 2003 to 2017. The two data sets are sponsored by the U.S. Bureau of Labor Statistics (BLS) and developed by the U.S. Census Bureau (USCB).

The CES contains information on the purchasing habits of American households. In particular, the Interview Survey – one of the two basic components of the CES – is a rotating panel in which the household consumption of various goods is recorded during an entire year. It has been conducted annually since 1980. The ATUS provides measures of the amounts of time spent on various activities for one entire day, including working, leisure, childcare, and household activities. The survey has been conducted annually since 2003. The sample is extracted from the CPS. After the final CPS interview, one person of at least fifteen years of age is randomly selected from each household to be interviewed for the ATUS. The ATUS and the CPS can

5. Exceptions are the Danish Time Use Survey, or the Dutch LISS panel data.

thus be matched. The March Supplement of CPS includes supplemental information on non-labor income that are used in our estimations (as non-labor income is not directly reported in ATUS). In the ATUS and CES the direct information on the price is not reported, therefore we use the regional price indexes for our commodity groups, which are accessible on the Federal Reserve website⁶.

We define five commodities around the following activities: (a) eating, (b) housing maintenance, (c) clothing, (d) transport, (e) leisure. Other expenses are included in a residual commodity. In the following paragraph we explain the detailed construction of each commodity from money and time spent.

Eating Activity. Expenditure on food is defined as the sum of all expenditures on food and nonalcoholic beverage prepared at home or away from home (restaurants, bars, catering, etc.). This includes the daily expenses over about 100 items from expenditure surveys comprising fresh and processed food, cereals, meat, vegetables and nonalcoholic drinks. The total time devoted to food activity corresponds to the sum of the meal time of the individual at home and outside, time spent shopping at the grocery store, time spent cleaning and cooking food, and time spent cleaning the kitchen.

Home Maintenance Activity. The main expense for the home maintenance activity is the price of housing. For owners, we use a question on the hypothetical monthly rent that the individual would pay if he rented his accommodation. For the tenants, we take the rent calculated over the year. We add the sum of expenses for mortgage interest, property taxes, maintenance, repairs and cleaning, insurance and other expenses. We also add expenses for public services, fuels such as natural gas, electricity, fuel oil and other fuels, telephone services, water and other public services, domestic operations (domestic services, other expenses households), furniture and equipment. Finally, we construct the daily housing expenditure to be harmonized with the other variables. The total time spent on home maintenance is the sum of the

6. <https://fred.stlouisfed.org/>

time spent cleaning, furnishing, decorating, repairing, heating and air conditioning, building and repairing furniture, house maintenance, housing security and activities related to the purchase / sale of real estate and the use of real estate, real estate services.

Clothing-related Activity. For this activity, expenses include all annual apparel purchases, that is, clothing for men and boys, clothing for women and girls, clothing for children under two years, footwear and other apparel products and services. It also includes annual expenses for the maintenance of clothing such as shoes and fabric repairs, as well as annual expenses for washing, ironing and repairing fabrics outside the home. The total time spent on this activity is all time spent buying clothes, washing and ironing, repairing and maintaining textiles, and using repair and cleaning services. The minutes spent to repair, weave and sew old or new clothes is also taken into account here.

Transport Activity. For the transport activity, expenditure on private and public transport are included. Specifically, it includes vehicle purchases and all transportation costs such as gasoline and motor oil, vehicle finance costs, vehicle maintenance and repairs, vehicle insurance, vehicle rentals, leases and licenses. Public transport includes the costs of taxis, city and regional buses, trucks and boats. Time expenditure includes time spent traveling, but also time spent repairing and maintaining vehicles, picking and picking up household members, and waiting associated with the vehicle.

Leisure Activity. These expenses include expenses related to recreational and leisure activities such as watching television, reading, playing sports, listening to the radio, traveling and going to the movies. Money spent on books, magazines, theater, museum, sound equipments, other equipments and services are also taken into account. The time spent for leisure contains the minutes devoted to reading, writing, watching TV, going to cultural activities (theater, museum, opera, music concert, cinema football match, etc) and making sport activities.

To compute prices, we use the consumer price index for different items for four census regions – Northeast, West, Midwest, South⁷ – which is published by the Bureau of Labor Statistics. The ATUS and the CES contain information on hourly wages⁸, working time (at least when ATUS is matched to CPS⁹) and various socio-demographic variables.

The original sample includes 514,480 households (ATUS and CES together). We select a sub-sample of single-headed households between ages 25 to 60 without children in order to eliminate the intra-household allocation issues.

Table 3.1 – Descriptive statistics of our sample

	ATUS		CES	
	Mean	sd	Mean	sd
Age	39.16	10.18	43.96	10.33
Sex	0.51	0.50	0.55	0.50
White race	0.69	0.46	0.82	0.39
At most high school	0.18	0.39	0.21	0.40
At most bachelor degree	0.60	0.49	0.63	0.48
Master, PhD, professional	0.21	0.40	0.16	0.36
Region1: North east	0.19	0.39	0.19	0.39
Region2: Midwest	0.23	0.42	0.23	0.42
Region3: South	0.37	0.48	0.35	0.48
Hourly wage	20.56	9.99	22.05	10.10
Total Income(Y)	357.47	174.87	395.97	172.92
Food share*	0.099	0.060	0.033	0.015
House share	0.022	0.044	0.085	0.034
Clothing share	0.027	0.045	0.004	0.004
Transport share	0.021	0.024	0.031	0.024
leisure share	0.226	0.150	0.010	0.006

*Food share for ATUS is a daily cost of time devoted to food preparation.

Additionally, we exclude non-workers from our sample. This selection and the exclusion of observations with missing information leaves us a sample of 5,622 households (2,789 of CES and 2,833 ATUS). In Table 3.1, descriptive statistics of our sample are presented. The mean and the standard deviation of the main variables are shown for ATUS and CES. There are no considerable differences between the means of the demographic variables in ATUS and CES. For example, in both datasets there is about 50 percent of males and the age mean is about 40 years. The

7. Find more explanation about the 4 regions in Appendix 3.5.4

8. For further explanation, refer to Appendix 3.5.1

9. Appendix 3.5.2

mean of hourly wage is about 20 dollars. In CES, the share of goods is the daily expenditure share for each commodity. In ATUS, it is a daily cost of time devoted to each good. More precisely, the time devoted to each activity is multiplied by the cost of the time, hourly wage.

To obtain Y from the ATUS and the CES, we assume that the household consumes all its income: therefore, the total income can be used as being equal to total expenditure: $Y = Tw + y$, where y is non-labor income, T is total time available (e.g., 24 hours per day removing the sleeping time) and w is the hourly wage. This is the usual approach followed in labor supply models.

3.3.1 Empirical Investigation and Parametric Specification

The CES does not contain information on time allocation (with the exception of the total amount of non-market time $\sum T_k$) while the ATUS does not contain information on expenditure. The estimation method has to take into account this limitation of our data. We suppose that the production function $f_k(X_k, T_k)$ is of the constant elasticity of substitution (CES) form with constant return to scales, that is,

$$f_k(X_k, T_k) = \kappa_k \times (\phi_k \cdot X_k^{r_k} + (1 - \phi_k) \cdot T_k^{r_k})^{1/r_k} \quad (3.3.1)$$

where κ_k , ϕ_k and r_k are parameters specific to commodity k . As it is well known, the parameter r_k is related to the elasticity of substitution in the production process of commodity k . If r_k is equal to 1, then X_k and T_k are perfectly substitutable, i.e., the production function is linear, while if r_k approaches $-\infty$, then X_k and T_k tend to perfect complementarity, i.e., the production function is of the “min” form. If r_k is equal to zero, then elasticity of substitution is equal to one, i.e., the production function is of the Cobb-Douglas form. This is a great advantage of this specification as the degree of substitutability/complementarity between factors is a crucial parameter in welfare analysis. If ϕ_k is equal to one, then the model boils down to the traditional model without domestic production.

As it is easily shown, the corresponding cost function is the following:

$$E_k = \kappa_k^{-1} \times Z_k \times (P_k^{1-s_k} \phi_k^{s_k} + (1 - \phi_k)^{s_k} W^{1-s_k})^{\frac{1}{1-s_k}}$$

where $s_k = 1/(1-r_k)$ is the elasticity of substitution. Because of constant returns to scale, the cost is proportionate to the level of production. The price of commodity k is thus:

$$\Pi_k = \kappa_k^{-1} \times (P_k^{1-s_k} \phi_k^{s_k} + (1 - \phi_k)^{s_k} W^{1-s_k})^{\frac{1}{1-s_k}}$$

and the demand equations in budget shares are:

$$\frac{\partial \log E_k}{\partial \log W} = \frac{T_k W}{E_k} = W \left(\frac{1 - \phi_k}{W} \right)^{s_k} (P_k^{1-s_k} \phi_k^{s_k} + (1 - \phi_k)^{s_k} W^{1-s_k})^{-1} \quad (3.3.2)$$

and

$$\frac{\partial \log E_k}{\partial \log X_k} = \frac{X_k P_k}{E_k} = P_k \left(\frac{\phi_k}{P_k} \right)^{s_k} (P_k^{1-s_k} \phi_k^{s_k} + (1 - \phi_k)^{s_k} W^{1-s_k})^{-1}. \quad (3.3.3)$$

Note that these equations are independent of κ_k , hence this parameter cannot be identified from these equations without additional information. From the data we have, we do not observe expenditures E_k and thus these equations cannot be directly estimated. In what follows, we propose another approach.¹⁰

To go further, we suppose that the preferences of the individual are such that the system of demand equations has the AIDS form (Deaton and Muellbauer, 1980), that is, the budget share equations are of the form:

$$\frac{E_k}{Y} = \alpha_k + \sum_{k,k'} \beta_{kk'} \log \Pi_{k'} + \gamma_k (\log Y - \log P) \quad (3.3.4)$$

where

$$\log P = \sum_k \alpha_k \log \Pi_k + \frac{1}{2} \left(\sum_k \sum_{k'} \beta_{kk'} \log \Pi_k \log \Pi_{k'} \right)$$

10. If we had a single data set with information of time use and expenditure, the easiest way to estimate these parameters would consist in taking the ratio of these equation and obtaining:

$$\log(T_k/X_k) = s_k \log((1 - \phi_k)/\phi_k) + s_k \log(P_k/W).$$

See Canelas, Gardes, Merrigan and Salazar (2019) or Hamermesh (2008) for an application.

and Π_k is defined as previously. If this expression is incorporated in (3.3.2) and (3.3.3), we obtain:

$$\frac{X_k P_k}{Y} = P_k \left(\frac{\phi_k}{P_k} \right)^{s_k} \left(\frac{\alpha_k + \sum_{k,k'} \beta_{kk'} \log \Pi_{k'} + \gamma_k (\log Y - \log P)}{P_k^{1-s_k} \phi_k^{s_k} + (1 - \phi_k)^{s_k} W^{1-s_k}} \right) \quad (3.3.5)$$

and

$$\frac{T_k W}{Y} = W \left(\frac{1 - \phi_k}{W} \right)^{s_k} \left(\frac{\alpha_k + \sum_{k,k'} \beta_{kk'} \log \Pi_{k'} + \gamma_k (\log Y - \log P)}{P_k^{1-s_k} \phi_k^{s_k} + (1 - \phi_k)^{s_k} W^{1-s_k}} \right). \quad (3.3.6)$$

where, as usual, the following conditions are satisfied: $\sum_k \alpha_k = 1$, $\sum_k \gamma_k = 0$, $\sum_{k'=1}^K \beta_{kk'} = 0$ for all k , $\beta_{kk'} = \beta_{k'k}$.¹¹

For five commodities, we have ten equations, five for the expenditure share and five for the time allocated to each good. To estimate this model, we add an error term to each equation. This error term represents measurement/optimization errors or unobservable heterogeneity. We also add socio-demographic¹² variables in the constant α_k .

3.3.2 Estimation Results and Discussion

The parameters of the model are estimated by the iterated SUR method (Zellner and Theil (1992)). The results for the extended AIDS model (3.3.5) and (3.3.6) are presented in Tables 3.2 (The estimated parameters for the main variables) and A2 (the estimated parameters for the demographic variables). For the sake of comparison, the results for the traditional AIDS model are also presented. The latter is a particular case of the extended model where ϕ_k is equal to one. We find that, for most of them, the estimated parameters for the extended model are different from – but of the same order of magnitude as – those obtained with the traditional model. If we take the example of the effect of full income on budget shares, the

11. Quite interestingly, all the structural parameters of the model can be identified from the estimation of the sole equation (3.3.5). It thus appears that time use data are not necessary with this specific functional form (3.3.6). Time use data are, however, important to obtain robust results.

12. You can find more explanation of the socio-demographic in Appendix (3.5.3).

estimated parameters γ_k for the two models are very similar for food and transport but significantly different for clothing.

In Table 3.2, the most interesting results are the estimated parameters of the production function. We find that all the estimated parameters r_k and ϕ_k of the production function are significantly different from one. The traditional model is thus rejected. The traditional model is the AIDS model with the equation on the expenditure shares excluding the equation on the allocated time to each activity. In addition, all the r_k are negative, indicating a (strong) complementarity between production factors. The elasticities of substitution, $s_k = 1/(1 - r_k)$, are between 0.35 (for food) and 0.94 (for clothing). As expected, all the ϕ_k are comprised between 0 and 1, indicating that marginal productivity of both production factors is positive. The parameter ϕ is generally below 0.5 (with the exception of house maintenance), suggesting that the weight of cost in time in the price of commodities is considerable.

To better understand the differences between the two models, the evolution of the shadow prices for the different commodities and the evolution of the corresponding current prices are displayed in the Fig. 3.1. The prices are the mean of prices on the individual. We find that shadow prices and market prices increased during the analysis period. The rates of increase are, however, different. For instance, the increase in the food shadow price (Π_f) is much smaller than the increase in the corresponding market price (P_f). Considering ϕ for food, The weight of the time is important in food preparation ($\phi = 0.0006$). For housing, there is no considerable difference between the market price and the shadow price, which is not surprising as its ϕ is more than 50 percent. In contrast, the shadow price for clothing is greater than the market price, and it seems that the market price underestimates the value of the clothing. Fig. 3.2 presents yearly hourly wage or the time price. The price of clothing increased slightly over the period while the price of time increased more. For transport and leisure, the shadow prices are lower than the market prices and have almost the same trend. The last chart in the right bottom presents the Laspeyres

Table 3.2 – Comparison of results for two estimations

	Food			Housing			Clothing			Transportation			Leisure			
	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time	
β_{Food}	0.0008 (.0743)	0.1248 (0.178)														
$\beta_{Housing}$	0.0920 (.0463)	0.0664 (.2918)	0.1117 (.0482)	0.0443 (.6354)												
β_{Cloth}	-0.0011 (.0458)	-0.0698 (.0302)	0.0106 (.0312)	-0.0962 (.0469)	0.2319 (.1287)	-0.0045 (.0091)										
$\beta_{Transport}$	0.0819 (.0396)	0.0172 (.1078)	0.0531 (.0307)	0.0091 (.2164)	-0.0219 (.0238)	-0.0365 (.0187)	0.0482 (.0358)									
$\beta_{Leisure}$	0.0904 (.0871)	-0.0028 (.0612)	-0.1464 (.0537)	-0.0014 (.0908)	-0.2150 (.1201)	-0.0077 (.0135)	0.0127 (.0538)	0.0472 (.0906)								
α	-3.4346 (.829)	0.0891 (1.9197)	-0.5331 (.5008)	1.1490 (3.2908)	0.8496 (.6908)	0.4276 (.399)	-0.4045 (.3907)	0.1474 (1.0786)								
γ	-0.0540 (.0129)	-0.0510 (.0016)	-0.0147 (.0134)	-0.1213 (.004)	0.0040 (.0077)	-0.0027 (.0004)	-0.0360 (.011)	-0.0378 (.0024)								
ϕ	0.0006 (.0006)		0.5433 (.1148)				0.3238 (.0702)									
r	-1.8285 (.2781)		-1.1750 (.4451)				-0.5742 (.1608)									
α_{age}	-0.0001 (.0001)	-0.0001 (.0001)	-0.0002 (.0001)	-0.0002 (.0002)	-0.0002 (.0001)	-0.0001 (.0001)	0.0001 (.0001)	0.0001 (.0001)								
α_{sex}	0.0130 (.0021)	0.0130 (.0016)	-0.0056 (.0019)	-0.0044 (.0042)	-0.0112 (.0011)	-0.0034 (.0004)	0.0056 (.0016)	0.0056 (.0026)								

index (PL)¹³ for shadow price and our current price. The PL is calculated for each year compared to the basket of goods of the base year 2003. As it is shown, the PL for the market price and for the shadow price are approximately the same. However, we saw that there are notable differences between the shadow prices and the market prices for all commodities except housing. By analysing the PL, we can not observe the heterogeneity according to commodities. It is therefore crucial to calculate the shadow price for each commodity separately as we did.



Figure 3.1 – Mean of commodities prices and estimated Π s on individual for each good.

The PL presents the Laspeyres Index.

These types of results highlight the potential effects in terms of well-being analysis of taking into account the full price of food. If the full price of food – which is basically a necessary commodity – has increased little over the period of interest, then changes in the well-being of the poorest, who devote a large part of their resources to food,

13. Appendix 3.5.5.

can be underestimated by traditional models of consumption. Similarly, the increase in the shadow price of leisure and transport is more pronounced than the increase of the corresponding market prices. The converse is true for clothing.

3.4 Concluding remarks

Time allocation issues were not addressed by the economists for a long time. In the 60s, Becker has a remarkable contribution by his paper entitled "A Theory of the Allocation of the Time". In this paper, he claims that the households face both budget and time constraints in their optimization problem and maximize their utility by choosing so-called commodities that are produced by market goods and time. Despite the policy relevance of the Becker model, its empirical applications are rare.

Our paper has two parts, theoretical and empirical. In the theoretical part, we use a model which is based on the Beckerian model, where a household maximizes utility from the consumption of final goods produced with money and time. In the empirical part, we estimate the parameters of our model by the iterated SUR method using the data of the American consumer Expenditure Survey, the American Time Use Survey and the Current Population Survey. We focus on five main groups of commodities: food, housing maintenance, clothing, transport and leisure. For the sake of comparison, we estimate our extended model once and then we compare the results with the traditional AIDS model.

As a result, we find that the estimated parameters for the extended model are different from - but of the same order of magnitude as - those obtained with the traditional model. Furthermore, we discover that the estimated parameters r_k and ϕ_k of the production function are significantly different from one, which means that the traditional model is rejected. All the r_k are negative, indicating a (strong) complementarity between production factors. Moreover, the comparison of the evolution of the shadow prices for the different goods with the evolution of the corresponding current prices shows that the shadow and the market prices increased

during the analysis period. However, the rates of increase are different. Finally, we calculate the Laspeyres index (PL) for both shadow and market prices using different commodities. The PL is calculated for each year compared to the basket of goods of the base year 2003. We see that both increase during the period and the PL based on the shadow price is not capable of presenting the heterogeneity between the shadow prices of each commodity.

The present findings confirm the importance of measuring the time allocation in the household maximization utility program. These types of results emphasize the potential effect in terms of well-being analysis of taking into account the full price of goods. For instance, if we do not consider the full price for food, which is a necessary commodity, we might under-estimate the well-being of the poorest, who devote a large part of their resource to food.

Bibliography

- Aguiar, M. and Hurst, E. (2005). Consumption versus expenditure. *Journal of political Economy*, 113(5):919–948.
- Aguiar, M., Hurst, E., and Karabarbounis, L. (2013). Time use during the great recession. *American Economic Review*, 103(5):1664–96.
- Becker, G. S. (1965). A theory of the allocation of time. *The economic journal*, pages 493–517.
- DeSerpa, A. C. (1971). A theory of the economics of time. *The Economic Journal*, 81(324):828–846.
- Evans, A. W. (1972). On the theory of the valuation and allocation of time. *Scottish Journal of Political Economy*, 19(1):1–17.
- Gelber, A. M. and Mitchell, J. W. (2012). Taxes and time allocation: Evidence from single women and men. *The Review of Economic Studies*, 79(3):863–897.
- Gorman, W. M. (1980). A possible procedure for analysing quality differentials in the egg market. *The Review of Economic Studies*, 47(5):843–856.
- Hamermesh, D. S., Frazis, H., and Stewart, J. (2005). Data watch: The american time use survey. *Journal of Economic Perspectives*, 19(1):221–232.
- Juster, F. T. and Stafford, F. P. (1991). The allocation of time: Empirical findings, behavioral models, and problems of measurement. *Journal of Economic literature*, 29(2):471–522.

- Mincer, J. (1962). Labor force participation of married women: A study of labor supply. In *Aspects of labor economics*, pages 63–105. Princeton University Press.
- Nevo, A. and Wong, A. (2019). The elasticity of substitution between time and market goods: Evidence from the great recession. *International Economic Review*, 60(1):25–51.
- Zellner, A. and Theil, H. (1992). Three-stage least squares: simultaneous estimation of simultaneous equations. In *Henri Theil's Contributions to Economics and Econometrics*, pages 147–178. Springer.

3.5 Appendix

3.5.1 Hourly Wage

We can calculate the hourly wage using the available data on weekly earning and weekly hours of works in ATUS. In CES, there is the information on annual earning and the number of the weeks that the person worked in the year. The hourly work per week is also reported. Therefore, it is possible to calculate the hourly wage. The calculated hourly wage is presented in Table A1.

Table A1 – Mean of hourly wage for ATUS and CES

	ATUS	CES	Average salary for US workers ¹⁴
Hourly wage	22.37	21.98	22.63
Std. Dev.	(12.92)	(14.442)	



Figure 3.2 – Yearly mean of hourly wage.

3.5.2 Non-labor income through CES

To calculate Y , we need to have the non-labor income. In the ATUS data set, the information on non-labor income is not available. But as the ATUS households are selected from the CPS data base, we used CPS March Supp to add the non-labor

income to our ATUS sample.

3.5.3 Demographic variables

In our estimations, we used different demographic variables to control the differences between different characteristics of households. The socio-demographic variables we used are: the gender of the individual (α_{sex}), the three dummy variables for the four different regions (α_{regi}), three dummy variables for four different education categories (α_{educa}), illiterate, at most high school, at most bachelor degree, master or post graduate degree, a dummy variable for the race of the population (α_{wh}), white and not-white, not-white included Hispanic and not-white, and finally we control for the period as well.

Table 3.1 presents the summary statistics of the soci-demographic variables of our sample.

3.5.4 Geographic Regions

Figure 3.3 presents the four geographic regions used in this research.

3.5.5 Laspeyres and Paasche indices

Price indices are used to monitor changes in prices levels over time. This is useful when separating real income from nominal income, as inflation is a drain on purchasing power. The two most basic indices are the Laspeyres index(P_L)¹⁵ and the Paasche index(P_p)¹⁶.

$$P_p = \frac{\sum(p_{c,t_n})*(q_{c,t_n})}{\sum(p_{c,t_0})*(q_{c,t_n})}, P_L = \frac{\sum(p_{c,t_n})*(q_{c,t_0})}{\sum(p_{c,t_0})*(q_{c,t_0})}$$

where P is the relative index of the price levels in two periods, t_0 is the base period (usually the first year), and t_n is the period for which the index is computed. Note that the only difference in the formulas is that the former uses period n quantities,

15. Named after Etienne Laspeyres

16. Named after Hermann Paasche

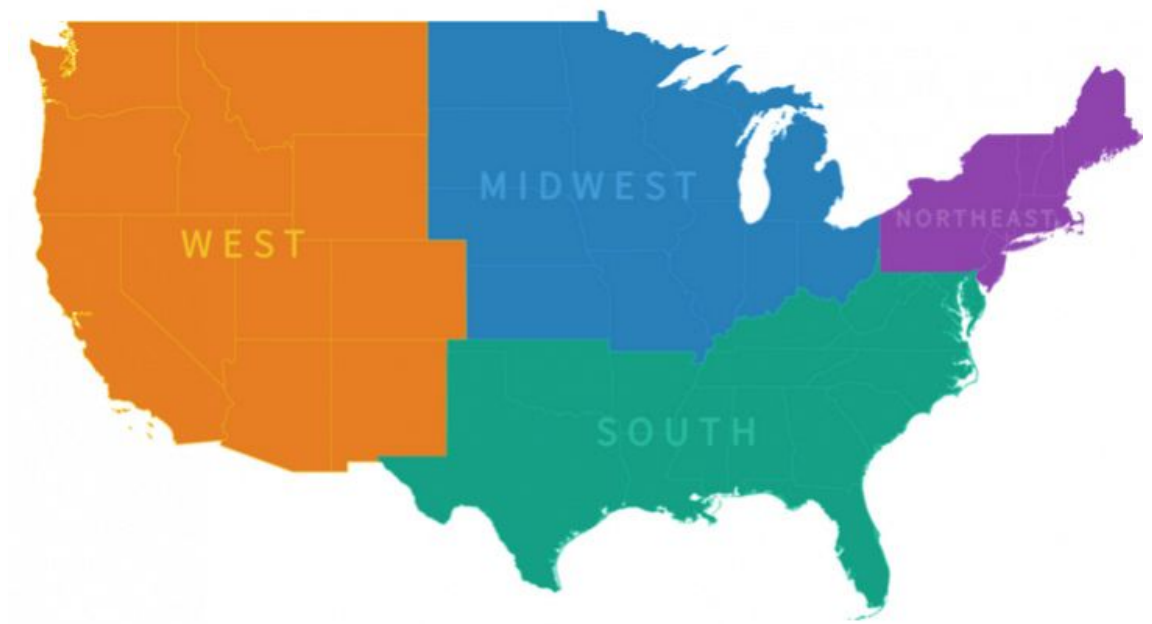


Figure 3.3 – US four geographical regions.

source: www.worldatlas.com

whereas the latter uses base period (period 0) quantities.

What this translates to is the following: a Laspeyres index of one means that, as the nominator is the same as the denominator, an individual can afford the same basket of goods in the current period as he did in the base period. As the quantities are the same, this just leaves price as a variable, which must remain unchanged. This translates to the concept of compensated variation (CV): by how much do we need to increase an individual's income in order to offset inflation? That is, at the new level of prices, how much is required to compensate the effect of the price increase? A Paasche index of one means that the consumer could have afforded the same bundle of goods in the base period as they can now. This can be translated to the concept of equivalent variation (EV): how much income would we have to take away from an individual, at the base price level, to have the same impact on their utility as the inflation between the base period and period 1. In this research, we calculate both Laspeyres and Paasche index. As we did not find considerable differences between the two, we presented the Laspeyres index finally. To calculate the Laspeyres index, first we measure the median of the expenditure for each group

of goods by year and then we calculate the Laspeyres index using the median.

3.5.6 Estimated Demographics Variables

Table A2 – Comparison of the estimated demographic parameters for two estimation

	Food			Housing			Clothing			Transportation			Leisure		
	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time	Exp+Time	Exp	Exp+Time
α_{age}	-0.0001 (.0001)	-0.0001 (.0001)	-0.0002 (.0001)	-0.0002 (.0001)	-0.0002 (.0001)	-0.0001 (.0001)	-0.0001 (.0001)	-0.0001 (.0001)	0.0001 (.0001)	0.0001 (.0001)	0.0001 (.0001)	-0.0001 (.0003)	-0.0001 (.0002)	0.0001 (.0002)	-0.0001 (.0002)
α_{sex}	0.0130 (.0021)	0.0130 (.0016)	-0.0056 (.0019)	-0.0056 (.0019)	-0.0044 (.0042)	-0.0034 (.0004)	-0.0034 (.0004)	-0.0034 (.0004)	0.0056 (.0016)	0.0056 (.0016)	0.0056 (.0026)	0.0125 (.0052)	0.0125 (.0007)	-0.0002 (.0007)	-0.0002 (.0007)
α_{regi1}	-0.0033 (.0038)	0.0025 (.0057)	-0.0056 (.0033)	-0.0056 (.0033)	-0.0102 (.0096)	-0.0025 (.0011)	-0.0025 (.0011)	-0.0025 (.0011)	0.0018 (.0028)	0.0018 (.0028)	0.0055 (.005)	0.0139 (.0085)	0.0139 (.0022)	-0.0007 (.0022)	-0.0007 (.0022)
α_{regi2}	-0.0084 (.0048)	0.0016 (.0072)	-0.0056 (.0043)	-0.0056 (.0043)	-0.0136 (.0156)	-0.0021 (.0015)	-0.0021 (.0015)	-0.0021 (.0015)	0.0048 (.0032)	0.0048 (.0032)	0.0092 (.0066)	0.0072 (.0086)	0.0072 (.0031)	0.0030 (.0031)	0.0030 (.0031)
α_{regi3}	0.0034 (.0053)	0.0138 (.0068)	-0.0005 (.0044)	-0.0005 (.0044)	-0.0041 (.0156)	-0.0032 (.0015)	-0.0032 (.0015)	-0.0032 (.0015)	0.0010 (.0038)	0.0010 (.0038)	0.0039 (.0068)	-0.0049 (.0086)	-0.0049 (.0028)	0.0026 (.0028)	0.0026 (.0028)
α_{wh}	0.0050 (.0025)	0.0036 (.0021)	0.0003 (.0024)	0.0003 (.0024)	0.0037 (.0054)	0.0001 (.0005)	0.0001 (.0005)	0.0001 (.0005)	-0.0003 (.0019)	-0.0003 (.0019)	0.0050 (.0033)	0.0126 (.006)	0.0126 (.0009)	0.0033 (.0009)	0.0033 (.0009)
α_{year}	0.0018 (.0004)	0.0000 (.001)	0.0002 (.0002)	0.0002 (.0002)	-0.0005 (.0017)	-0.0004 (.0003)	-0.0004 (.0003)	-0.0004 (.0003)	0.0002 (.0022)	0.0002 (.0022)	-0.0001 (.0005)	-0.0001 (.0004)	-0.0001 (.0005)	-0.0001 (.0005)	-0.0001 (.0005)
α_{educa1}	-0.0181 (.0099)	-0.0035 (.0084)	0.0028 (.0095)	0.0028 (.0095)	0.0171 (.0214)	-0.0054 (.002)	-0.0054 (.002)	-0.0054 (.002)	-0.0222 (.0085)	-0.0222 (.0085)	-0.0156 (.013)	0.0778 (.0271)	0.0778 (.0037)	0.0105 (.0037)	0.0105 (.0037)
α_{educa2}	-0.0168 (.0099)	0.0017 (.0083)	0.0077 (.0094)	0.0077 (.0094)	0.0400 (.0212)	-0.0038 (.0019)	-0.0038 (.0019)	-0.0038 (.0019)	-0.0198 (.0085)	-0.0198 (.0085)	-0.0064 (.0129)	0.0732 (.0268)	0.0732 (.0036)	0.0128 (.0036)	0.0128 (.0036)
α_{educa3}	-0.0017 (.0102)	0.0104 (.0085)	0.0110 (.0097)	0.0110 (.0097)	0.0616 (.0217)	-0.0034 (.002)	-0.0034 (.002)	-0.0034 (.002)	-0.0228 (.0087)	-0.0228 (.0087)	-0.0091 (.0132)	0.0649 (.0275)	0.0649 (.0037)	0.0125 (.0037)	0.0125 (.0037)

General Conclusion

The consumption of goods and services is an essential determinant of human welfare. For a given income level, consumption determines saving and therefore investment through capital supply. Also the distribution of consumption among individuals has a crucial role in many important matters such as measuring living standards, poverty and inequality, in economic, political and social fields. Therefore, the analysis of consumer behavior has always held a central position in economic research throughout the last century. Over the last four decades, research on consumption have considerably progressed hugely in different aspects of theoretical and empirical analysis.

The main goal of this thesis is to shed light on the black box of the households. Because the household plays an essential role in welfare analysis through different channels, such as: its formation, resource sharing and collective model, domestic production and economies of scale. We aim to analyze the contribution of time on the households production in their demand as well as in their well-being level. In addition, we address the issue of economics of scale to understand a famous puzzle in this literature (Deaton and Paxson puzzle). Furthermore, we investigate the changes in the household's welfare due to price changes in a developing country, Iran. In addition, taking advantage of the price changes during our period of study (the thirteen years), we calculate the elasticity of prices precisely.

In the first chapter of this thesis, we evaluate the consequences of price changes of main commodities in terms of welfare change using the compensated variation method for a developing country, Iran. In the second chapter, we deal with the economic scale issue for private and public goods. We investigate the Deaton and Paxson puzzle using our rich expenditure and income survey data of Iran. We review the related literature and examine the other private goods to figure out more about the puzzle. Finally, the last chapter, is an attempt to fulfill the economic gap of time in the production of domestic output. Indeed, one of the most valuable uses of time is its contribution in domestic production, which is defined as the goods and services produced by households. These goods have the singularity of being the same as those consumed by the household itself. Households are consumers and

producers of their own goods. Time, as money, is needed for the domestic production of goods. Therefore, the time dimension is as essential as the monetary expenses for the family's welfare.

The results of these different analyses can be summarized as follows:

In the first chapter, we look at the welfare changes due to the recent price shocks coming from the recent economic sanctions in a developing country, Iran. This new wave of sanctions targeted the financial and energy sectors of Iran. It led to a significant decline in oil sales (about one million barrels per day) as well as in the currency reserves. As the Iranian economy is dominated by oil and gas production, it was profoundly impacted by the recent economic sanctions. The combination of macroeconomic disturbance, including import restrictions, a parallel market in foreign exchange, and high inflation led to economic slowdown and two years of negative GDP growth.

Thanks to the price variations in our thirteen-year period of interest, we estimated the price and income elasticity precisely for five categories of commodities (food, water-gas-electricity, housing, clothing, and transport). Food and water-gas-electricity are necessary goods and clothing and transport are luxury. Additionally, all the price elasticity values are negative and statistically significant, which is consistent with the demand theory. The outcome of analyzing the welfare changes due to the recent price shocks indicates that the households in the middle of the income distribution are more adversely affected by the price shocks in both rural and urban areas compared to the households in the bottom and top of the income distribution. Further, we find that the households who work in the public sector were less vulnerable than the agricultural and private sectors. Finally, families without children are less influenced by the recent price shocks. Moreover, our results show that poor families were not negatively effected by the price shocks, even though they were the most vulnerable group. Studying the price and welfare changes, we conclude that the government's cash transfer policy was pro-poor.

In the second chapter, we study the well-known puzzle in the economies of scale issue, the Deaton and Paxson puzzle. According to [Barten \(1964\)](#)'s model, the utility function of a household is composed of private and public goods. The model explains the relation between the share of the private and public goods and the increase of the family size when controlling for the per capita income. If two individuals unify to a couple, the share of the public goods per capita decreases and the public goods become relatively cheaper. As a result, if the income elasticity of the private good is greater than its price elasticity, the share of the private good will increase by increasing the family size, given constant per capita income. [Deaton and Paxson \(1998\)](#) implemented the Barten model on the data from seven countries. Their research shows that if the household size increases the share of food decreases, given per capita income constant. This result, which is not predicted by the Barten model, became well-known as a puzzle in the consumption literature and launched numerous researches to explain the reason of the paradox. In our second chapter, we review the studies which deal with this puzzle. We also use the Iranian income and expenditure household survey to explain the puzzle.

To be fair to Deaton-Paxson's paper, we use the same method but we estimate our model for clothing (as another private good) and transportation in addition to the food and housing expenditure share. Additionally, we examine the effect of additional adult separately from the additional child to take into the account the heterogeneity between the consumption pattern of adults and children. Our outcomes for food are in line with the Deaton and Paxson paper. This means that increasing the household size, the food share decreases holding the per-capita income constant. Furthermore, this negative relation remains the same for additional child or additional adult in the family for urban and rural areas. In addition, by studying this relation on the distribution of the income, we find that the decrease in the food share in larger households is stronger in poor households than in rich ones. We examine the relation between the household size and the clothing share (more private good compared to food) holding the per capita income constant. Clothing behaves like a private good as predicted in Barten's model. Analyzing the relation

on the distribution of income shows a stronger relation for poor families compared to rich ones as expected in the Barten model.

In the last chapter, we analyze the contribution of time on the households' demand. We expand the model based on the Backerian unitary model of household to analyze the relation between different goods, expenditure and time in households. We propose the empirical application of our model using the data-set conducted by the Bureau of Labor Statistics, the American Time Use Survey (ATUS) and the Consumer Expenditure Survey for fifteen waves (CES) (2003-2017). Our findings show that the two main inputs of the domestic production (time and money) are complementary in the production goods. The estimated parameters for the extended model are different from those obtained with the traditional model. Furthermore, we discover that the estimated parameters r_k and ϕ_k of the production function are significantly different from one, which means that the traditional model is rejected. Moreover, the comparison of the evolution of the shadow prices for the different goods with the evolution of the corresponding current prices shows that the shadow and the market prices increased during the analysis period. However, the rates of increase are different.

The present findings confirm the importance of measuring time allocation in the household maximization utility program. These types of results emphasize the potential effect in terms of well-being analysis of taking into account the full price of goods. For instance, if we do not consider the full price for food, which is a necessary commodity, we might under estimate the well-being of the poorest, who devote a large part of their resource to food.

This thesis highlights different issues about measuring the welfare in developing country, the economies of scale and the role of time allocation in the household production function. More research is needed in these fields. Regarding the first chapter, the impact of economic sanctions and subsidy reform on the welfare of the household was not evaluated separately. It would be interesting to study the different channels through which the household could be affected by economic sanctions or the subsidy reform. Additionally, analyzing the precise impact of the cash transfer

on the households' expenditure and their welfare would be important for policy-making.

In the second chapter, we use cross-sectional data. It is appreciated to use different periods and investigate the Deaton and Paxson puzzle during various periods for private goods such as food and clothing, and public goods to analyze the evolution of the food share with the family size over the time. Also, studying the characteristics of food and clothing could be useful to clarify the differences between their behaviour as private goods.

Finally, in the last chapter, we analyze the role of time in the demand function of households and we implement our model using the ATUS and CES data-sets. The literature related to the role of the allocated time on the demand and welfare of households suffers from lack of empirical research more than theoretical research, because of the difficulties in translating theoretical models into practice, especially due to lack of data. Along with our research, different categories of commodities need to be studied estimating our model. It also might be interesting to separate the domestic production in the food category and estimate our model with the food and domestic production independently.

Bibliography

Barten, A. P. (1964). Family composition, prices and expenditure patterns.

Deaton, A. and Paxson, C. (1998). Economies of scale, household size, and the demand for food. *Journal of political economy*, 106(5):897–930.