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Fiscal Multipliers in an Incomplete Markets Economy

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FILCAL MULTIPLIERS IN AN INCOMPLETE MARKETS ECONOMY .

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"Os melhores sonhos da vida,
acontecem quando estamos acordados"

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Resumo

Este artigo estuda o comportamento dos multiplicadores fiscais em dois ambientes econômicos distintos: mercados completos e incompletos. Com base na análise do estado estacionário de ambas economias, são encontrados multiplicadores do produto em um intervalo entre 0.49 e 0.66, quando os mercados são completos. Quando os mercados são incompletos, o multiplicador do produto encontrado ficou em um intervalo entre 0.75 e 0.94. Estes resultados indicam que a estrutura de mercado, que reflete o nível de compartilhamento de risco e o grau do motivo precaucionário enfrentado pelos indivíduos, desempenha um papel fundamental na determinação dos multiplicadores fiscais. Na segunda parte do artigo, foi realizado exercício para analisar a resposta dinâmica dos agregados macroeconômicos em reação a um aumento exógeno e inesperado dos gastos do governo financiado por meio de impostos lump-sum. Neste caso, os multiplicadores de impacto sobre o produto ficaram entre 0.64 e 0.68, quando os mercados são completos, e entre 1.05 e 1.20 quando os mercados são incompletos. Os resultados obtidos à partir da análise dinâmica sob mercados incompletos ficaram bastante próximos daqueles encontrados na literatura relacionada, que geralmente obtém multiplicadores dessa magnitude usando uma abordagem econométrica ou por meio de modelos Novo Keynesianos. Estes resultados mostram que levar em consideração as deficiências nos mecanismos de seguro podem ser uma forma interessante de reconciliar os modelos teóricos com os resultados encontrados na literatura relacionada, sem a necessidade de adotar hipóteses *ad-hoc* sobre a estrutura da rigidez de preços.

PALAVRAS CHAVE: *Multiplicadores Fiscais. Mercados Incompletos. Política Fiscal.*

Abstract

This paper studies the behavior of fiscal multipliers in two different economic environments: complete markets and incomplete markets. Based on steady state analysis, output multipliers are found within a range between 0.49 and 0.66, when the markets are complete. Under incomplete markets, output multiplier was found in an interval between, 0.75 and 0.94. These results indicates that the market structure, which reflects the degree of risk sharing and the intensity of the precautionary motive faced by individuals, plays a key role in determining the fiscal multipliers. In the second part of the paper, was performed an exercise to analyze the dynamic response of macroeconomic aggregates to an exogenous and unexpected rise in government spending financed by lump-sum taxes. In this case, impact output multipliers varies in a range between 0.64 and 0.68, under complete markets, and within 1.05 and 1.20 when markets are incomplete. The results found under incomplete markets are very close to that found on related literature which usually uses an econometric approach or calibrated/estimated New Keynesian models. These results shows that taking into account the deficiencies in the insurance mechanisms can be an interesting way to reconcile theoretical models with the results found on related current literature, without the need of ad-hoc assumptions relative to price stickness.

KEYWORDS: *Fiscal Multipliers. Incomplete Markets. Fiscal Policy.*

Contents

1 Introduction

Since the economic crises in 2008, fiscal police has regained a prominent role in the economic discussion. Monetary police limitations, opened room for an increase in fiscal stimulus as a mechanism to soften the sharp drop in the economic activity of the major developed economies. For instance, in the European Union, the fiscal stimulus adopted within the European Economic Recovery Plan (EERP) amounted to around 2% of the region's GDP cumulatively over the period between 2009 and 2010. The fiscal stimulus was even larger in the United States, where measures contained in the American Recovery and Reinvestment Act of 2009 (ARRA) amounted to around 5% of GDP in the years between 2009 and 2011. In this new economic environment, largely unknown by the academics and the police makers, we have also observed a significant increase on research about the potential of fiscal police as an economic buffer. Unfortunately, there is little if any agreement among economists on its effectiveness. In fact, all this new research effort aims to answer the following questions: What are the effects of an increase in the government purchase of goods and services? How these effects changes along time? How an increase in the government spending affects other macroeconomic variables? In short, all these questions are related, in some degree, to an economic measure called fiscal multiplier, which accounts the change on output in response of one dollar increase on government spending.

Roughly speaking, we can say that the literature about this issue is divided in two distinct groups, which reflects different approaches on assessment of the fiscal multipliers. The first, based on information obtained directly from economic data, follows an econometric approach using vector autoregressions (VARs), where fiscal shocks are identified through alternative techniques, usually by making assumptions about the sluggish reaction of some variables to fiscal policy and relying on assumption of exogeneity of government purchases movements. For the US the literature typically finds short-term multipliers that usually rank between 0.4 and 1, though in some studies multipliers above 1 are also obtained, while for longer horizons the dispersion is even larger. Accordingly, is worth to mention the work of Blanchard and Perotti (2002), which has found multipliers close to one studying American economy, Perotti (2005), shows that estimates vary greatly across OECD countries and across time, with a range of -2.3 to 3.7 , Mountford and Uhlig (2009), that finds larger than one impact multipliers for the United States, but emphasizes that the multipliers associated with tax cuts are much higher than those associated with changes in spending and Fatas and Mihov (2001), which also finds output multipliers above than one.

The second approach, is based on DSGE models, estimated or calibrated, that uses different assumptions about the input and output market structure. Standard neoclassical

models, that usually assumes the existence of complete financial markets and competitive market for the inputs and output, produces relatively small fiscal multipliers. In this sense, we can mention Hall (2009), which finds an output multiplier equals to 0.4, in the lower limit of the results obtained using econometric models, and consumption multiplier equals to −0.6. In the same line, Uhlig (2010), using a traditional neoclassical growth model, finds net present multipliers well excess to unity, however, this turns into negative as the horizon increases. Although RBC models can produce an expansion in output following an increase in government expenditures, consumption always decreases in response to an expansion in government spending because of the negative wealth effects. Still on the second group, we can mention the fiscal multipliers obtained by the New Keynesian models, which assumes existence of complete financial markets and monopolistic competition on input markets, besides price stickness in some stage of the production chain. In this group of models, there is a substantial increase on fiscal multiplier, which approaches the results obtained from economic models to ones obtained by the use of VAR models. In this sense, is worth to mention, Hall (2009), that calibrates an New Keynesian model which considers complementarity in preferences and capital adjustment costs, finds a impact output multiplier equal to 0.98 and a consumption impact multiplier of −0.03 on his preferred specification. Cogan et al. (2010), that uses an extension of a model developed by Smets and Wouters (2007), which relies on Bayesian estimation, finds an output impact multiplier equals to 0.96, when the federal funds rate is set to zero along the first year of simulation, and 1.03 when the interest rates are set on zero lower bond in the first two years after the fiscal shock. They also includes in the original model a group of households that are not able to adopt an optimizer behavior, the so called rule of thumb consumers. As a result, they obtain a quite higher multiplier. In the same line, Galí et al. (2007), at their preferred value of the fraction of consumption subject to rule-of-thumb behavior founds that the output multiplier on impact is 1.9 and the consumption multiplier is 1.0.

The main advantage of the this class of models is that structural interrelations among economic variables are modeled explicitly. However, results depend heavily on built-in assumptions. Furthermore, as argues Hall (2009) these New Keynesian models generate other unrealistic results, such as a decline in the markup ratio of price over cost when output rises, and a dramatically pro-cyclical labor share. In fact, economic data shows a quite different behavior, a markup ratios tends to rise during economic expansions and decline when the economy faces a recession, while labor share tends to shrink in expansions. VAR models, in turn, are less dependent on theoretical assumptions, but they provide weaker economic interpretations.

This paper aims to answer a quite different question: How financial market structure affects the size and the dynamics of the fiscal multiplier? Accordingly, I explored a relatively different approach for calculation of fiscal multiplier. Unlike the models of the

second group, cited on the previous paragraph, I develop a model based on an economy which have incomplete financial markets and heterogeneous agents in context of perfect competitive input and output markets. In particular, we consider an environment in which agents faces idiosyncratic productivity shocks, can save only trough a risk-free bond, and are borrowing constrained, the so-called Bewley economy with production used on Aiyagari (1994). As a benchmark, we also develop a complete markets model, without price rigidities, and compute its fiscal multiplier. Based on steady state analysis, I found output multipliers within a range between 0.49 and 0.66, when the markets are complete. Under incomplete markets, output multiplier was in a interval between, 0.75 and 0.94. These results indicates that the market structure, which reflects the degree of risk sharing and the intensity of the precautionary motive faced by individuals, plays a key role in determining the size of fiscal multipliers.

In the second part of the paper, I perform an exercise to analyze the dynamic response of macroeconomic aggregates to an exogenous and unexpected rise in government spending financed by lump-sum taxes. In this case, impact output multipliers varies in a range between 0.64 and 0.68, under complete markets, and within 1.05 and 1.20 when markets are incomplete. The results found under incomplete markets are very close to that found on related literature which usually uses an econometric approach or calibrated/estimated New Keynesian models. In other words, I have found that the incomplete markets economy is also consistent with a sizable effect of government expenditures on the GDP. For practical purposes, these findings means that fiscal policy is more effective when financial markets are less developed.

I also implement a dynamic transition that emerges in response to a rise in government spending, for both market structures. Under complete markets, the transition dynamics presents the traditional crowding out effect, which is represented by a decrease on consumption and investment as a result of the fiscal expansion. When markets are complete, there is a decrease in consumption, in line with the findings of the complete markets approach, however, there is also an important increase on the savings right after the fiscal shift, reflecting a precautionary behavior of individuals, which results in a rising of the investments in the first period. This higher capital level combined with a higher working hours results in a higher output increase and also on a more persistent trajectory over the transition path.

This paper is organized as follows: Section 2 describes the economic environment that is used on both models, Section 3, provides details about the calibration methods, parameters and functional forms used, Section 4 presents the main results of the paper, including the steady state and the transition dynamics analysis, and finally, on Section 5 are reported the main conclusions.

2 The Economic Environment

In this section is described the economic environment used as base for model's construction. The economies analyzed on this paper are populated by a continuum of households with measure one that lives forever, are ex-ante identical, are subject to idiosyncratic productivity shocks and has access to financial markets. On the supply side, there is a single production unity which uses capital and efficient units of labor as inputs. Finally, there is also a fiscal authority. Both economies analyzed on this paper are similar, however, in our benchmark model we consider complete financial markets and perfect competitive input and output markets, while on the second model the financial markets are incomplete. Therefore, on the second model, households must self-ensure themselves against adverse states of nature. Apart from market structure, our models are largely based on the canonical neoclassical growth model.

2.1 Households

There is a *continuum* of infinitely-lived households, ex-ante identical, indexed by $i \in I \equiv [0,1]$ which derives utility from consumption and disutility in labor hours supplied. The measure of agents i in the set I is denoted by μ^i. The number of total agents is normalized to one, $\int_I d\mu^i = 1$, so that averages and aggregates are the same. The agents order their stream of consumption and labor hours by the following time separable expected utility function on date zero:

$$U = E_0 \left\{ \sum_{t=0}^{\infty} \beta^t u(c_t^i, h_t^i) \right\} \tag{1}$$

where $\beta \in (0,1)$ is the intertemporal discount factor, the vector (c_t^i, h_t^i) represents the consumption and the supply of labor hours, respectively, of household i on period t. As usual, the period utility is assumed to be such that $u_c > 0$,$u_{cc} < 0$, $u_h < 0$ and $u_{hh} > 0$. Agents are heterogeneous in skills, i.e., in units of efficient labor that each one can supply. Each period the agent receives productivity shocks. By assumption, these shocks are not related to the provision of working hours. Thus, in our analysis, we are abstracting from considerations about moral hazard associated with the choices of agents. The idiosyncratic shock of given individual in period t is denoted by z_t^i and belongs to the productivity set $Z = \{z_1, z_2, ..., z_S\}$. Productivity shock evolves according to a Markov chain denoted by (Z, Π), where Π is the transition matrix. Each entry of Π is given $\Pi_{zz'} = \pi(z', z) = prob(z_{t+1} = z' | z_t = z)$ for all t. We assume law of large numbers to hold, so $\pi(z', z)$ is also the fraction of agents in population subject to this

transition between states of nature. We assume this Markov chain is well behaved, so there is a unique invariant distribution $\bar{\pi}$. As a result, in the steady state, the aggregate endowment of efficient labor units in date t is given by

$$L_t = \int_I z_t^i h_t^i (z) \, d\mu^i \tag{2}$$

2.2 Firms

In the production side of the economy, there is a *continuum* of identical firms, indexed by $j \in J \equiv [0,1]$, with measure of firm j in the set J denoted by μ^j. This measure is normalized to one, such that $\int_J d\mu^j = 1$. Each firm produces the only consumption good of the economy using a constant of returns to scale technology, with decreasing marginal returns in both inputs. This production technology also respects standard Inada's conditions, and is denoted by

$$Y_t^j = F(K_t^j, L_t^j) \tag{3}$$

where Y_t^j is the output, K_t^j is the demand for capital and L_t^j is the demand for efficient units of labor of firm j in on date t. The production technology is strictly increasing, strictly concave and differentiable. Each firm rents capital and efficient labor units from the households. There is no aggregate uncertainty on this model. Firms here are price takers and operates in a perfect competitive markets environment. Assumptions provided above implies that production can be described by a single representative firm. Further, K can be viewed as the aggregate demand for capital and L can be viewed as the aggregate demand of efficient units of labor. Thus, the firm's optimal behavior implies that $F_K(K,L) = r + \delta$ and $F_L(K,L) = w$, where the vector (r,w) is composed by the interest rate paid upon the capital and the wage paid for each unity of labor supplied, respectively. Finally, the parameter $\delta \in (0,1)$ is the capital rate of depreciation.

2.3 Government

The government collects lump-sum taxes, denoted by T_t, as the only source of income to finance an exogenous stream of spending, denoted G_t. We assume government budget must be balanced every period, such that

$$T_t = G_t \tag{4}$$

In the exercises conducted on Section 4, we analyze two specific fiscal shocks. On the steady state analysis, I analyze the economic response to an exogenous and unexpected permanent rise on lump-sum tax T_t. On dynamic analysis, I study the economy response to an exogenous and unexpected transitory rise on lump-sum tax.

2.4 The Complete Markets Economy

The complete markets economy is taken as a benchmark. In this economy, there are three distinct markets: Final good market, a Labor market and a Capital market. There are spot markets for the final good, which can be used for both consumption and investment, whose price is normalized to one. The agents who live in this economy have access to a complete financial market and, therefore, can use this market to ensure themselves against every possible contingency. The agent's portfolio is composed by Arrow securities which pays one unit of consumption on the next period in the event of a specific productivity shock, and zero otherwise. They also can buy a risk-free asset called capital, which is a redundant asset, because its payoff can be replicated by a combination of Arrow securities. In this market arrangement, an anonymous household solves a problem denoted by the following bellman equation:

$$v\left(z,k,b(z)\right) = \underset{\{c,h,k',b'(z')\}}{max} \left\{ u(c,h) + \beta \sum_{z' \in Z} \Pi_{zz'} v\left(z', b'(z')\right) \right\} \tag{5}$$

$$s.t.: \quad c + k' + \sum_{z' \in Z} q\left(z,z'\right) b'(z',z) = wzh + (1+r)k + b(z) - T \tag{6}$$

$$c \geq 0,\ h \geq 0,\ k' > 0,\ b' \geq 0$$

where $q\left(z,z'\right)$ is the price of Arrow security that given the current agent's productivity shock is z pays a unity of the consumption good in the beginning of the next period if the realized shock is z' and $b'(z',z)$ is the amount of Arrow security chosen contingent on the realization of $z' \in Z$, given the state variable z. Finally, $\beta \in (0,1)$ is the intertemporal discount factor, a measure of agent's degree of impatience, and T is the lump-sum tax.

The solution to this problem is given by the policy functions $b'(z',z) = g^b\left(z, b\left(z\right), z'\right)$, $c\left(z, b\left(z\right)\right) = g^c\left(z, b\left(z\right)\right)$ and $h\left(z, b\left(z\right)\right) = g^h\left(z, b\left(z\right)\right)$ and the value function $v\left(z, g^b\left(z, z'\right)\right)$. The households first order conditions gives the following known results:

$$q\left(z,z'\right) = \beta \frac{u\left(c',h'\right)}{u\left(c,h\right)} \Pi_{zz'},\ for\, \forall\, z' \in Z \tag{7}$$

that is the Arrow security pricing equation obtained through the intertemporal asset allocation, and by the no-arbitrage condition given by $q(z,z') = (1+r)^{-1}\Pi_{zz'}$. Thus, we have the familiar Euler Equation,

$$u(c,h) = \beta u(c',h')(1+r), \tag{8}$$

Notice that if a full set of Arrow contingent claims is available, the economy will collapse to a representative agent model with a stationary amount of savings such that $\beta(1+r) = 1$. Otherwise, i.e., if $\beta(1+r) > 1$, which implies that $u(c,h) > u(c',h')$, means that the consumption and the assets would rise along the time. So, Therefore, under complete markets, the Euler equation simplifies to,

$$u(c,h) = u(c',h'), \tag{9}$$

The equation 9 implies that households choose Arrow securities to equalize marginal utility of consumption across different states of nature, along the time.

The optimality condition related to labor hours of choices is given by,

$$u_c(c,h)\, wz = -u_h(c,h) \tag{10}$$

that is the relation that rules the intratemporal substitution between consumption and labor choice.

Definition 1 *A steady state equilibrium for the complete markets economy is a set of functions $\{v, g^b, g^c, g^h\}$, a vector of prices $\{w,r\}$, a government policy $\{T,G\}$, a measure of households μ, and a pricing function $q(z,z')$ such that:*

1. *Given a pair of prices $\{w,r\}$, government policy $\{T,G\}$ and the pricing function $q(z,z')$, the functions $\{v, g^b, g^c, g^h\}$ solve the household's decision problem as stated in equation 5;*
2. *Prices are given by marginal productivity, $r = F_K(K,L) - \delta$ and $w = F_L(K,L)$;*
3. *Factor inputs are obtained aggregating over households, $L = \int_I z g^h d\mu$ and $K = \int_I \left(\sum_{z\in Z} q(z,z')\, g^b(z, b(z), z')\right) d\mu$;*
4. *The government budget is balanced, $G = T$;*
5. *The pricing function $q(z,z')$ satisfies the no-arbitrage condition in the insurance industry, $q(z,z') = (1+r)^{-1}\Pi_{zz'}$;*

6. *The steady state condition* $\beta(1+r) = 1$ *holds;*

7. *By Walras' law, the good market is also in equilibrium, so the aggregate resource constraint of the economy is automatically satisfied,* $C + K' = F(K, L) + (1 + r - \delta)K - T$.

where capital letters represents aggregate variables.

Under the assumptions presented in this session, it is possible to proof that, under complete markets, this economy admits a representative agent. In this case, the consumer's and firm's problem can be jointly represented by the following central planner problem,

$$\underset{\{c_t, L_t, K_{t+1}\}_{t=0}^{\infty}}{Max} \sum_{t=0}^{\infty} \beta^t u(c_t, L_t) \tag{11}$$

$$S.t.: \qquad c_t + K_{t+1} = F\left(K_t, L_t\right) + \left(1 + r - \delta\right) K_t - T_t \tag{12}$$

$$c_t \geq 0,\ L_t \geq 0,\ K_{t+1} \geq 0,\ K_0,\ given \tag{13}$$

This formulation will be used on the following sections.

2.5 The Incomplete Markets Economy

In the incomplete markets economy there is also three markets: Final good market, a Labor market and a Capital market. In this economy agents can save only through a risk-free asset whose the price is one and that yields the gross interest rate $(1 + r)$ in the next period for each unity of income saved. In this economy there is no asset with a contingent payoff, and, naturally, the risk-free asset is not sufficient to cover all possible contingencies faced by individuals. So, in this market arrangement agents must self-ensure themselves against negative states of nature.

As a consequence, a precautionary motive arises in this environment, what influences the decisions of consumption, savings and labor supply. As well as we further argue, this extra motivation for savings and for rise the supply of working hours is the main driver for higher multipliers in the incomplete markets economy. In every period agents can borrow to smooth their consumption in adverse states, however, there is a liquidity constraint

denoted by b which limits agent's degree of leverage. The borrowing constraint b is exogenously determined . So, in every period agent must choose $a' \geq -b$ in terms of asset position. Given a_0, the agent's problem, in its recursive formulation, is given by:

$$v\left(z, a(z)\right) = \underset{\{c,\, h,\, a'(z')\}}{max} \left\{ u(c,h) + \beta \sum_{z' \in Z} \Pi_{zz'} v\left(z', a'(z')\right) \right\} \tag{14}$$

$$s.t.: \quad c + a' = wzh + (1+r)a - T \tag{15}$$

$$c \geq 0,\ h \geq 0,\ a' \geq -b$$

The individual is denoted by the pair (a, z), which is also called state. Let λ the distribution of agents over states and $\bar{a}$ be the maximum asset holding in the economy, assuming that this upper bound exists. Defining the compact set $A = [-b,\ \bar{a}]$ and using the set of productivity states Z, let state space S be the cartesian product $A\ \times\ Z$. Let the σ-algebra Σ_S be defined as $B_A \otimes P\left(Z\right)$, where B_A is the Borel σ-algebra on A and $P(Z)$ is the power set of Z. The space $(S,\ \Sigma_S)$ is a mensurable space. Let $\mathcal{S} = (\mathcal{A} \times \mathcal{Z})$ be the typical subset of Σ_S. To characterize the way individuals transit across states over time we use a transition function. Therefore, we define the function$\mathcal{Q}\left((a,\ z), \mathcal{A} \times \mathcal{Z}\right)$ as the probability that an individual with current state $(a,\ z)$, transits to the set $\mathcal{A} \times \mathcal{Z}$ next period. Formally this function is stated as $\mathcal{Q}:\ S\ \times\ \Sigma_S \rightarrow [0,\ 1]$, with,

$$\mathcal{Q}\left((a,z), \mathcal{A} \times \mathcal{Z}\right) = \mathcal{I}_{\{a'(a,z) \in \mathcal{A}\}} \sum_{z' \in Z} \pi(z', z) \tag{16}$$

where $\mathcal{I}_{\{.\}}$ is an indicator function, which takes 1 if its argument is true and 0 if its false, and $a'\left(a, z\right)$ is the optimal saving policy. Then Q is our transition function and the associated next period state distribution is given by

$$\lambda\left(\mathcal{A} \times \mathcal{Z}\right) = \int_{A \times Z} \mathcal{Q}\left((a,z), \mathcal{A} \times \mathcal{Z}\right) \lambda\left(da, dz\right) \tag{17}$$

Definition 2 *A stationary recursive competitive equilibrium for the incomplete markets economy is a set of functions* $\{v,\ g^a,\ g^c,\ g^n\}$*, with* $v:\ S \rightarrow \mathbb{R}$ *as a value function and* $g^a:\ S \rightarrow \mathbb{R}$*,* $g^c:\ S \rightarrow \mathbb{R}$*,* $g^n:\ S \rightarrow \mathbb{R}$ *as policy functions, a government policy* $\{T, G\}$*,a measure of households* λ *and a vector of prices* $\{w, r\}$ *such that:*

1. *Given a pair of prices* $\{w, r\}$ *and the government policy* $\{T, G\}$*, the policy functions*

$\{g^b, g^c, g^h\}$ *solve the household's decision problem, as stated in equation 14, and* v *is the associated value function;*

2. *Prices are chosen optimally, i.e., are given by marginal firm's productivity,* $r = F_K(K, L) - \delta$ *and* $w = F_L(K, L)$*;*

3. *Labor supply is obtained aggregating over households* $\int_{A\times Z} z g^h(a, z)\, d\lambda^*$ *and the labor market clears:* $L = \int_{A\times Z} z\, g^h(a, z)\, d\lambda^*$*;*

4. *Capital supply is obtained aggregating over households* $\int_{A\times Z} g^a(a, z)\, d\lambda^*$ *and the capital markets clears:* $K = \int_{A\times Z} g^a(a, z)\, d\lambda^*$*;*

5. *The government budget is balanced:* $G = T$;

6. By *Walras' law, good market also clears. Therefore, the aggregate resource constraint of the economy is automatically satisfied,* $F(K, L) + (1 + r - \delta)K - K' - T = \int_{A\times Z} g^c(a, z)\, d\lambda^*$.

7. *For all* $(A \times Z) \in \Sigma_S$*, the invariant probability measure satisfies,*

$$\lambda^*(\mathcal{A} \times \mathcal{Z}) = \int_{A\times Z} \mathcal{Q}((a, z), \mathcal{A} \times \mathcal{Z})\, \lambda^*(da, dz),$$

Where Q *is defined as 16.*

3 Calibration

In this section, is described the functional forms assumed on our approach for both economies, as well as the parameters choices and other underlying assumptions. In general lines, time is discrete and set to be equal a quarter. Some of the parameter's values where chosen to fit data from United States economy and some of them are chosen to be close to recent literature. We calibrate these values in order to matches some statistics from data, in the steady state equilibrium of the complete markets economy.

3.1 Preferences

Some of the preference parameters are chosen to make our exercise comparable to recent literature. In this sense, we assume that the household's utility is given by the quite standard following CRRA function, with a slight modification to allow complementarity between work and leisure choices,

$$u(c,h) = \frac{c^{1-\sigma}}{1-\sigma} - \chi c^{1-\sigma} h^{1+\psi} - \gamma \frac{h^{1+\psi}}{1+\psi} \tag{18}$$

where σ is a parameter that measures the degree of relative risk aversion, that is how unwilling the individual are to tolerate consumption fluctuations, χ measures complementarity between consumption and labor, γ is related to degree of disutility of an additional unity of labor supply and ψ describes the curvature of the utility function with respect to the volume of work, which also expresses the responsiveness of hours worked to small changes in the wage rate. With this utility function, the intertemporal elasticity of substitution of consumption is given by $1/\sigma$ and the Frisch elasticity of labor supply is given by $1/\psi$. In our exercises we experiment different values for preference parameters, but in baseline specification, we use $\sigma = 2$, which corresponds to an elasticity of substitution of 0.5 and $\psi = 1.9$, which corresponds to a Frisch elasticity of 0.526. Those parameters were chosen using specifications suggested by Hall (2009). Finally, we use $\gamma = 1.102$, and $\chi = 0$. In order to analyze the sensitivity of the multipliers with respect to ψ, γ, $and\, \chi$, I also performed simulations with different specifications for these parameters.

3.2 Productivity

I want to calibrate the labor endowment shocks to replicate the typical dynamics of individual earnings in the U.S. economy. Typically, articles use data from *Panel Study*

of Income Dynamics (PSID), which gives a panel data about individual wage rates $w_{i,t}$. There are several articles estimating processes for wages. In this sense, we can quote the classical work of Flodén and Lindé (2001), French (2003), Pijoan-Mas (2006), Krueger and Perri (2006)and Blundell et al. (2008). In the typical set up used on these papers, which considers wage distribution net of fixed heterogeneity, we have the following specification for the hourly wage rate,

$$w_{i,t} = \theta s_{i,t} + \phi_i + z_{i,t} + u_{i,t}, \qquad with\ u_{i,t} \sim N\left(0, \sigma_u^2\right) \tag{19}$$

where $w_{i,t}$ is the log of wage received for individual i on time$t$, $s_{i,t}$ is a vector of observable characteristics, ϕ_i reflects an individual i unobserved fixed component, $u_{i,t}$ is an homoscedastic error term normally distributed and $z_{i,t}$ is the log of an specific component to wage formation of individual i on time t. This idiosyncratic component is used in this literature as an approach to the productivity shock. As an assumption, its assumed that this component evolves according to an AR(1) process, following equation,

$$z_{i,t} = \rho z_{i,t-1} + \varepsilon_{i,t}, \qquad with\ \varepsilon_{i,t} \sim N\left(0, \sigma_\varepsilon^2\right) \tag{20}$$

where the parameter ρ measures the degree of persistence of the productivity shock $\varepsilon_{i,t}$, since $Var(z) = \frac{\sigma_\varepsilon^2}{1-\rho^2}$, given that $|\rho| < 1$. That is, the higher the persistence of shock, the higher the magnitude of idiosyncratic risk. The estimates for ρ varies in a range between 0.9 and 0.99. In this paper, we follow the results found on Flodén and Lindé (2001), which estimates $\rho = 0.92$ and $\sigma_\varepsilon = 0.21$ using data from PSID. Besides I discretize this continuous stochastic process for the income using Tauchen (1986) methodology. I assume $S = 7$, which means that there is 7 different productivity states for individuals.

3.3 Production

To be consistent with the non-trended factor shares observed in US data for the post-war years, I assume that firm's technology is given by the following Cobb-Douglas function:

$$F(K, L) = K^\alpha L^{1-\alpha} \tag{21}$$

where α is the income share of the capital, with $\alpha \in (0, 1)$. This production function is quite standard on the related literature and is well behaved. On production's side

calibration, we aim the following targets from aggregate data, in the complete markets economy: the capital to output ratio, the ratio of investment to output and the income share of the labor. The parameter α can be measured in the data as the share of total income paid to owners of capital. In the NIPA accounts this number comes out to be 1/3 and is fairly constant in the data, that is in fact one of the main growth facts in Kaldor (1957). I target capital to output ratio equal 3, which results in a time discount factor $\beta = 0.987$. The depreciation rate can be measured by making use of the accounting identity and annual data on the capital stock and investment. The implied average depreciation rate in the data appears to be about 0.1, or about 0.025 at a quarterly frequency. I target the investment to output ratio of 0.25, which results on a depreciation rate $\delta = 0.025$.

3.4 Government

In the model, government is assumed to have a balance budget, in every period. The exercises performed on Section 4.2, I simulate the effects of a transitory shift on the lump-sum taxes. In the initial steady state, I calibrate the lump-sum tax to match 18% of steady state GDP, both for complete and incomplete markets economy. This rate is commonly accepted as a good figure of the share of government expenditure in the US economy. After the first period, our exercise consists is an unexpected rise on lump-sum tax to 25% of initial steady state GDP. In the transitory shock exercise, performed on Section 4.2, I assume that government purchases declines at a 30 percent annual rate. Therefore, the parameter $\rho_G = 0.7$, in annual terms, or 0.92 on a quarterly basis.

3.5 Liquidity Constraint

In the exercises performed on Section 4, I let b vary to analyze how the fiscal multiplier change with the borrowing constraints. I use three different specification for borrowing constraint. In the first, b is set to be zero, which represents an economy where individuals have access to financial markets, but they can not borrow to buffer adverse productivity shocks. When $\tau = 18\%$, the steady state percentage of individuals borrowing constrained varies between 0.5% and 0.8%. When $\tau = 25\%$, the percentage of individuals borrowing constrained varies between 0.3% and 0.6%. If an individual becomes borrowing constrained, it means that they behave like an hand-to-mouth individual which don't have possibility to save.

In the second specification, I used $b = 4$, which represents a higher borrowing limit. Under this specification, when $\tau = 18\%$ the steady state percentage of individuals which uses debt to smooth consumption varies between 4.5% and 6%, and the percentage of

individuals that hits the borrowing constraint varies between 0.1% and 0.5%. When $\tau = 25\%$, the percentage of individuals in debt varies between 3.5% and 5.1%, and the percentage of individuals that hits the borrowing constraint varies between 0.05% and 0.4%. Finally, I use an intermediary specification, in which $b = 2$. In this case, when $\tau = 18\%$, the percentage of individuals in debt varies between 3% and 4%, and the percentage of individuals that hits the borrowing constraint varies between 0.3% and 0.6%. When $\tau = 25\%$, the percentage of individuals in debt varies between 2.5% and 3%, and the percentage of individuals that hits the borrowing constraint varies between 0.2% and 0.45%.

4 Results

In this section, which is is subdivided in two parts, I present the main paper results. The first part deals with the the steady state analysis of a fiscal shift, both in a complete markets as in an incomplete markets environment. The second part deals with the transition dynamics that begins after the tax change. In this case, we analyze the economic dynamics in case of a transitory shock.

4.1 Steady State Analysis

4.1.1 Complete Markets Economy

The effects we study here can be considered long run effects of a fiscal shift in government spending. The quantitative results of the paper depends on the households willingness to substitute leisure and consumption across time and states of the world. Therefore, we considered different specifications for consumption elasticity substitution (σ), Frisch elasticity of labor supply ($1/\psi$), labor disutility (γ), complementarity (χ) and lump-sum tax (τ). For the first group, for which the lump-sum tax is set as 18% we have steady state output ranging between 2.27 and 2.65. When lump-sum tax is set as 25%, the output varies from 2.38 to 2.81. The key parameters related to the output level Under complete markets the main results are stated on the table1

In the steady state, the interest rate is given by the intertemporal discount rate and depreciation rate, primitive parameters of the model. As a standard result, the steady state interest rate is not affected by the government fiscal policy. In the same way, capital to labor ratio K/L is determined by firm's first order condition $\left(F'\left(\frac{K}{L}\right) = \frac{1}{\beta} - 1 + \delta\right)$, so, is not affected by government consumption. The same reasoning is valid to the equilibrium wages (w), to productivity, measured as (Y/H) , and for the capital to labor ratio (K/L). As a result, any change in the level of government consumption, even when its permanent, has no effect on the long run values of this variables. Whereas that these measures do not depend on σ, ψ, γ, χ and τ, the steady state value for wage is 1.78, the steady state value for interest rate is 2.06%, the capital to output ratio is 19.18 and the output to hours ratio is 2.65. On the other hand, because that higher government spending means lower wealth for the household, an increase in government consumption raises labor hours supplied. In the simulations performed, labor hours range in an interval between 0.86 and 1.0, in case which $\tau = 18\%$, and ranges between 0.90 to1.06 in case that $\tau = 25\%$. In our analysis, which can be seen as a permanent response to a fiscal shock, it follows that employment, in terms of work hours, and the output increase both in the short run and in the long run, so as to keep the long run levels of capital intensity and productivity unchanged. The

Table 1: Parameters and Allocations on the Complete Markets Economy

τ	σ	ψ	γ	χ	Y	C	I	G	K	H	L
0.18	2.0	1.90	0.617	0.00	2.65	1.70	0.48	0.48	19.20	1.00	1.08
0.18	2.0	1.90	0.617	0.33	2.32	1.49	0.42	0.42	16.77	0.88	0.94
0.18	2.0	2.48	1.103	0.00	2.29	1.46	0.41	0.41	16.60	0.87	0.93
0.18	2.0	2.48	1.103	0.33	2.27	1.45	0.41	0.41	16.44	0.86	0.92
0.25	2.0	1.90	0.617	0.00	2.81	1.56	0.51	0.74	20.35	1.06	1.14
0.25	2.0	1.90	0.617	0.33	2.48	1.37	0.45	0.66	17.94	0.94	1.01
0.25	2.0	2.48	1.103	0.00	2.41	1.33	0.44	0.64	17.46	0.91	0.98
0.25	2.0	2.48	1.103	0.33	2.38	1.32	0.43	0.64	17.24	0.90	0.97

table 1 presents the equilibrium allocations under different model specifications.

As can be seen in table 1, the complementarity in preferences results in a lower output, consumption, investment and working hours. The increase in output, investment, working hours e effective labor supply varies between 4.7% and 6.0%. The slump in aggregate consumption, which represents a crowding out effect in response to a higher government consumption, varies between 8% and 9%. In general lines, the drop in consumption can be seen as a direct consequence of the intratemporal agent's problem, that can be resumed on the following equation:

$$u_c\,(c,h)\,wz = -u_h\,(c,h)$$

Giving a productivity level and providing that the utility function is such that $u_c > 0$, $u_{cc} < 0$, $u_h < 0\, and\, u_{hh} > 0$, an increase in labor hours along with a non-increasing wage rate results in a consumption drop.

The strongest increase in output, investment and labor occurs under the following parameters specification: $\sigma = 2$, $\psi = 1.9$, $\gamma = 0.617$ and $\chi = 0$. Under the same parameters, the fall in consumption is less acute. Under $\sigma = 2$, $\psi = 2.48$, $\gamma = 1.103$ and $\chi = 0.33$ these variables show a weaker performance. A possible explanation relies in the use of labor as a mechanism to smooth the fiscal shock, which occurs most significantly when the Frisch elasticity of labor supply is higher and when the marginal disutility of labor is lower. In section 2.5 I carry out further analysis of the allocations obtained at the steady-state equilibrium, comparing these results with those obtained under incomplete markets.

On table 2 we present the fiscal multipliers obtained under complete markets for different parameters specification. As we can see, the output multiplier varies from 0.49 to 0.66, a range quite below empirical estimates using standard economic data. A slightly significant variation of the product is due to the modest increase of production factors.

Table 2: Fiscal Multipliers on Complete Markets Economy

	σ	ψ	γ	χ	$Multiplier$
Output					0.60
Consumption	2.00	1.90	0.617	0.00	-0.52
Investment					0.11
Output					0.66
Consumption	2.00	1.90	0.617	0.33	-0.46
Investment					0.12
Output					0.52
Consumption	2.00	2.48	1.103	0.00	-0.57
Investment					0.09
Output					0.49
Consumption	2.00	2.48	1.103	0.33	-0.57
Investment					0.09

The market completeness reduces the precautionary motive for savings, while the increase in hours supplied is also less significant due to the existence of contingent insurance to smooth income fluctuations. As expected, consumption multiplier is negative, and varies from -0.46 to -0.57 and the investment multiplier ranges between 0.08 and 0.12. We can see that complementarity in preferences has little effect on the output and consumption multiplier.

4.1.2 Incomplete Markets Economy

Under incomplete markets, the increase in government purchases can have non-trivial long run effects. The picture here is quite different from complete markets case. The same wealth effect that, in response to an increase in government consumption, stimulates labor supply also raises the precautionary savings to buffer the wealth loss. I found different long run effects in response to a fiscal shift. First, a permanent increase in government consumption reduces the interest rate. This is a direct consequence of the precautionary motive, since that in a scenario of higher government spending the agents rise their savings to self-ensure themselves against negative productivity shocks. A lower interest rate is followed by a a higher capital to labor ratio and higher wages. Because households face consumption risk, they have a precautionary motive for save. Preferences exhibits diminishing absolute risk aversion, so, this precautionary motive is stronger when the level of wealth is low. Furthermore, the existence of a wealth distribution among individuals in society tends to further increase the precautionary effect, since poorer individuals react more forcefully to an adverse income shock. When markets are complete, the absence of a wealth distribution means that the reaction to income shock is symmetric for all individuals.

Table 3: Precautionary Savings in the Incomplete Markets

	σ	ψ	γ	χ	b	K_{CM}	K_{IM}	K_{IM}/K_{CM}
$\tau = 18\%$	2.0	1.90	0.617	0.00	0	19.20	21.89	1.14
	2.0	1.90	0.617	0.00	4	19.20	19.76	1.03
$\tau = 25\%$	2.0	1.90	0.617	0.00	0	20.35	23.77	1.17
	2.0	1.90	0.617	0.00	4	20.35	21.77	1.07

Table 4: Precautionary Savings in the Incomplete Markets

	σ	ψ	γ	χ	b	K_{CM}	K_{IM}	K_{IM}/K_{CM}
$\tau = 18\%$	2.0	1.90	0.617	0.33	0	16.77	20.22	1.20
	2.0	1.90	0.617	0.33	4	16.77	17.84	1.06
$\tau = 25\%$	2.0	1.90	0.617	0.33	0	17.94	22.28	1.24
	2.0	1.90	0.617	0.33	4	17.94	19.59	1.09

An increase in government spending provides a negative wealth shock. So, the steady state aggregate savings are higher and then the steady interest rates are lower than in the initial steady state. This is the first result we can draw from the steady-state analysis of incomplete markets economy. How lower is the interest rates? How big is the precautionary motive? Are there another consumption smoothing mechanism? To address these questions, we can compare the steady state capital level in both market structures, as shown in table 3 and 4.

In tables above, we see that the steady state capital level is higher under incomplete markets. The differences varies from 3 to 20%, when $\tau = 18\%$, and from 7% to 24% when $\tau = 25\%$. In line with the arguments presented above, a tighter credit constraint implies in a higher precautionary motive, and then results in a higher steady state capital ratio. In this sense, Flodén (2008) shows that existence of borrowing constraints increase savings if the income stream fluctuates, even if it is perfectly foreseen. We also see that complementarity raises the steady state capital ratio (between complete and incomplete markets) in something between 2% and 6%. In both market structures, the steady state capital levels are higher without complementarity, but complementarity in preferences induces a higher steady state capital ratio. Under complete markets, the fiscal shift results in a rising of the steady-state capital level in a range between 8% and 10%, depending on the parameter combination. In the case of incomplete markets, the rising in the steady state capital level varies between 8% and 10%, when $\chi = 0$ and between 9% and 10% when $\chi = 0.33$. Despite the proximity of the variation range in both market structures, specially when $\chi = 0$, we can see on tables above that the steady-state capital level in incomplete markets economy is higher than in complete markets economy, for all parameter combination. These differences varies between 3% and 20% times, when $\tau = 18\%$, and between 7% and 24% in the case when $\tau = 25\%$. This is a possible measure

for precautionary savings. Its worth to note that precautionary savings is quite sensitive to the level of credit constraint. In line with the conventional intuition, when financial markets are less developed, i.e., when the credit constraint is tighter, individuals are forced to save more to insure against adverse shocks.

The debt limit also exerts an important influence on consumption. According to our findings, when the credit constraint is in the tightest level, consumption reduces almost 5% after the fiscal shift. When the borrowing constraint is its loosest level, steady state consumption has a lower reduction. A tighter borrowing limit reduces the scope for consumption smoothing in the case of adverse shocks in productivity. Providing that optimal consumption path respects the Euler equation in 22, we can say that expected marginal utility is higher in case of a tighter credit limit.

$$U_c(c_t, h_t) = \beta E_t \left\{(1 + r_t)U_c\left(c_{t+1}, h_t\right)\right\}, \ if \ a_{t+1} > b \tag{22}$$

$$U_c(c_t, h_t) > \beta E_t \left\{(1 + r_t)U_c\left(c_{t+1}, h_t\right)\right\}, \ if \ a_{t+1} = b \tag{23}$$

The market structure also implies different household behavior in labor market. As regards the labor market, we have two distinct effects that act in the same directions. In the first, as in complete markets case, the negative wealth effect on labor supply contributes towards higher employment, as we can see in the consumer's intratemporal optimality condition stated in equation 10. In the second effect, unlike complete markets, the existence of a borrowing constraint limits the individual's ability to manage their budget in the case of an adverse productivity shock. Therefore, individuals rises the working hours as a mechanism to smooth income variations. This effect is called precautionary working hours. Naturally, as looser the debt limit, lesser will be pressure on the supply of working hours since it increase the possibilities of debt in case of adverse shocks. The comparison between labor market dynamics in terms of effective labor and hours supplied, in both market structures, is summarized in the tables below:

In table 5 we can see the differences between supplied work hours in complete and incomplete markets. Under complete markets, an increase in taxation rises the supplied working hours in 5%, when $\chi = 0$. Under incomplete markets, the fiscal shift rises the supplied hours in a range between 6% and 7%.

According the data above, we can see that when taxation is 18%, the agents that

Table 5: Working hours - Complete vs. Incomplete Markets

	σ	ψ	γ	χ	b	H_{CM}	H_{IM}	H_{IM}/H_{CM}
$\tau = 18\%$	2.0	1.90	0.617	0.00	0	1.00	1.03	1.03
	2.0	1.90	0.617	0.00	4	1.00	1.01	1.01
$\tau = 25\%$	2.0	1.90	0.617	0.00	0	1.05	1.11	1.06
	2.0	1.90	0.617	0.00	4	1.05	1.07	1.02

Table 6: Labor - Complete vs. Incomplete Markets

	σ	ψ	γ	χ	b	L_{CM}	L_{IM}	L_{CM}/L_{IM}
$\tau = 18\%$	2.0	1.90	0.617	0.00	0	1.08	1.05	1.03
	2.0	1.90	0.617	0.00	4	1.08	1.01	1.07
$\tau = 25\%$	2.0	1.90	0.617	0.00	0	1.14	1.12	1.02
	2.0	1.90	0.617	0.00	4	1.14	1.06	1.08

lives in the incomplete markets economy supplies between 1% and 3% more working hours than the individuals which lives on the complete markets economy. When lump-sum tax is based on $\tau = 25\%$, the extra supply of hours rises to a range between 2% and 6%.As tighter the credit market is, greater will be the supply of precautionary labor hours.

The effective labor supply also have significant differences according to the market structure. The main reason for this is due to relation stated on the equation 10. In the incomplete markets, the existence of contingent asset ensures that the consumption does not changes in response to productivity shocks. This occurs because the productivity shocks does not cause any wealth effect over consumption. Therefore, the agent has the ability to offer more hours of work when receiving positive productivity shocks and less working hours when receiving negative productivity shocks. Under incomplete markets, the productivity shocks reduces disposable income and thus consumption. As a result, an individual offers more working hours when receiving negative productivity shocks and can reduce the supplied hours of work when have a better productivity situation. These peculiarities of labor supply behavior according to the market structure was highlighted in Pijoan-Mas (2006). Under complete markets, an increase in taxation rises the labor supplied in something around 5%. When markets are incomplete, the fiscal shift rises the supplied hours in a range between 5% and 7%. Thus, we can conclude that the work is supplied more efficiently when markets are complete.

Results presented along this section allow us to respond the following important question: which is the main mechanism for smoothing negative income shocks, working hours or precautionary savings? As we saw by the arguments and data presented so far, the steady-state capital level under incomplete markets outperforms the complete markets allocation in an extent between 3% and 14%, when $\tau = 18\%$, and between 7% and 24% when $\tau = 25\%$. In its turn, the hours worked under incomplete markets exceeds the

Table 7: Parameters and Allocations on the Incomplete Markets Economy

τ	σ	ψ	γ	χ	b	Y	C	I	G	w	r
0.18	2.0	1.90	0.617	0.00	0	2.88	1.81	0.55	0.52	1.82	1.83%
0.18	2.0	1.90	0.617	0.33	0	2.59	1.62	0.51	0.47	1.84	1.75%
0.18	2.0	1.90	0.617	0.00	2	2.82	1.79	0.53	0.51	1.82	1.98%
0.18	2.0	1.90	0.617	0.33	2	2.50	1.58	0.47	0.45	1.82	1.95%
0.18	2.0	1.90	0.617	0.00	4	2.73	1.74	0.50	0.49	1.79	2.05%
0.18	2.0	1.90	0.617	0.33	4	2.43	1.54	0.45	0.44	1.81	2.03%
0.25	2.0	1.90	0.617	0.00	0	3.10	1.73	0.59	0.77	1.85	1.84%
0.25	2.0	1.90	0.617	0.33	0	2.81	1.55	0.56	0.70	1.88	1.70%
0.25	2.0	1.90	0.617	0.00	2	3.01	1.68	0.57	0.75	1.84	1.89%
0.25	2.0	1.90	0.617	0.33	2	2.69	1.49	0.52	0.67	1.86	1.78%
0.25	2.0	1.90	0.617	0.00	4	2.91	1.64	0.54	0.73	1.82	1.96%
0.25	2.0	1.90	0.617	0.33	4	2.61	1.47	0.49	0.65	1.83	1.94%

number of hours worked under complete markets in a range between 1% and 3%, when $\tau = 18\%$, and between 2% and 6%, when $\tau = 25\%$. Therefore, we can conclude that, under the models parameters and assumptions, most of the preventive efforts made by households rests on the accumulation of precautionary savings. As a consequence, the level of the steady state output of the economy under incomplete markets exceeds its counterpart in a range between 7% and 9%, when $\tau = 18\%$, and between 9% and 11%, when $\tau = 25\%$. As mentioned before, the tightness of the credit constraint plays a key role in determining the output level, because precautionary savings and working hours increases when b is low.

Providing that our main objective is to investigate the fiscal multipliers, it's is beyond the scope of this paper to measure how much of this result is due to parameters used, or even a discussion about the robustness of this findings. In Pijoan-Mas (2006), using a quite different parameters set, the author finds that precautionary savings are relatively close to the precautionary working hours.

In the table 7, there is a summary of parameters and allocations under incomplete markets.

Finishing this section, I present on the table 8 a summary of the fiscal multipliers in the incomplete markets economy.

The fiscal multiplier under incomplete markets varies in a range between 0.77 and 0.94, which is an interval relatively higher than the range obtained when markets are complete, 0.49 and 0.66. The consumption multiplier is negative in all possible parameter combination, responding to the intratemporal household mechanism decision and investment multiplier is positive. As we can see, complementarity in preferences seems to support the multipliers in a higher level, making the consumption multipliers less negative.

Table 8: Fiscal Multipliers on Incomplete Markets Economy

	σ	ψ	γ	χ	b	*Multiplier*
Output						0.85
Consumption	2.00	1.90	0.617	0.00	0	-0.33
Investment						0.18
Output						0.94
Consumption	2.00	1.90	0.617	0.33	0	-0.28
Investment						0.22
Output						0.75
Consumption	2.00	1.90	0.617	0.00	2	-0.43
Investment						0.19
Output						0.85
Consumption	2.00	1.90	0.617	0.33	2	-0.40
Investment						0.25
Output						0.77
Consumption	2.00	1.90	0.617	0.00	4	-0.42
Investment						0.19
Output						0.84
Consumption	2.00	1.90	0.617	0.33	4	-0.35
Investment						0.20

Nevertheless, the consumption multiplier is only slightly smaller in the presence of complementarity, which contradicts some findings in the literature regarding this parameter like Bilbiie (2009), which shows that under some assumptions complementarity can bring consumption multiplier close to zero. Under complementarity, investment multipliers are higher. However, the above results indicate that the main factor influencing the output multiplier is the degree of credit tightness. In this sense, there is an positive relation between the multipliers and the credit tightness, as already expected, because when the possibilities of financing are more limited, greater will be the precautionary savings and working hours.

The results presented on the previous sections clearly indicates that the long run effects of government spending can be significantly affected by incomplete risk sharing. Therefore the incomplete markets approach seems to be a very reasonable way to approximate the empirical models results to the quantitative findings about the multipliers which comes from the economic data.

4.2 Transition Dynamics

In this section we examine the entire transition dynamics resulting from a fiscal shift both for complete and for incomplete markets. For the exercises performed here,

we are assuming that the shift in fiscal policy is an unexpected and transitory change in the lump-sum tax. The assumption that the fiscal policy change is unexpected is very important, because if it was anticipated, agents could take actions in advance, as soon as the new information is revealed, to guarantee that their consumption path throughout the transition be as smooth as possible. In the first period before the shock, the economy is assumed to be in the steady state which we have analyzed on section 4.1, where the tax rate which defines the amount of lump-sum tax is equal to $\tau = 18\%$. Suddenly, there is an unexpected change in the lump-sum tax, which is raised to an amount of 25% of the initial steady state output. After the fiscal shock, government purchases declines monotonically from this new level on a trajectory fully known by all agents. The transition path for government purchases are given by the following equation:

$$G_t = \bar{G} + (\rho_G)^t \Delta G \tag{24}$$

where $\bar{G}$ represents the spending level on the initial steady state and ΔG represents the amount of change in government spending that arrives after the fiscal shift. Whereas that the main objective of this paper is to analyze the fiscal multipliers under different market structures, and considering that there are several different ways to evaluate them, it is appropriate to define the fiscal multipliers measures to be used in the following subsections. In general, a fiscal multiplier is defined as a measure of the change in the variable of interest, that in this paper is represented by output, consumption or investment, caused by an one-unit increase in a fiscal variable, that in this paper is government spending. Due to the dynamics of the interest variables in response to a fiscal shock, the multipliers can vary significantly along time. Therefore I focus on three specific measures of fiscal multipliers.

The first, is the *Impact Multiplier*, that represents the immediate response of the interest variable in the time in which the fiscal impulse occurs. The Impact Multiplier, is defined as:

$$IM_V = \frac{\Delta V_t}{\Delta G_t} \tag{25}$$

The second, is the *N-Period Multiplier*, that represents the response of the interest variable N periods after the fiscal impulse occurs. The N-Period Multiplier, is defined as:

$$NM_V = \frac{\Delta V_{t+N}}{\Delta G_t} \tag{26}$$

The third and last measure of fiscal multiplier is the *Cumulative Multiplier*, which measures the cumulative change in the interest variable per unit of the accumulated government expenditure, from the time of the initial impulse to the reported horizon. The Cumulative Multiplier, is defined as:

$$CM_{V,N} = \frac{\sum_{j=0}^{N} \Delta V_{t+j}}{\sum_{j=0}^{N} \Delta G_{t+j}} \tag{27}$$

When we let $N \to \infty$, we obtain a measure of Cumulative Multiplier which accounts the accumulated impact of the fiscal impulse in the long run. I also report this multiplier, which is called *Long Run Multiplier.* The Multiplier definitions used here are the same found on Spilimbergo et al. (2009).

4.2.1 Complete Markets Economy

Under complete markets, the agent faces each period the following optimization problem, stated in the recursive formulation:

$$v_t\left(K_t\right) = \underset{\{c_t,\, h_t,\, K_{t+1}\}}{max} \left\{u(c_t, h_t) + \beta v\left(K_{t+1}\right)\right\} \tag{28}$$

$$s.t.: \quad c_t + K_{t+1} = w_t h_t + (1 + r_t) K_t - T_t \tag{29}$$

$$c_t \geq 0,\; h_t \geq 0,\; K_{t+1} \geq 0$$

In this problem we have a single representative agent, choosing optimally sequences of consumption, labor supply and capital holdings, and a representative firm, choosing optimally its sequence of production inputs. Market completeness vanishes the uncertainty from the productivity shocks. This optimization problem can be easily stated as a social planner's problem, which shows that this simple representative agent problem holds Pareto optimality properties. Now the value function and the policy functions are also a function of time since the fiscal policy, given by the vector (T_t, G_t) and, hence, aggregate

prices (r_t, w_t) varies across the time. There is no uncertainty in this problem, since the transitional dynamics induced by the fiscal shift is deterministic. Now, the definition of equilibrium with transition dynamics can be stated as:

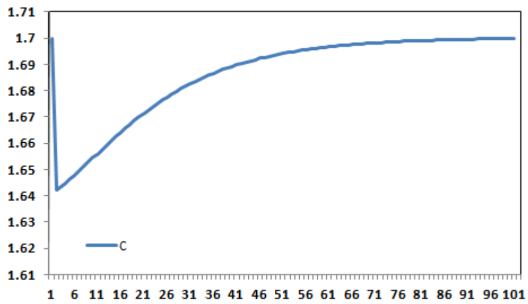
Definition 3 *A transitional recursive competitive equilibrium for the complete markets economy is a set of sequence of functions* $\left\{v_t,\, g_t^k,\, g_t^c,\, g_t^h\right\}_{t=0}^{\infty}$, *with* $v_t : S \to \mathbb{R}$ *as a value function of date t and* $g_t^k : S \to \mathbb{R}$, $g_t^c : S \to \mathbb{R}$, $g_t^h :$ *and* $S \to \mathbb{R}$ *as policy functions of date t, a vector of sequence of prices* $\{w_t, r_t\}_{t=0}^{\infty}$ *and a government policy* $\{T_t, G_t\}_{t=0}^{\infty}$ *such that:*

1. *Given a pair of prices* $\{w_t, r_t\}$ *and a government policy* $\{T_t, G_t\}$*, the sequence of functions* $\left\{v_t,\, g_t^k,\, g_t^c,\, g_t^h\right\}$ *solve the household's decision problem as stated in equation 28;*
2. *Prices are given by marginal productivity,* $r_t = F_K(K_t, L_t) - \delta$ *and* $w_t = F_L(K_t, L_t)$*;*
3. *Factor inputs are in equilibrium in every t;*
4. *The government budget is balanced,* $G_t = T_t$*, in every t;*
5. *By Walras' law, the good market is also in equilibrium, so the aggregate resource constraint of the economy is automatically satisfied,* $C_t + K_{t+1} = F(K_t, L_t) + (1 + r - \delta)K_t - T_t$.

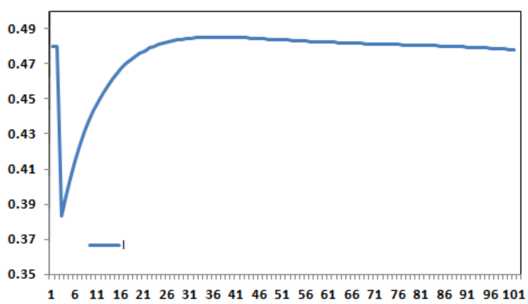
When the economy is hit by the unexpected fiscal shift, the representative agent needs to absorb a negative wealth shock. Under complete markets, individuals have full insurance against adverse productivity shocks, but do not have insurance for an unexpected change of fiscal policy. Therefore, there is a substantial change in the choices of individuals with regard to the allocations chosen on the steady state before the shock. The initial reaction of this individual is to increase the supply of working hours, reduce the amount of the savings and cut the demand of the consumption good. Therefore, we see the classical crowding out effect changing the composition of the economy aggregate demand, once public consumption rises and private consumption decreases. Despite the contractionary pressure exerted by private demand, the net effect of an increase in government consumption financed by lump-sum taxes is an increase in the total output of the economy. In terms of production factors, we can say that the increase in labor supply is more than enough to offset the decline in the capital supply, resulting in an increase in the output. Therefore, under a transitory shock, the working hours are the main mechanism used by the agent to buffer the negative wealth effect caused by the rising of the lump-sum tax. This result is significantly different from that analyzed in the Section4, in which after the change in the fiscal policy occurred an increase both in hours worked and the capital stock.

Figure 1: Transition Dynamics Under Complete Market

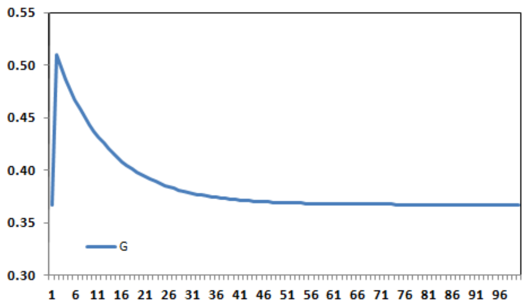
(a) Consumption



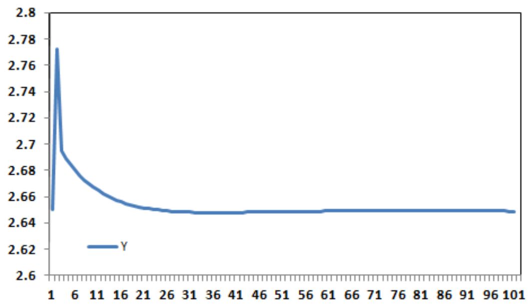
(b) Investment



(c) Government Spending



(d) Output



The main difference is that in the previous chapter, the change in fiscal policy could be regarded as a permanent shock that led the economy to a new steady state, however, in this case, we have a transitory shock which reverts over time.

Considering that the fiscal shock is transitory and that the path of the government consumption is known by all the agents, that is supposed to have full knowledge about equation 24, after the initial impulse begins a process of gradual adjustment toward the initial steady state. During this process, the working hours reduces, consumption and investment rises. This dynamics is show in the figure 1.

Regarding to the fiscal multipliers, the rising in the government consumption calibrated in this section results in an output impact multiplier, obtained using equation 25, that varies between 0.64 and 0.68. So, in response to an increase in the government spending in an amount that represents nearly 7% of the steady state GDP, the output increases in a ratio less than 1 to 1. In fact, this range is very close to that found on the steady state analysis performed on section 4.1. The higher output response occurs when there is complementarity in preferences, however, the impact on the multiplier is quite small. The consumption impact multiplier varies in a range between -0.36 and -0.32, which represents the consumption adjustment that follows the negative wealth effect. Again, complementarity increases only slightly the impact consumption multiplier. Finally, the impact investment multiplier varies between -0.41 and -0.34, which reflects

Table 9: Impact and N-Period Multipliers in Complete Markets

σ	ψ	γ	χ	IM_Y	IM_C	IM_I	$NM_{Y,4}$	$NM_{C,4}$	$NM_{I,4}$	$NM_{Y,8}$	$NM_{C,8}$	$NM_{I,8}$
2	1.9	0.6	0.0	0.66	-0.34	-0.34	0.18	-0.32	-0.23	0.11	-0.28	-0.13
2	1.9	0.6	0.3	0.68	-0.32	-0.38	0.15	-0.31	-0.27	0.07	-0.28	-0.16
2	2.5	1.1	0.0	0.64	-0.36	-0.37	0.14	-0.34	-0.26	0.06	-0.30	-0.15
2	2.5	1.1	0.3	0.65	-0.35	-0.41	0.10	-0.34	-0.29	0.03	-0.31	-0.17

the decline in capital accumulation by agents.

Is also interesting note that $N - period$ output multiplier decreases quickly over time, passing through an interval between 0.10 and 0.18 in the end of the fourth quarter, to an interval between 0.03 and 0.11 in the end of the eighth. Considering that the capital savings recover after the initial fiscal impulse, this may reflect a relatively fast reduction in the supply of labor hours. The $N - period$ consumption multiplier increases more smoothly, leaving an interval between -0.34 and -0.31 at the end of the fourth period, to a range between -0.31 and -0.28 in the end of the eighth. The $N - period$ investment multiplier increases faster than the correspondent consumption multiplier, once it leaves an interval between -0.29 and -0.23 at the end of the fourth period, and goes to a range between -0.17 and -0.13 at the end of the eighth period. This means that after the fiscal shift, agents are more concerned in use the additional stream of income, that is released as the lump sum tax decreases, to restore the capital to its initial level, than to increase consumption.

The $Cumulative\ Multiplier$ presents a quite similar behavior seen in the $N - period$ multiplier, decreasing along time and with a greater persistence for the consumption multiplier. The long run multiplier is very small, but positive in case of output, and quite negative in the case of the consumption. It is beyond the scope of this paper considerations of welfare changes resulting from fiscal policy implemented by the government, however, a quick comparison between the long run output and consumption multiplier indicates that the social costs of an expansionary fiscal policy may be higher than its benefits. This findings, at least in terms of signaling, are similar to the results found in Uhlig (2010), which analyzes American fiscal response to the economic crisis of 2007/8. In a period of 40 years, he finds that a measure of the long run output multiplier that emerges in response to a fiscal impulse which replicates government reaction to the crisis is equal to -5.8. In exercises performed here, the long run output multiplier varies between -0.08 and 0.16. A combination of very low long run output multiplier with a large negative consumption multiplier may represent a reduction in welfare in response to the fiscal shock.

The results discussed above can be seen in greater detail on table 9 and table 10

Table 10: Cumulative and Long Run Multipliers in Complete Markets

σ	ψ	γ	χ	$CM_{Y,4}$	$CM_{C,4}$	$CM_{I,4}$	$CM_{Y,8}$	$CM_{C,8}$	$CM_{I,8}$	LR_Y	LR_C	LR_I
2	1.9	0.6	0.0	0.37	-0.37	-0.26	0.31	-0.42	-0.28	0.16	-0.69	-0.15
2	1.9	0.6	0.3	0.35	-0.36	-0.30	0.27	-0.41	-0.32	0.02	-0.78	-0.20
2	2.5	1.1	0.0	0.32	-0.40	-0.28	0.25	-0.45	-0.31	0.05	-0.78	-0.17
2	2.5	1.1	0.3	0.30	-0.39	-0.31	0.21	-0.45	-0.34	-0.08	-0.87	-0.22

4.2.2 Incomplete Markets Economy

Under incomplete markets, agents faces, each period, the following optimization problem, stated in the recursive formulation:

$$v_t\left(z_t, a_t(z_t)\right) = \max_{\{c_t, h_t, a_{t+1}\}} \left\{ u(c_t\, h_t) + \beta \sum_{z_{t+1} \in Z} \Pi_{z_t z_{t+1}} v\left(z_{t+1}, a_{t+1}(z_{t+1})\right) \right\} \tag{30}$$

$$s.t.: \quad c_t + a_{t+1} = w_t z_t h_t + (1 + r_t)a_t - T_t \tag{31}$$

$$c_t \geq 0,\ h_t \geq 0,\ a_{t+1} \geq 0$$

As in the previous subsection, value function and the policy functions are also a function of time since the fiscal policy, given by the vector (T_t, G_t) and, hence, aggregate prices (r_t, w_t) varies across the time. Again, is important to highlight that the transitional dynamics induced by the fiscal shift is deterministic. Since the agents know the exact future path for lump sum taxes, we also know that there will be a deterministic path for prices and for the distribution λ_t. Providing that there is no aggregate uncertainty, we do not need to keep track of the distribution as an additional state, once time is a sufficient statistic. The definition of equilibrium with transition is given by,

Definition 4 *A transitional recursive competitive equilibrium for the incomplete markets economy is a set of sequence of functions* $\left\{v_t,\ g_t^a,\ g_t^c,\ g_t^h\right\}_{t=0}^{\infty}$*, with* $v_t : S \to \mathbb{R}$ *as a value function of date t and* $g_t^a : S \to \mathbb{R}$*,* $g_t^c : S \to \mathbb{R}$*,* $g_t^h : S \to \mathbb{R}$ *as policy functions of date t, a sequence of government policy* $\{T_t, G_t\}_{t=0}^{\infty}$ *, a sequence of households measures* $\{\lambda_t\}_{t=0}^{\infty}$*, where* $\lambda_0 = \lambda^*$*, and a sequence of prices* $\{w_t, r_t\}_{t=0}^{\infty}$ *such that:*

1. *Given a pair of prices* $\{w_t, r_t\}$ *and the government policy* $\{T_t, G_t\}$ *, the policy functions* $\left\{g_t^a,\ g_t^c,\ g_t^h\right\}$*solve the household's decision problem, as stated in equation 30,*

and v_t is the associated value function;

2. *Given the pair of prices $\{w_t, r_t\}$ the firms chooses optimally the capital (K_t) and the labor demand (L_t), which are given by marginal firm's productivity, $r_t = F_K(K_t, L_t) - \delta$ and $w_t = F_L(K_t, L_t)$;*

3. *Labor supply is obtained aggregating over households $\int_{A\times Z} z_t\, g_t^h\left(a_t, z_t\right) d\lambda_t$ and the labor market clears: $L_t = \int_{A\times Z} z_t\, g_t^h\left(a_t, z_t\right) d\lambda_t$;*

4. *Capital supply is obtained aggregating over households $\int_{A\times Z} g_t^a\left(a_t, z_t\right) d\lambda_t$ and the capital markets clears: $K_t = \int_{A\times Z} g_t^a\left(a_t, z_t\right) d\lambda_t$;*

5. *The government budget is balanced, every period: $G_t = T_t$;*

6. *By Walras' law, good market also clears. Therefore, the aggregate resource constraint of the economy is automatically satisfied, $F(K_t, L_t) + (1 + r_t - \delta)K_t - K_{t+1} - T_t = \int_{A\times Z} g_t^c\left(a_t, z_t\right) d\lambda_t$.*

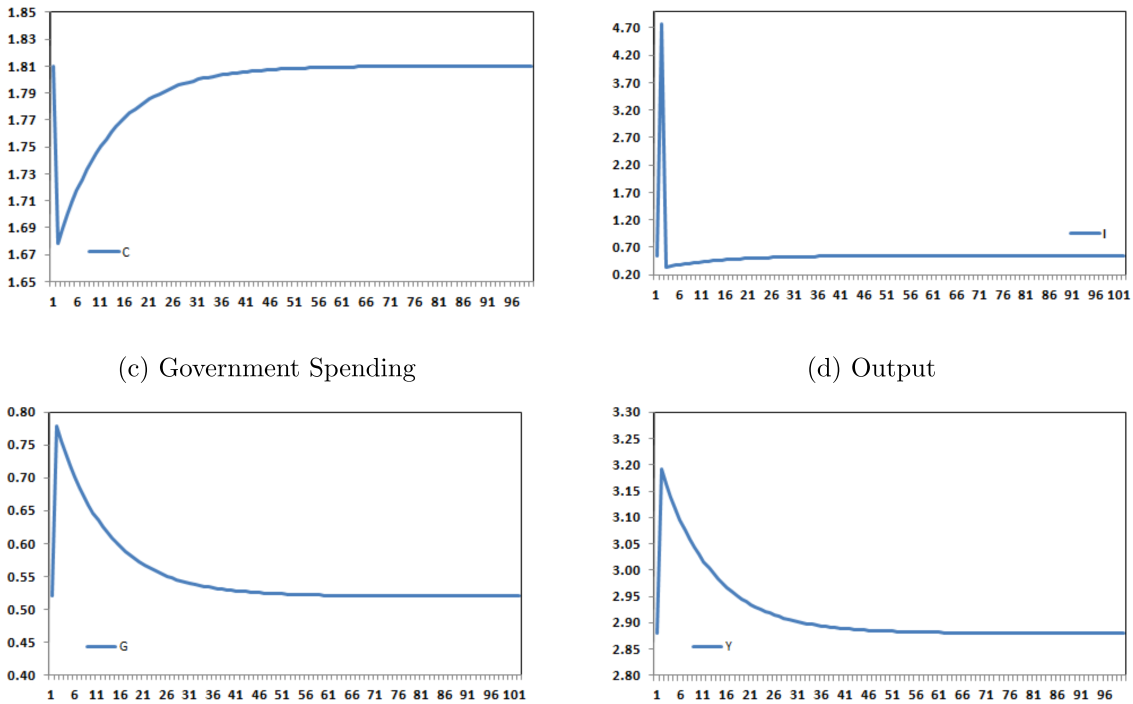
7. *For all $(A \times Z) \in \Sigma_S$, the invariant probability measure satisfies,*

$$\lambda_{t+1}\left(\mathcal{A} \times \mathcal{Z}\right) = \int_{A\times Z} \mathcal{Q}_{\sqcup}\left(\left(a_t, z_t\right), \mathcal{A} \times \mathcal{Z}\right) \lambda_t\left(da, dz\right),$$

$where\ Q_t is\ defined\ as\ Q_t\left(\left(a_t,\ z_t\right), \mathcal{A} \times \mathcal{Z}\right) = \mathcal{I}_{\{a_{t+1}(a_t, z_t)\in\mathcal{A}\}} \sum_{z_{t+1}\in Z} \pi(z_{t+1},\ z_t)$

When markets are incomplete, an unexpected fiscal shift results in two distinct concerns for individuals. The first is the negative wealth effect, which also occurs when markets are complete, that results in a budget adjustment process that involves increasing supply of labor hours and decreasing consumption. The second is a preventive effect that aims to protect individuals from adverse productivity shocks in the future, as they become more vulnerable after the increase in the tax burden. The second consequence of the fiscal shock was not present in complete markets, because in that case individuals had full insurance against adverse productivity shocks. Now the lack of appropriate insurance mechanisms, leads individuals to self insure themselves against this kind of shock, even when the fiscal path is fully known. Therefore, contrary to what is observed when markets are complete, now occurs an increase in capital savings after the shock, which in turn results in an increase in investment. The labor supply also increases more intensely when markets are incomplete. In simulations performed on this subsection, the labor supply increases in a range between 7% and 8%, while when markets are complete labor supply rises nearly 3%. The combination of these factors helps to explain why the consumption multiplier is very similar to the multiplier observed when markets are complete, while the output and the investment multiplier are quite different.

Figure 2: Transition Dynamics Under Incomplete Market ($b = 0$)



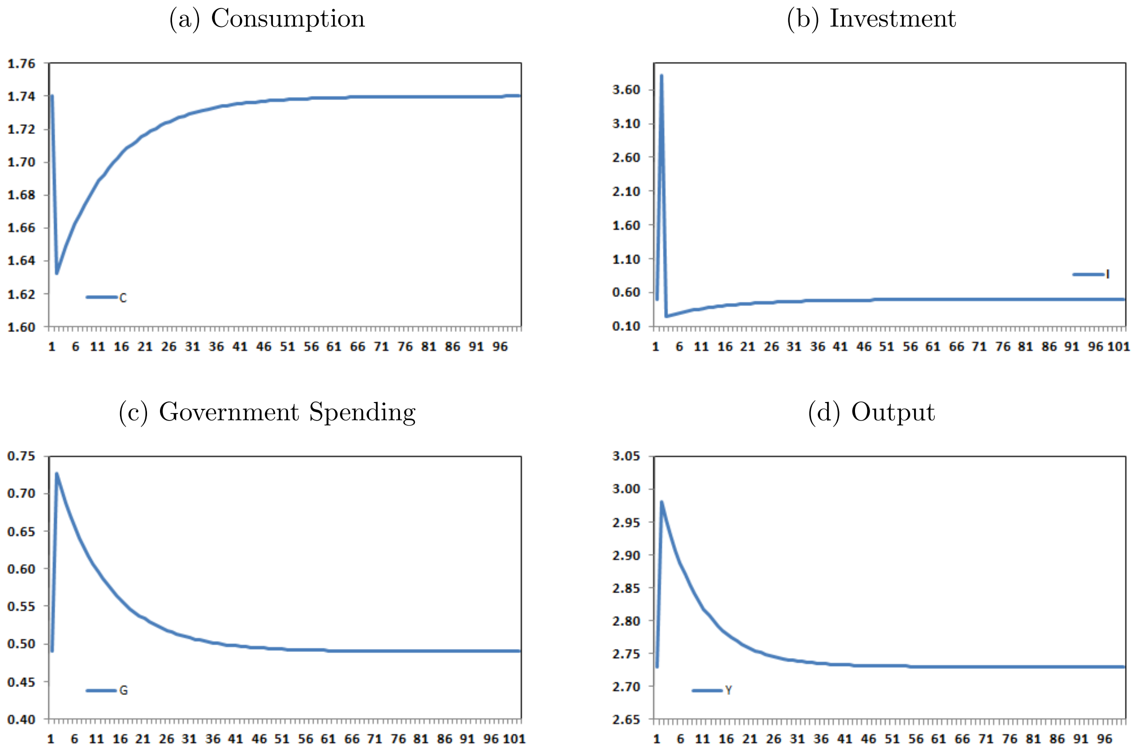
(a) Consumption (b) Investment

(c) Government Spending (d) Output

Since the shock is transitory, as the fiscal pressures are reduced, preventive mechanisms used by individuals are gradually relaxed. Thus, both the savings realized through capital accumulation and labor supply follows toward the steady state levels observed before the shock. It is also interesting to note that the degree of tightness in credit conditions directly influence the preventive mechanisms used by individuals. When the liquidity restriction is high (which means that b is low) is observed a higher capital accumulation and a higher increase in labor supply, which results in a slower transition toward the initial steady state. The transition dynamics in response to the fiscal shift are presented on figure 2, for the case that $b = 0$, and figure 3, for the case that $b = 4$.

Now, the impact output multiplier varies between 1.05 and 1.20, depending on the level of the borrowing constraint. This is quite above the interval found under complete markets, and is also closer to results found on empirical multipliers literature. Using a similar calibration, Hall (2009), built a model which incorporates investment dynamics, with capital adjustment costs and a counter-cyclical markup rate. He founds that output impact multiplier varies between 0.40 and 0.98, and consumption impact multiplier varies in a range between -0.25 and -0.03. In the baseline case, which results in a output impact multiplier of 0.98 and a consumption multiplier of -0.03, Hall (2009) considers the existence of a markup rate, complementarity in preferences and a capital adjustment cost. In my results, a relative high output multiplier is obtained without complementarity

Figure 3: Transition Dynamics Under Complete Market ($b = 4$)



and without other Keynesian features, however, consumption multiplier is quite negative. As shown on section 4.1.1 and 4.1.2, complementarity seems to make the consumption multiplier less negative, however, its impact is relatively small in the environment used in this paper. Thus, the substantial reduction of this multiplier should be related to the new Keynesian elements included in the model by Hall, as well as their interaction with complementarity.

However, the highlight in terms of incomplete markets results is the behavior of the investment multiplier. The investment impact multiplier varies in a range between 15.5 and 16.6. This high values reflects the sharp increase in capital savings in response to the fiscal shock.

In terms of dynamics, $N - period$ multiplier reflects the gradual decrease toward the initial steady state, as the fiscal stimulus fades. Four periods after the shock, $N - period$ output multiplier varies between 0.74 and 0.88, which represents a large increase over the range observed under complete markets, for the same period of assessment. In fact, when the markets are complete few periods after the initial shock output decreases quickly, reflecting a decrease in labor supply. When the markets are incomplete, the preventive behavior of individuals results in a very slow decrease both in savings as in labor supply. This can be seen when comparing figure 1d with figures 2d and 3d. Thus, the output path shows more persistence when markets are incomplete, which also can be seen by the

Table 11: Impact and N-Period Multipliers in Complete Markets

σ	ψ	γ	χ	b	IM_Y	IM_C	IM_I	$NM_{Y,4}$	$NM_{C,4}$	$NM_{I,4}$	$NM_{Y,8}$	$NM_{C,8}$	$NM_{I,8}$
2	1.9	0.6	0	0	1.20	-0.50	17.6	0.88	-0.38	-0.75	0.58	-0.27	-0.55
2	1.9	0.6	0	4	1.05	-0.44	15.5	0.74	-0.35	-0.99	0.47	-0.25	-0.73

Table 12: Cumulative and Long Run Multipliers in Incomplete Markets

σ	ψ	γ	χ	b	$CM_{Y,4}$	$CM_{C,4}$	$CM_{I,4}$	$CM_{Y,8}$	$CM_{C,8}$	$CM_{I,8}$	LR_Y	LR_C	LR_I
2	1.9	0.6	0	0	1.18	-0.50	4.31	1.15	-0.50	2.12	1.05	-0.50	0.53
2	1.9	0.6	0	4	1.01	-0.45	3.48	0.97	-0.45	1.50	0.83	-0.48	0.03

behavior of the multiplier after eight periods.

Four periods after the shock, $N - period$ consumption multiplier varies between -0.38 and -0.35, which represents an interval quite close to the range found when markets are complete. Again, this apparently contradictory result is due to the strong increase in labor supply, which allows an increase of saving and a fall in consumption that is similar to that observed when markets are complete. After eight periods, the $N - period$ consumption multiplier continues presenting similar results to that found on section 4.2.1. The $N - period$ investment multiplier varies between -0.99 and -0.75, after four periods, reflecting a different dynamic in relation to that presented by the impact multiplier. While the impact multiplier accounts for an increase in the preventive savings, the $N - period$ multiplier reflects the gradual reduction in capital supply after the initial peak, following the reduction of budget pressures that follows the reduction in lump sum tax. This process continues along the time, until the fiscal impact fades out. It is worth to note that the savings accumulation decreases faster when the credit constraint is looser, which reflects a sharper fall on investments when $b = 4$.

In long run, multipliers are very different to that found on section 4.2.1. The Long Run output multiplier varies in a range between 0.83 and 1.05, the consumption multiplier varies between -0.50 and -0.48 and finally the investment multiplier belong to an interval between 0.03 and 0.53. In this case, unlike what we observed when markets were complete, fiscal policy can result in a significant economic stimulus for the output in the long run., which seems to offset, at least in part, the social welfare loss that occurs with the drop in consumption. Again, we are abstracting from issues related to social welfare along the transition that begins after the fiscal impulse, but fiscal stimulus seems to be more effective when financial markets are less developed. The results discussed above can be seen in greater detail on tables 11 and 12.

5 Conclusion

In this paper is studied the behavior of fiscal multipliers in two different economic environments: complete markets and incomplete markets. From the results presented and analyzed in the previous sections, I can draw at least four main conclusions. First, market structure has a fundamental role in determining the size of fiscal multipliers. When markets are complete, the existence of a complete set of insurance instruments reduces the precautionary motive, and as a result, individuals are less reactive to an exogenous and unexpected fiscal shock. Second, the structure of insurance markets also plays a key role in the dynamics that begins after a fiscal policy shock. When markets are incomplete, after an expansion in government consumption, individuals act preventively in order to protect themselves against possible future adverse shocks in an environment where they have greater financial fragility. Thus, the effects of a fiscal shock tend to have both greater magnitude and greater persistence when markets are incomplete. Third, when markets are complete, the long-term effects of an expansionary fiscal policy through an increase in spending may result in a loss of private consumption much greater than the increase in output. When markets are incomplete, we note that an expansion in government spending may result in a considerable increase in output in the long term, which can potentially more than offset the losses from the drop in consumption. Therefore, fiscal stimulus seems to be more effective when financial markets are less developed. Fourth, the results found under incomplete markets are very close to that found on related literature which usually uses an econometric approach or calibrated/estimated New Keynesian models. These results shows that taking into account the deficiencies in the insurance mechanisms can be an interesting way to reconcile theoretical models with the results found on related current literature, without the need of ad-hoc assumptions relative to price stickness.

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