

Propagation in a Model of Goods, Labor and Financial Market Frictions*

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Abstract

Investigating mechanisms of propagation has been central to the business cycle research agenda since its inception. Recent search models of the labor market fail in generating both the size and the persistence of their of central variables to productivity shocks, as does the RBC model in the case of output. Building a model with three imperfect markets - goods, labor and credit -, we find that goods market frictions drastically change the qualitative and quantitative dynamics of labor market variables, leading to significant improvements in bridging the gap with the data both in terms of persistence and volatility. Two factors affecting the expected path of the value to hiring a worker generate persistence: first, the expected dynamics of congestion on goods market, which depends on consumers' search for goods and the entry of new products; and second, the expected dynamics of prices, which alter future profit flows. In the absence of these frictions, there is no persistence in the growth rates, and little amplification, of labor market variables.

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1 Introduction

Since its inception the Real Business Cycle literature has faced the same challenge, emphasized in King and Rebelo (1999) and Cogley and Nason (1995): that of the propagation of technological shocks. In the standard RBC model, it is necessary to assume large technological shocks in order to obtain realistic business cycle fluctuations. However, the model cannot generate the amount of autocorrelation in the growth rate of output that we see in the data. This twin failing in the lack of both the amplification and the persistence, which is even more severe for search models of unemployment, has generated separate literatures that either argue different values for key parameters or incorporate various frictions to specific markets. In this paper, we build a model with three imperfect markets - credit, labor and goods - and find that goods market frictions drastically change the qualitative and quantitative dynamics of the labor market, bridging the gap with the data both in terms of persistence and volatility.

Our modeling approach mirrors a growing literature measuring gross and net creation and destruction flows in the three markets. Following the seminal contributions in the labor markets of Davis and Haltiwanger (1990, 1992), Del'Arricia and Garibaldi (2005) have measured creation and destruction of loans in US banks. Recently, Broda and Weinstein (2010) have carefully documented the magnitude of flows of entry and exits of goods, as well as procyclical features of net product creation flows. Each friction is abstracted by a process of matching two sides of a market. The relative supply and demand measures a degree of market tightness; the familiar vacancy to unemployment ratio for the labor market, the ratio of prospecting consumers and products on the goods market, and the ratio of investment projects to banks on the credit market.

We find that imperfect goods markets, working through the forward looking nature of job creation, change the qualitative and quantitative responses of the model to productivity shocks. In particular, the dynamics of the goods market generate persistence in the growth of the incentives to hire workers, which translates into responses of labor market tightness to productivity shocks that are hump-shaped, or highly persistent. During the first stages of an economic expansion more firms enter the goods market relative to the change in the the effective demand from consumers. This causes an increase in congestion firms face on the goods markets, and a decline in the negotiated price at which the goods are eventually sold. From the perspective of a firm deciding to hire a worker, this decreases the incentive to create a vacancy at the beginning of an expansion as it is less likely the additional production will find an outlet, and if it does, it sells at a lower price. However, as the cycle continues and productivity is returning to trend, the goods market eases in the sense of their being relatively more demand from consumers than products competing for customers. This decrease in congestion, which also leads to firms obtaining a better price, actually increases the incentive to recruit workers. We thus see a rise in labor market tightness for several periods after the initial shock, a persistence that arises from the

fact that the economic value of hiring a worker is linked to congestion and prices on goods markets, generating interesting intertemporal linkages. These mechanisms are absent from the standard labor search model and a large class of extensions.

At least since Keynes' (1936) general theory of employment, interest and money, it has been recognized that frictions in goods markets can generate additional unemployment. Several waves of research have attempted to put this intuition into models, from the neo-Keynesian work of Barro and Grossman (1971) and later Benassy (1982, 1986, 1993) and Malinvaud (1977), to the synthesis of this work with the RBC literature (Goodfriend and King, 2002). This previous literature has mostly been centered around the idea of price rigidities leading to excess supply (or demand) of goods and in turn generating inefficient outcomes in the labor market. In our paper, goods market imperfections propagate shocks without relying on price rigidity. There has also been a revival of the interest in the impact of demand shocks in the good markets and their implications for the identification of technology shocks and the RBC paradigm (see Bai, Rios-Rull and Storesletten, 2011).

An early wave of research into propagation in models of the business cycle focused on the labor market, either increasing the elasticity of labor supply, e.g. models of indivisible labor as in Hansen (1985) and Rogerson (1988), or introducing of a market friction in the form of wage rigidity.¹ The importance of the latter for amplifying the response of the demand for labor to changes in productivity has received renewed attention in search models of equilibrium unemployment, as a means of addressing the lack of volatility in of job vacancies and unemployment.² Papers such as Bernanke and Gertler (1989), Kiyotaki and Moore (1997) emphasized the role of credit markets in amplifying exogenous shocks to economies and the existence of a *financial accelerator*. We also incorporate a financial accelerator as in a Wasmer and Weil (2004) and Petrosky-Nadeau and Wasmer (2010) to evaluate its relative contribution to propagation.

This paper is organized as follows. In Section 2, we develop the model and discuss the evidence motivating are modeling of the goods market. In Section 3, we calibrate the model to quarterly data, using evidence on goods market flows, and investigate the sources of propagation in detail. Section 4 compares the quantitative results for alternative configurations of market frictions, emphasizing the preponderant role of goods market frictions for propagation, while Section 5 concludes.

¹Reference long literature from staggered wage contracts to monopolistic competition in the supply of labor services.

²This deficiency of the canonical model was shown in Cole and Rogerson (1999) and Shimer (2005). See also Hall (2005). An alternative is to set wages close enough to the value of leisure (the small surplus assumption in Hagedorn and Manovskii, 2008) which itself amounts to raising the degree of wage rigidity as wages are more disconnected from labor productivity. Other mechanisms were suggested in the literature, such as introducing on-the-job search (Mortensen and Nagypál, 2007). Fujita and Ramey (2007) also focus on the lack of persistence in the growth rates of labor market variables in this class of models.

2 An economy with goods, labor and credit market frictions

We consider the case of a firm looking at marginal investment projects. These projects first need to obtain financing on the credit market. This is the meeting of banks and investment projects. The financed project then manage to maximize the value to the firm and the bank, and needs to hire a worker to produce a good. However, the good cannot be sold until a consumer has been found. We review in detail the empirical case for modeling this friction in the goods market as a matching process, before determining prices and closing the model.

2.1 Banks and investment projects

Time is discrete. An investment project is initially in need of a financial partner (hereafter called a “banker”). This financing will cover the cost of recruiting a worker and cover the wage bill when the firm has not found a demand for its product. For that, it prospects on a credit market and pays a per-period effort cost e . With probability p_t it finds a banker, with complementary probability it remains in this stage (denoted by c like *credit*). We denote by J_c the asset value of the investment project in this stage. At the time of the meeting between the bank and the project both sides agree on the terms of a financial contract whereby the resulting firm is financed by the bank when its cash-flow is negative (in stages 2 and 3) and reimburses the banker when the cash-flow is positive (in stage 4).

Now matched with a banker, the project enters the second stage, where it prospects on the labor market in order to hire a worker. It must pay a per-period cost γ to maintain an active job vacancy. With probability q_t the firm is successful in hiring the worker, with complementary probability it remains in this stage (denoted by l like *labor*). We denote by J_l the asset value of a project in this stage. The firm offers a wage w_t to the worker as long as the firm is active.

In the third stage, now endowed with a worker the firm could start producing y_t units of output and attempt to sell it on the goods market, but it has no customers. Meeting with a consumer comes with probability λ_t , and production can be sold the following period. By assuming the production involves an operating cost Ω over and above the wage and the good cannot be stored, the firm chooses not to produce in this stage, which we denote by g for *goods* market. The value to this stage is denoted J_g . Note that the bank is still financing the firm by transferring the amount of cash necessary to pay the worker. At the end of the period in this stage, and the next, the firm is hit by a destruction shock with probability s .

In the fourth and final stage, now matched with a consumer, the output is sold at price \mathcal{P}_t . With revenue $\mathcal{P}_t y_t$, the firm pays the worker w_t , the operating cost Ω_t , an amount ϱ_t to the bank, and enjoys the difference. We denote this stage by π standing for profit and by J_π its associated the asset value. In addition, the consumer may stop consuming the particular good produced by the firm with probability τ , in which

case the firm returns to the previous stage g to search for another consumer.

Finally, as in Pissarides (2000), all profit opportunities are exhausted by new entrants such that the value of the entry stages are always driven to zero. In the case of the credit market, this implies that $J_{c,t} \equiv 0$ at all times, which is also the continuation value following a destruction shock s .

Given these assumptions, the Bellman equations of the investment project, which faces a discount rate r , assuming that transitions from the credit to the labor market stages occur within a single period, are:

$$J_{c,t} = 0 = -e + p_t J_{l,t} \quad (1)$$

$$J_{l,t} = -\gamma + \gamma + \frac{1}{1+r} \mathbb{E}_t [q_t J_{g,t+1} + (1 - q_t) J_{l,t+1}] \quad (2)$$

$$J_{g,t} = -w_t + w_t + \left(\frac{1-s}{1+r} \right) \mathbb{E}_t [\lambda_t J_{\pi,t+1} + (1 - \lambda_t) J_{g,t+1}] \quad (3)$$

$$J_{\pi,t} = \mathcal{P}_t y_t - w_t - \varrho_t - \Omega_t + \left(\frac{1-s}{1+r} \right) \mathbb{E}_t [(1 - \tau) J_{\pi,t+1} + \tau J_{g,t+1}] \quad (4)$$

The bank's lifetime closely follow that of the investment project, with values denoted by B_j , $j = c, l, g$ or π for each of the stages. In stage c , it prospects on the credit market to find a viable project to finance, which occur with probability \hat{p}_t , and pays a per period screening cost κ . Free entry on this side of the credit market implies that $B_{c,t} = 0$ at all times. In stage l , the bank pays the cost of a vacancy γ and waits for the hiring to be realized. In stage g , the bank now pays the wage cost w_t and waits for the firm to be matched with a consumer. In stage π , the bank cashes in the repayment ϱ_t .

The corresponding Bellman equations for the banker are

$$B_{c,t} = 0 = -\kappa + \hat{p}_t B_{l,t} \quad (5)$$

$$B_{l,t} = -\gamma + \frac{1}{1+r} \mathbb{E}_t [q_t B_{g,t+1} + (1 - q_t) B_{l,t+1}] \quad (6)$$

$$B_{g,t} = -w_t + (1 - s) \frac{1}{1+r} \mathbb{E}_t [\lambda_t B_{\pi,t+1} + (1 - \lambda_t) B_{g,t+1}] \quad (7)$$

$$B_{\pi,t} = \varrho_t + (1 - s) \frac{1}{1+r} \mathbb{E}_t [(1 - \tau) B_{\pi,t+1} + \tau B_{g,t+1}] \quad (8)$$

Going forward, we will be interested in the joint values of a bank and investment project, which we refer to as a "firm." Let the value of a firm for each of the stages be denoted by $S_{j,t} = J_{j,t} + B_{j,t}$, with $j = c, l, g, \pi$. The Bellman equations for the value of a firm in each stage can be obtained by summing the corresponding equations for

projects and banks, that is (1) to (4) and (5) to (8). We have, after rearrangement:

$$S_{c,t} = 0 \Leftrightarrow \frac{\kappa}{\hat{p}_t} + \frac{e}{p_t} = S_{l,t} \quad (9)$$

$$S_{l,t} = -\gamma + \frac{1}{1+r} \mathbb{E}_t [q_t S_{g,t+1} + (1-q_t) S_{l,t+1}] \quad (10)$$

$$S_{g,t} = -w_t + \frac{1-s}{1+r} \mathbb{E}_t [\lambda_t S_{\pi,t+1} + (1-\lambda_t) S_{g,t+1}] \quad (11)$$

$$S_{\pi,t} = \mathcal{P}_t y_t - w_t - \Omega + \frac{1-s}{1+r} \mathbb{E}_t [(1-\tau) S_{\pi,t+1} + \tau S_{g,t+1}] \quad (12)$$

Equation (9) states that the value of a firm in the hiring stage is equal to the sum of capitalized search costs paid by each side in the previous stage. This is driven to zero in the absence of credit market frictions. The formulation the labor market stage in equation (10) describes the value of a job vacancy as a flow cost γ and an expected gain from hiring a worker, value at S_g . As we will discuss in detail, the presence of a frictional goods markets fundamentally alters the dynamics of S_g compared to the standard framework through the dynamics of the goods market meeting rate λ_t and the price \mathcal{P}_t .

2.2 Search and matching on goods markets

2.2.1 Evidence (To be completed)

Broda and Weinstein (2010) document the nature, extent and cyclicity of product entry and exit in the U.S., with a focus on the implication for the measurement of aggregate consumer prices, using a data set with the universe of products purchased by households. Their data set is preferable to scanner data for their purposes and ours, as one knows whether the product is truly new to the household, and document three main facts.

First, the vast majority of product creation and destruction occurs within the boundary of the firm. That is, 92% of product creation and 97% of product destruction, happens within existing manufacturers. Second, they find up to four times more turnover in products than in establishment or labor market data. In a typical year, 40% of household expenditures are on goods created in the last four years, and 20% of expenditures are in goods that will disappear in the next four years. Product entry and exit rates, defined from the point of view of a household, are significant. At an annual frequency, they find a product entry rate in the bundle of consumed products of 0.25, and an exit rate of 0.24. Third, net creation of products of strongly pro-cyclical whereas destruction are weakly counter-cyclical. This suggests that high demand leads to the introduction of new goods, reminiscent of the implementation cycles in Shleifer (1986).

There is also indirect evidence for the presence of frictional goods market that are well described by a search and matching process. For example, Foster, Haltiwanger and Syverson (2008) suggest as an explanation for their finding that new firms face

lower demand the presence of frictions in acquiring information about a producer, are accessing a distribution network to reach consumer. Both lead to time and costs for both side of the goods market in searching before acquiring or beginning to consume a good for the first time.

2.2.2 Matching in the goods market

Consumers may spend their disposable income Y^d on either an essential good c_0 or a preferred manufactured good c_1 . Consuming the later first requires searching on the goods market. When a consumer is matched with a manufacturing firm, it purchases the production that is y_t at a unit price \mathcal{P}_t . The remaining income is spent on the essential good, which is supplied with a CRS technology and under a zero-profit condition.

At any point in time there are unmatched consumers and matched consumers in this economy. As the mass of consumers is 1, we denote their shares by $\mathcal{C}_{0,t}$ and $\mathcal{C}_{1,t}$, respectively. Unmatched consumers $\mathcal{C}_{0,t}$, exerting an average search effort \bar{e}_t , find unmatched goods $\mathcal{N}_{g,t}$ through a process summarized by a constant returns to scale function $M_G(\bar{e}_t\mathcal{C}_{0,t}, \mathcal{N}_{g,t})$, where $\bar{e}_t\mathcal{C}_{0,t}$ can be thought of the effective demand for new goods. Thus the meeting rates between consumers and firms are given by:

$$\frac{M_G(\bar{e}_t\mathcal{C}_{0,t}, \mathcal{N}_{g,t})}{\mathcal{N}_{g,t}} = \lambda(\xi_t) \quad \text{with} \quad \lambda'(\xi_t) > 0$$

$$\frac{M_G(\bar{e}_t\mathcal{C}_{0,t}, \mathcal{N}_{g,t})}{\bar{e}_t\mathcal{C}_{0,t}} = \tilde{\lambda}(\xi_t) \quad \text{with} \quad \tilde{\lambda}'(\xi_t) < 0$$

where $\xi_t = \frac{\bar{e}_t\mathcal{C}_{0,t}}{\mathcal{N}_{g,t}}$ is the natural concept for tightness in the goods market (from the point of view of consumers) and $\lambda(\xi_t) = \xi_t\tilde{\lambda}(\xi_t)$. That is, $\tilde{\lambda}_t$, the probability that an unmatched consumer finds a suitable firm from which to buy goods, is decreasing in goods market tightness. Conversely, the greater ξ_t , the greater the demand from consumers relative to the goods awaiting to consumers, the shorter the duration of search for producers. This creates an important feedback from the goods market to the labor market as the returns to hiring a worker are greater when it is easiest to find customers.

2.3 Consumers and the demand for goods

Recall that consumers want to consume manufactured goods but may not buy them before they are matched with a firm. Let us denote by $D_{0,t}$ and $D_{1,t}$ the values for a consumer of being unmatched and matched, respectively. The generic utility of consuming both goods is denoted by $v(c_1, c_0)$ where c_1 and c_0 are the consumption of the manufactured and essential goods. Unmatched consumers search for a good at an effort cost $\sigma(e)$, with $\sigma'(e) > 0$ and $\sigma''(e) \geq 0$, and perceive their search effort as influencing their effective finding rate, $e_t\tilde{\lambda}_t$. Consequently, we have:

$$D_{0,t} = v(0, c_{0,t}) - \sigma(e_t) + \frac{1}{1+r} \mathbb{E}_t \left[e_t \tilde{\lambda}_t D_{1,t+1} + (1 - \tilde{\lambda}_t e_t) D_{0,t+1} \right] \quad (13)$$

$$D_{1,t} = v(c_{1,t}, c_{0,t}) + \frac{1-s}{1+r} \mathbb{E}_t [\tau D_{0,t+1} + (1-\tau) D_{1,t+1}] + \frac{s}{1+r} \mathbb{E}_t D_{0,t+1} \quad (14)$$

Assuming the manufactured good has great marginal utility, matched consumers will always spend up to $\mathcal{P}_t y_t$ on $c_{1,t}$ and then consume what is left $Y_t^d - \mathcal{P}_t y_t$ on $c_{0,t}$. In the current version, we assume a marginal utility for c_1 of $\Phi > 0$ and that the essential good provides a basic level of utility independent of the quantity consumed (we think of food and utilities, for example).

2.3.1 Optimal search effort

The optimal individual search effort is simply given a condition equating the marginal cost of effort to the discounted, expected benefit yielded by the marginal unit of effort:

$$\sigma'(e_t) = \frac{\tilde{\lambda}_t}{1+r} \mathbb{E}_t [(D_{1,t+1} - D_{0,t+1})] \quad (15)$$

and it follows that all consumers exert the same effort :

$$e_t^* = \bar{e}_t$$

Equation (15) implies that consumer search effort is increasing in the expected capital gain from consuming the manufactured good. Both disposable income and the dynamics of the price \mathcal{P} , which we discuss next, play a determining role in this respect.

2.3.2 Determining the dynamics of the goods surplus and price

Consistent with the search literature, we postulate that the price \mathcal{P}_t is bargained between a consumer and a firm. The total surplus to the consumption relationship is $G_t = (S_{\pi,t} - S_{g,t}) + (D_{1,t} - D_{0,t})$. The price for the good is determined as $\mathcal{P}_t = \underset{\mathcal{P}_t}{\operatorname{argmax}} (S_{\pi,t} - S_{g,t})^{1-\delta} (D_{1,t} - D_{0,t})^\delta$, where $\delta \in (0, 1)$ is the share of the goods surplus G_t going to the consumer. This results in a the sharing rule is

$$(1 - \delta) (D_{1,t} - D_{0,t}) = \delta (S_{\pi,t} - S_{g,t}) \quad (16)$$

with which we can express the goods market surplus by the dynamic equation:

$$G_t = \Phi y_t + (1 - \eta_\sigma) \sigma(\bar{e}_t) - \Omega + [(1 - \tau) - (1 - \delta) \lambda_t] \frac{1-s}{1+r} \mathbb{E}_t G_{t+1} \quad (17)$$

where where $\eta_\sigma > 0$ is the elasticity of the effort cost function and the details of the derivation for this and subsequent equations are provided in the appendix.

The negotiated price follows the rule:³

$$\mathcal{P}_t y_t = (1 - \delta) [\Phi y_t + (1 - \eta_\sigma) \sigma(\bar{e}_t) + (1 - s) \sigma'(\bar{e}_t) \xi_t] + \delta \Omega \quad (18)$$

first states the that price is increasing in the marginal utility Φ and the cost expending by consumer searching, $\sigma(\bar{e}_t)$. It is also increase in goods market tightness ξ_t : the greater the effective demand on the consumer side to the supply of unmatched goods \mathcal{N}_g , the greater the price and hence profits for firms.

2.4 Matching in the labor market and wages

We assume that matching in the labor market is governed by $M_L(\mathcal{N}_{l,t}, u_t)$, where u_t is the rate of unemployment and the total number of unemployed workers since the labor force is normalized to 1. $\mathcal{N}_{l,t}$ is the number of firms in stage l , or the number of "vacancies." The function is assumed to be constant return to scale, hence the rate at which firms fill vacancies is a function of the ratio $\mathcal{N}_{l,t}/u_t$, a measure of the tightness of the labor market denoted by θ_t . This rate, $q(\theta)$, is given by

$$q(\theta_t) = \frac{M_L(\mathcal{N}_{l,t}, u_t)}{\mathcal{N}_{l,t}} \text{ with } q'(\theta_t) < 0.$$

Conversely, the rate at which the unemployed find a job is

$$\frac{M_L(\mathcal{N}_{l,t}, u_t)}{u_t} = \theta_t q(\theta_t) = f(\theta_t) \text{ with } f'(\theta_t) < 0.$$

Once employed, workers earn a wage w_t , which we assume, for simplicity, takes the functional form

$$w_t = \chi_w (\mathcal{P}_t y_t)^{\eta_w} \quad (19)$$

where η_w can be interpreted as the elasticity of wages to the marginal product of labor $\mathcal{P}_t y_t$. In the spirit of search models, one may want to have a different wage determination schedule as the outcome of Nash-bargaining between the firm and the worker. We decided to avoid the complications implied by Nash-bargaining in this context to focus on the role of the elasticity of wages to productivity for propagation, leaving aside the question of bargaining in this context for future work.⁴

³Expressing the price as $\mathcal{P}_t y_t = (1 - \delta) [\Phi y_t + (1 - \eta_\sigma) \sigma(e)] + \delta \Omega + (1 - \delta) \lambda_t \frac{1-s}{1+r} \mathbb{E}_t [\delta G_{t+1}]$ emphasizes the forward looking aspect of price determination. Today's price is increase in the expectations of tomorrow surplus on the goods market.

⁴Some complications with bargaining are as follows. First, given that firms pays the worker in two different stages (when it does not produce and when it does), this would imply not one but two wage schedules, with analytical complications but for a small quantitative difference since the surplus value of the firm in each stage are very close and exactly equal when the discount rate is small compared to the rate at which it finds a consumer, a plausible assumption. Hence, a similar wage rule in the two stages is a quantitatively good assumption. Second, the number of parties several complexities arise in which we would need to take assumptions on timing and bargaining structure which we ignore here by choosing a rather simple wage determination rule.

2.5 Matching and bargaining in the credit market

The matching rates p_t and \widehat{p}_t are made mutually consistent by the existence of a matching function $M_C(\mathcal{B}_{c,t}, \mathcal{N}_{c,t})$, where $\mathcal{B}_{c,t}$ and $\mathcal{N}_{c,t}$ are respectively the number of bankers and projects in stage c . This function is assumed to have constant returns to scale. Hence, denoting by ϕ_t the ratio $\mathcal{N}_{c,t}/\mathcal{B}_{c,t}$, which is a reflection tightness of the credit market from the point of view of projects, we have

$$p_t = \frac{M_C(\mathcal{B}_{c,t}, \mathcal{N}_{c,t})}{\mathcal{N}_c} = p(\phi_t) \text{ with } p'(\phi_t) < 0. \quad (20)$$

$$\widehat{p}_t = \phi_t p(\phi_t) \text{ with } \widehat{p}'(\phi_t) > 0. \quad (21)$$

The division of rents from implementing a project, $S_{l,t}$, are determined by bargaining about ϱ upon meeting. Calling $\beta \in (0, 1)$ the bargaining power of the bank, the Nash-bargaining condition

$$(1 - \beta)B_{l,t} = \beta J_{l,t} \quad (22)$$

states that with $\beta = 1$ the bank receives all the surplus. Note that the rule for ϱ is determined at the time of the meeting but paid a few periods after the negotiation, when the firms becomes profitable. We assume that there is no commitment problem (as in Wasmer and Weil 2004) so that any new realization of aggregate productivity will not undo the financial contract and there is no renegotiation.

Combining (1), (5) and (22), as well as the definition of \widehat{p} in (21), we can obtain the equilibrium value of ϕ_t denoted by ϕ^* with

$$\phi^* = \frac{\kappa}{e} \frac{1 - \beta}{\beta} \forall t \quad (23)$$

The double free-entry condition of both banks and projects on credit markets implies a credit market tightness that is constant over time, even out of the steady-state. Also, it is useful to characterize the total transaction costs paid by both firms and banks in stage c as

$$K(\phi^*) \equiv \frac{\kappa}{\phi^* p(\phi^*)} + \frac{e}{p(\phi^*)} \quad (24)$$

2.6 Stocks of consumers, employment and unemployment

Having stipulated the transition rates for all agents in the economy, we can now write the laws of motion for the stocks of consumers, firms and, consequently, employment. Potential consumers \mathcal{C}_0 become consumers the period after meeting a producer, and a fraction $0 < \tau < 1$ of current consumers separate from their product only to return to the pool of potential consumer the following period. The stocks of consumers and producers on the goods market therefore evolve according to:

$$\mathcal{C}_{0,t+1} = (1 - \tilde{\lambda}_t)\mathcal{C}_{0,t} + [s + (1 - s)\tau]\mathcal{C}_{1,t} \quad (25)$$

$$\mathcal{C}_{1,t+1} = (1 - s)(1 - \tau)\mathcal{C}_{1,t} + \tilde{\lambda}_t\mathcal{C}_{0,t} \quad (26)$$

New workers add to the stock of firms \mathcal{N}_g at a flow $q(\theta_t)\mathcal{N}_{l,t}$ every period, while additions to those firms who do not match with a consumer also arrive as the firms separate from consumers at rate τ , yields the laws of motion:

$$\mathcal{N}_{g,t+1} = (1-s)(1-\lambda_t)\mathcal{N}_{g,t} + (1-s)\tau\mathcal{N}_{\pi,t} + q(\theta_t)\mathcal{N}_{l,t} \quad (27)$$

$$\mathcal{N}_{\pi,t+1} = (1-s)(1-\tau)\mathcal{N}_{\pi,t} + (1-s)\lambda_t\mathcal{N}_{g,t} \quad (28)$$

Finally, the dynamics of aggregate unemployment and employment are then given by

$$u_{t+1} = s(1-u_t) + (1-f(\theta_t))u_t \quad (29)$$

$$1-u_t = \mathcal{N}_{g,t} + \mathcal{N}_{\pi,t} \quad (30)$$

2.7 Disposable income

The total net profits flows in this economy, Π_t , are the sum profit flows to projects and banks. This corresponds to:

$$\Pi_t = (\mathcal{P}_t y_t - \Omega)\mathcal{N}_{\pi,t} - w_t \mathcal{N}_t - \gamma \mathcal{N}_{l,t} - \kappa \mathcal{B}_{c,t}$$

The first term is the revenue generating by firms in stage 4, net of operating costs, the second term represents wage payments in the economy, while the remaining terms represent the negative cash-flows of the bank during the first stages due to prospection costs in labor and credit markets.

These profits net of search costs are pooled and distributed lump sum to workers. The mass 1 of workers, the unemployed and employed, therefore receive per person and per period Π_t as a cash transfer. Further, resources are pooled across categories of workers, as in Merz (1995) and Andofaltto (1996), such that the average disposable income of a representative consumer, $\Pi_t + \mathcal{N}_t w_t$, is simply

$$Y_t^d = (\mathcal{P}_t y_t - \Omega)\mathcal{N}_{\pi,t} - \gamma \mathcal{N}_{l,t} - \kappa \mathcal{B}_{c,t} \quad (31)$$

This measure corresponds to the potential demand for consumption goods, not all of which will be satisfied due to frictions in the goods market.

3 Evaluating the sources of propagation

We begin by detailing our calibration strategy. Next, we present the quantitative results for the full model and discuss in detail the sources of propagation. This section also presents some robustness results with respect to parameters of the goods market, while we compare the role of the difference frictions in Section 4.

3.1 Calibration strategy (To be completed)

We consider the basic unit of time to be a quarter and calibrate the model accordingly. The risk free rate r is set to 1%, corresponding to an annualized return close to the historical average on 3-month Treasury bills. The labor and goods market parameters are determined by matching a set of first moments, presented in Table 1 and detailed below, with the exception of the bargaining weight δ . We estimate the values of the AR(1) parameters and the consumer bargaining weight δ by maximizing the likelihood of the rational expectations solution to a linear approximation of the model on quarterly data for labor market tightness over the period 1977:1 to 2004:3. This estimation procedure yields parameter estimates for technology presented in Table 2, and a bargaining weight of $\delta = 0.34$.

Table 1: Targeted moments: good, labor and credit markets

Unemployment rate	u	10%
Wage rate	$\frac{w}{\mathcal{P}}$	0.75
Average recruiting cost over wage bill	$\frac{\gamma \mathcal{N}_i / q(\theta)}{w \mathcal{N}}$	3%
Unmatched goods	$\frac{\mathcal{N}_g}{\mathcal{N}}$	19%
Consumer matching rate	λ	0.75
Consumer search effort	$\mathcal{C}_0 \sigma(e)$	0.05
Share of essential good in consumption	$\frac{\mathcal{C}_0 \text{Exp} \mathcal{C}_{0,0} + \mathcal{C}_1 \text{Exp} \mathcal{C}_{1,0}}{Y^d}$	15%
Mark-up over marginal cost	$\frac{\mathcal{P}}{w + \Omega} - 1$	25%
Share of financial sector in GDP	Σ	3%

We target an average rate of unemployment of 10%, and a wage rate of three quarters of the marginal revenue, \mathcal{P} . We select the latter to remain distant from the small labor assumption, when the wage is close to the marginal product, which itself generates a large amount of amplification. In addition, we require recruiting costs to represent 3% of the wage bill in steady state, consistent with the evidence reported in Silva and Toledo (2007). Based on the evidence in Davis et al. (2006), we set the exogenous job separation rate to $s = 0.1$. The elasticity of the labor matching function is set to $\eta_L = 0.5$, in the mid-range of values reported in the survey by Petrongolo and Pissarides (2001). The elasticity of the wage to the marginal product is set to 0.5, close to the value suggested by Gertler and Trigari (2007).⁵

In this economy, only firms matched with a consumer sell their goods, thus workers at non-matched firms are un-utilized capacity. We target a capacity utilization rate of 81%, similar to the calibration in Bai, Rios-Rull and Storesletten (2011). These authors target a capacity utilization rate in the consumption sector of 81% based on the Federal Reserve's Statistical Release of Industrial Production and Capacity

⁵We present sensitivity to this and other parameters and targets in a set of tables provided in an On-line appendix.

Table 2: Baseline parameter values

Labor market			Goods market		
job separation rate	s	0.1	goods exit rate	τ	0.05
matching elasticity	η_L	0.5	matching level param.	χ_G	0.52
wage elasticity	η_w	0.5	matching elasticity	η_G	0.5
matching level param.	χ_L	0.58	consumer barg. weight	δ	0.34
wage level param.	χ_w	0.57	cost function - level	χ_σ	0.55
vacancy cost	γ	0.01	cost function - elasticity	η_σ	6.22
			Marginal utility of c_1	Φ	0.64
Credit market			Technology		
bank's barg. weight	β	0.27	labor productivity	y	1
matching elasticity	ϵ	0.5	persistence param.	ρ_y	0.975
matching level param.	χ_C	1.9	standard deviation	σ_y	0.01
search costs	$\kappa = e$	0.05	risk free rate	r	0.01

Utilization. Finally, the cost parameter Ω is adjusted to match a 25% price mark-up over marginal cost.

With respect to consumer search, we target average search duration a little over 5 weeks before finding and deciding on a new consumption good, implying $\tilde{\lambda} = 0.75$. Given our other calibration target, the steady state rate of product entry, defined as $\frac{\tilde{\lambda}C_0}{C_1}$, is 0.25 on an annualized basis. This is consistent with the product entry rate found by Broda and Weinstein (2010). To calibrate the effort placed into the search for consumption goods, we rely on the BLS' time use survey which reports that households spend on average half an hour a day purchasing goods and services (0.4 hours for men, 0.6 for women). Of course, this is not necessarily time spent searching and comparing goods before making a choice. Nor does it include travel related to these activities. Assuming an average 5 hours of a day, spread over a week, this corresponds to 10% of wage income, that is $0.1 \times w\mathcal{N} \simeq 0.1$, which is our target for $\sigma(e)$. Finally, in Broda and Weinstein's found a product exit rate of 0.24 at an annual frequency. The model rate is given by $s + (1 - s)\tau$. Targeting a quarterly rate of 0.1 implies a separation rate from a given good of $\tau = 0.053$.

In addition, we target an expenditure share in the essential good based on the household consumption expenditure survey's average annual expenditure on food consumed at home plus utilities over the period 1984 to 2009. This amounts to 15% of total annual expenditures. In the model, this share is defined as $\frac{C_0 \text{Exp}C_{0,0} + C_1 \text{Exp}C_{1,0}}{Y^d}$, where $\text{Exp}C_{1,0} = Y^d - \mathcal{P}$ is the expenditure the essential good of a matched consumer, and $\text{Exp}C_{0,0} = Y^d$ the expenditure of an unmatched consumer. These expenditures are weighted by the fraction of unmatched and matched consumers, C_0 and C_1 respectively.

The calibration of the credit market requires choosing parameters of the credit

matching function, assumed to be of the form $M_c(\mathcal{B}, N_c) = \chi_C \mathcal{E}^{1-\eta_C} \mathcal{B}^{\eta_C}$, the costs of prospecting on credit markets and the bargaining weight β , and follows Petrosky-Nadeau and Wasmer (2010). We assume symmetry in prospecting costs $\kappa = e$, and the remaining parameters, χ_C and β , are adjusted to accommodate a targeted share of the financial sector in GDP:⁶

$$\Sigma = \frac{\mathcal{B}_\pi \rho - \mathcal{B}_g w - \mathcal{B}_l \gamma - \mathcal{B}_c \kappa}{Y^d}$$

3.2 Looking into the sources of propagation (To be completed)

The central equation relating labor market tightness and the expected value of hiring a worker, equation (10), lies at the heart of propagation in this class of models. In combination with (9) and calling $o_t(r) \equiv r \left(\frac{1/q(\theta_t)-1}{1+r} \right)$ a term vanishing as the discount rate goes to zero, this is:

$$K(\phi^*)(1 + o_t(r)) + \frac{\gamma}{q(\theta_t)} = \frac{1}{1+r} \mathbb{E}_t S_{g,t+1} \quad (32)$$

which equates the average cost of creating a job (the left-hand side, equal to the financial costs properly discounted, $K(\phi)$, and the expected costs of search on the labor market, $\gamma/q(\theta_t)$) to the discounted expected value of a worker to the firm in the goods market stage (the right-hand side). A few words of comparison with the canonical search model are warranted here. First, the costs of financial intermediation enter the left hand side of the equation and place a lower bound on the value of a “vacancy” to a firm. Absent credit market frictions the average cost of creation depends on the flow cost of a vacancy γ and congestion on the labor market. Second, the expected value on the right hand side corresponds to the ability to produce and sell a good once a consumer has been located. Under frictionless goods markets the right hand side is simply the value of the fourth stage. Thus the current model nest the canonical search model when $K(\phi^*)$ tends to zero and the goods market friction is removed.

A log-linear approximation around the deterministic steady state of this job creation condition yields

$$\widehat{\theta}_t = \frac{1}{\eta_L} \frac{S_g}{S_g - K(\phi)} \mathbb{E}_t \widehat{S}_{g,t+1} \quad (33)$$

where η_L is the elasticity of the job filling rate with respect to labor market tightness and “hatted” variables indicate proportional deviations from the steady state. Over and above the amplification of changes in S_g from frictions in the labor markets,

⁶The derivation of the steady state repayment ρ , along with the numerical procedure, are detailed in the appendix.

measured as the inverse of the elasticity of the labor matching function, frictions in credit markets create an amplifying factor of $\frac{S_g}{S_g - K(\phi)}$. This financial accelerator is decreasing in the firm's surplus to hiring a worker, $S_g - K(\phi)$, and its full potential is explored in detail in Petrosky-Nadeau and Wasmer (2011).

Goods markets frictions fundamentally change the dynamics of S_g along two principal dimensions: 1) the expected likelihood of reaching the profit stage in the period after hiring the worker, λ ; 2) the expected profit flow which is now dependent on the expectation of what price the goods will fetch on the market, \mathcal{P} . In order to see this more clearly, recall that the values of the goods market and profit stages derived earlier:

$$\begin{aligned} S_{g,t} &= -w_t + \frac{1-s}{1+r} \mathbb{E}_t [\lambda_t S_{\pi,t+1} + (1-\lambda_t) S_{g,t+1}] \\ S_{\pi,t} &= \mathcal{P}_t y_t - w_t - \Omega + \frac{1-s}{1+r} \mathbb{E}_t [(1-\tau) S_{\pi,t+1} + \tau S_{g,t+1}] \end{aligned}$$

along side the value of a hired worker in the Mortensen-Pissarides world:

$$S_{g,t}^{MP} = y_t - w_t + \frac{1-s}{1+r} \mathbb{E}_t S_{g,t+1}^{MP}$$

From the recursive nature of $S_{g,t}^{MP}$, all that matters for the dynamics of labor market tightness is the expected path of the net profit flow $y_t - w_t$. For most wage rules, this will simply follow the path of the process for productivity and, consequently, and we have the familiar response of labor market tightness to a productivity shock (this is depicted as the crossed line in the first panel of Figure 3)⁷. Compare now the response of labor market tightness and S_g in the first two panels of Figure 1, which also plots the responses of the expectation of the key variables variables governing the dynamics of S_g at the moment the firm is make the vacancy decision, i.e. $\mathbb{E}_t \lambda_{t+1}$, $\mathbb{E}_t \mathcal{P}_{t+2}$, etc.

Labor market tightness and S_g reach their peak 11 periods after the realization of the shock to technology. As the bottom panels of Figure 1 indicate, firms expect a drop in the likelihood of selling their goods following recruiting a worker, but also that conditions on goods market will improve over time, both in terms of market congestion and the price at which they will sell. The evolution of the goods market thus creates increasing incentives to hire workers, even as productivity and the profit flow will be returning to trend. These first forces dominate the second in the initial phase of the expansion such that we see an increase in the value to recruiting a worker and, hence, labor market tightness.

The next table presence a series of second moments for labor and goods market variables, in terms of H.P. filtered standard deviations relative to output and contemporaneous correlation with output. Focusing first on congestion in the goods market, tightness $\xi = \frac{\bar{e}\mathcal{C}_0}{N_g}$ is countercyclical, consumers match more quickly with goods in a

⁷We can show that the autocorrelation function of the growth rate is essentially zero at all horizons.

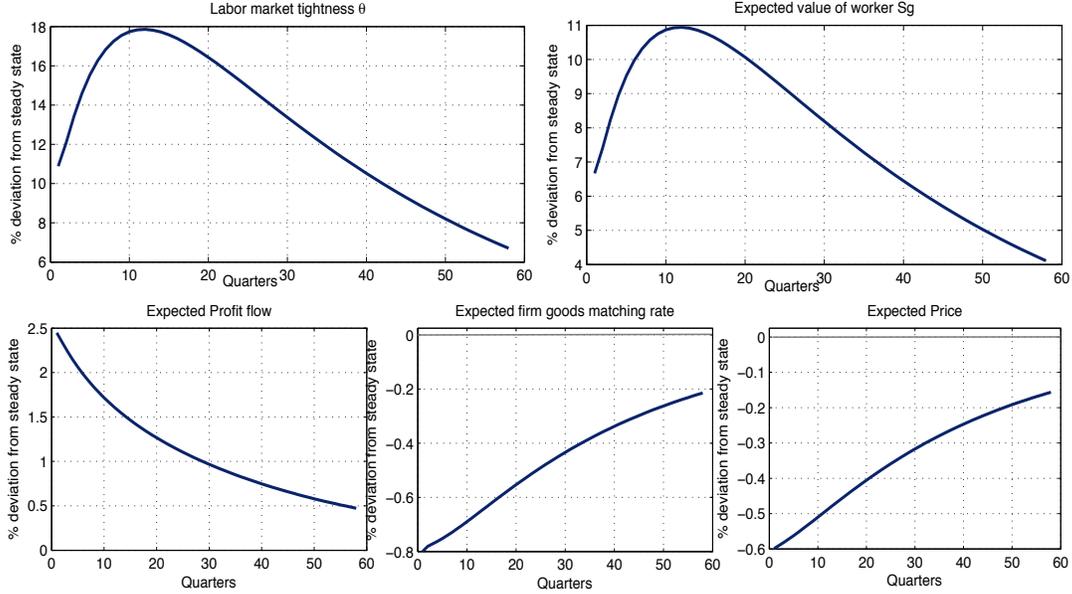


Figure 1: Impulse responses to a positive productivity shock

Table 3: HP filtered Goods market second moments

Goods market		a	b		a	b	
Tightness	ξ	1.37	-0.69	Consumer search effort	e	0.65	0.91
Firms hazard rate	λ	0.69	-0.69	Unmatched consumers	\mathcal{C}_0	0.53	-0.64
Consumer hazard rate	$\tilde{\lambda}$	0.69	0.69	Unmatched firms	\mathcal{N}_g	1.71	0.70
Price of goods c_1	\mathcal{P}	0.49	-0.79				

a: standard deviation relative to output; b: contemporaneous correlation with output.

boom while, as we mentioned, the matching rate of firms λ is countercyclical. The number of unmatched firms, or goods on the market search for consumers, is greater during an expansion, capturing motion as in Shleifer (1986) of booms being periods when more projects are implemented. Consumers search effort is pro-cyclical while the fraction of unmatched consumers is counter-cyclical.

3.3 The role of goods market congestion and prices

The elasticity of the goods matching function, η_G , and the consumer's bargaining weight, δ , will affect the responses of the variables that are key for the propagation mechanism that are goods market frictions. Figure 2 plot the impulse responses to the same technological innovation of labor market tightness and the values that enter the response of the value of a hired worker, S_g , when we increase the bargaining weight δ from 0.34 to 0.5, and reduce the elasticity η_G from 0.5 to 0.25. Table 4 reports the filtered second moments for each scenario.

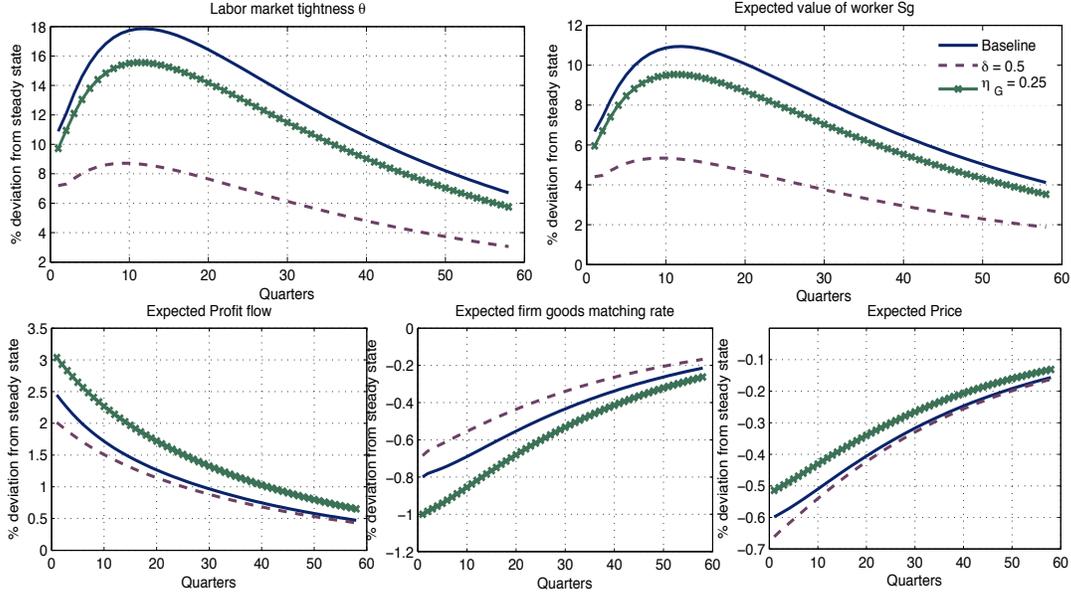


Figure 2: Sensitivity to goods market parameters η_G and δ

Increasing the share of the goods surplus accruing to the consumer implies a stronger downward response of price and, although the goods matching rate for firms λ still drops at first, the its return to steady state is very progressive. The result is much more muted response of the value of hiring a worker, with on a modest “hump.” The persistence of labor market tightness is thus only a third of what it was under the baseline parameter values, and its relative volatility decreases from 11.10 to 7.04. Reducing the elasticity of the goods matching function on the other hand has only a minor impact on the quantitative results, the second moments in Table 4 are mostly the same.

We perform a final sensitivity analysis in this Section in which we set the elasticities of the labor and goods matching function both to 0.25, retain the estimated value for the bargaining weight of 0.34. While this has little impact on the relative volatility of labor market tightness, this is due to a much stronger response of employment and output to the same changes in market tightness θ . As the job finding rate varies more over the business cycle, there is a significant increase in the relative volatility of unemployment, but in terms of persistence, the model is much closer to the autocorrelation in the growth rate of θ seen in the data.

Finally, Table 4 also reports the business moments of wages, consumption and output. The choice of elasticity of the wage to marginal product of $\eta_w = 0.5$ yields a volatility and cyclicity on the model wage that is in-line with what we observe in the data. The same holds for aggregate consumption, the model generating a relative volatility of 0.68 compared to 0.59 in the data, and similar contemporaneous correlation with output.

Table 4: Sensitivity to goods market parameters

Credit, labor and goods frictions	US data		baseline		Consumer barg. $\delta = 0.5$		Goods Match. $\eta_G = 0.25$		$\eta_L = \eta_G = 0.25,$ $\delta = 0.34$	
	a	b	a	b	a	b	a	b	a	b
	Vacancies	8.83	0.89	7.51	0.94	5.04	0.91	7.04	0.95	5.83
Unemployment	6.82	-0.88	5.00	-0.81	3.17	-0.76	4.68	-0.79	7.47	-0.90
Labor tightness	15.41	0.90	11.10	0.99	7.04	0.99	10.41	0.99	11.08	0.99
Wage	0.40	0.44	0.29	0.61	0.31	0.65	0.31	0.73	0.24	0.53
Consumption	0.59	0.80	0.68	0.89	0.65	0.81	0.71	0.92	0.81	0.97
$\sigma(GDP)$	1.40		1.13		1.03		1.08		1.47	
Persistence:	GDP	θ	GDP	θ	GDP	θ	GDP	θ	GDP	θ
$corr(\Delta x_t, \Delta x_{t-1})$	0.24	0.61	0.06	0.17	0.003	0.06	0.07	0.18	0.31	0.33
$corr(\Delta x_t, \Delta x_{t-2})$	0.19	0.40	0.26	0.18	0.14	0.07	0.16	0.17	0.44	0.29
$corr(\Delta x_t, \Delta x_{t-3})$	0.05	0.30	0.12	0.15	0.04	0.06	0.09	0.14	0.32	0.24

Notes: (a): standard deviation relative to GDP; (b): contemporaneous correlation with GDP.

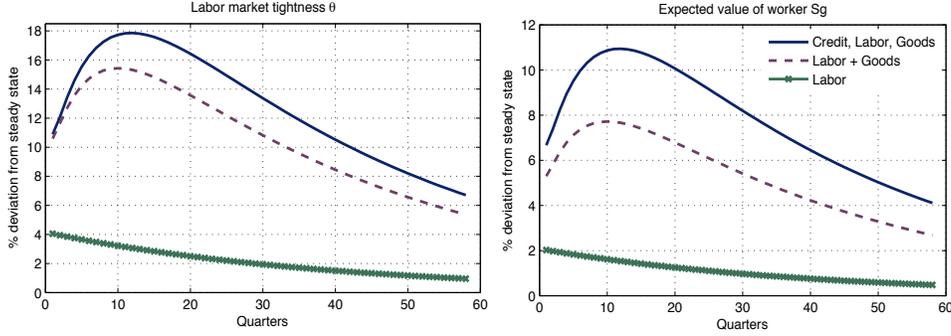


Figure 3: Good market frictions: inspecting the mechanism

4 Comparing frictions

We solve for three comparative models in which we remove and combine the different frictions to assess their relative quantitative importance. Table 5 reports the corresponding moments from the models. Both sets of moments summarize the empirical shortcomings of the canonical search model of unemployment in explaining short run fluctuations on labor markets. This first concern the well know lack of amplification of productivity shocks: labor market tightness is nearly 15 times more volatile than GDP over the business cycle whereas the model generates a relative volatility of 3. This shortcoming extends to the relative volatility of unemployment and job vacancies. The second concern persistence, measured as autocorrelations in growth rates. Labor market tightness is very persistent in the data, much more so than GDP. Just as the real business cycle model fails to deliver on the persistence in GDP, so too does the labor search model on the persistence of labor market tightness. The model generates no persistence: θ follows exactly the shock process.

Good market frictions provide a powerful amplification in the response of labor market tightness, reaching a relative volatility in the full model of 11, improve on the standard framework by a factor of 3.5. Second, goods market frictions are unique in generating persistence in the growth rate of labor market tightness. The values are still far away from the observed persistence in the data, but the model points out the right direction: margins of improvements of this statistics lie in goods market frictions.

Table 5: Second moments - data and model

	Credit, labor and goods frictions		Labor & Goods		Credit & Labor		Labor only	
	a	b	a	b	a	b	a	b
Vacancies	7.51	0.94	7.18	0.92	3.34	0.85	3.09	0.88
Unemployment	5.00	-0.81	4.72	-0.81	0.17	-0.66	0.16	-0.67
Labor tightness	11.10	0.99	10.50	0.99	3.46	0.86	3.20	0.88
Wage	0.29	0.61	0.29	0.66	0.38	0.86	0.40	0.88
Consumption	0.68	0.89	0.65	0.89	0.68	0.67	0.66	0.75
$\sigma(GDP)$	1.13		1.13		1.18		1.18	
Persistence:	GDP	θ	GDP	θ	GDP	θ	GDP	θ
$corr(\Delta x_t, \Delta x_{t-1})$	0.06	0.17	0.05	0.14	0.29	-0.01	0.26	-0.01
$corr(\Delta x_t, \Delta x_{t-2})$	0.26	0.18	0.24	0.14	0.24	-0.01	0.21	-0.01
$corr(\Delta x_t, \Delta x_{t-3})$	0.12	0.15	0.11	0.11	0.21	0	0.18	0

Notes: (a): standard deviation relative to GDP; (b): contemporaneous correlation with GDP.

Data sources: B.E.A., B.L.S. and Conference Board, 1977:Q1 to 2007:Q4.

5 Conclusion (To be completed)

Our paper shows the potential of goods market frictions in macroeconomics. The qualitative features of labor market dynamics is very much affected by complex congestion and price dynamics.

References

- [1] Barro, Robert and Herschel Grossman, "A General Disequilibrium Model of Income and Employment," *American Economic Review*, March 1971
- [2] Bai, Yan, Rios-Rull, Victor and Kjetil Storesletten. (2011). "Demand Shocks as Productivity Shocks", mimeo, U. Minnesota.
- [3] Bénassy, J.P. (1982), *The Economics of Market Disequilibrium*, Academic Press, New York.
- [4] Bénassy, J.P. (1986), *Macroeconomics: An Introduction to the Non-Walrasian Approach*, Academic Press, Orlando.
- [5] Bénassy, J.P. (1993), "Nonclearing Markets: Microeconomic Concepts and Macroeconomic Applications", *Journal of Economic Literature*, Vol. XXXI, June, pp. 732-761.
- [6] Bernanke, Ben and Gertler, Mark, "Agency Costs, Net Worth and Business Fluctuations," *American Economic Review*, March 1989, 79(1), 14-31.
- [7] Bernanke, Ben and Gertler, Mark, "Inside the Black Box: The Credit Channel of Monetary Policy Transmission," *The Journal of Economic Perspectives*, Autumn 1995, 9(4), 27-48.
- [8] Bernanke, Ben, Gertler, Mark and Gilchrist, Simon, "The Financial Accelerator and the Flight to Quality," *The Review of Economics and Statistics*, February 1996, 78(1), 1-15.
- [9] Broda, Christian and Weinstein, David. E. (2010). "Product Creation and Destruction: Evidence and Price Implications", *American Economic Review* 100 (June): 691–723.
- [10] Cole, Harold and Rogerson, Richard, "Can the Mortensen-Pissarides Matching Model Match the Business-Cycle Facts?," *International Economic Review*, November 1999, 40(4), 933-59.
- [11] Steven J. Davis & John Haltiwanger, 1990. "Gross Job Creation and Destruction: Microeconomic Evidence and Macroeconomic Implications," *NBER Chapters*, in: *NBER Macroeconomics Annual 1990*, Volume 5, pages 123-186 National Bureau of Economic Research, Inc.
- [12] Davis, Steven J & Haltiwanger, John C, 1992. "Gross Job Creation, Gross Job Destruction, and Employment Reallocation," *The Quarterly Journal of Economics*, MIT Press, vol. 107(3), pages 819-63, August
- [13] Dell’Ariccia, Giovanni and Pietro Garibaldi, 2005. "Gross Credit Flows," *Review of Economic Studies*, Blackwell Publishing, vol. 72(3), pages 665-685, 07.
- [14] Foster, Lucia, Haltiwanger, John and Chad Syverson, 2008. "Reallocation, Firm Turnover, and Efficiency: Selection on Productivity or Profitability?" *American Economic Review* 98(1), 394-425.

- [15] Gertler, Mark and Antonella Triggari. (2009). "Unemployment Fluctuations with Staggered Nash Wage Bargaining", *Journal of Political Economy*, vol. 117, no. 1
- [16] Hall, Robert, "Employment Fluctuations with Equilibrium Wage Stickiness," *American Economic Review*, March 2005, 95(1), 50-65.
- [17] Hagedorn, Marcus and Manovskii, Iourii, "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited," *American Economic Review*, September 2008, 98(4), 1692-1706.
- [18] Hansen, Gary D., 1985. "Indivisible labor and the business cycle," *Journal of Monetary Economics*, Elsevier, vol. 16(3), pages 309-327, November.
- [19] Hosios, Arthur, "On the Efficiency of Matching and Related Models of Search and Unemployment," *The Review of Economic Studies*, April 1990, 57(2), 279-298.
- [20] Keynes, John Maynard (1936) *The General Theory of Employment, Interest and Money*, London: Macmillan (reprinted 2007)
- [21] Kiyotaki, Nobuhiro and Moore, John, "Credit Cycles," *Journal of Political Economy*, April 1997, 105(2), 211-248.
- [22] Malinvaud Edmond (1977). *The theory of unemployment revisited*, Oxford, Basil Blackwell.
- [23] Mortensen, Dale T. and Pissarides, Christopher A., "Job Creation and Job Destruction in the Theory of Unemployment," *Review of Economic Studies*, July 1994, 61(3), 397-415.
- [24] Mortensen, Dale T. and Pissarides, Christopher A., "New Development in Models of Search in the Labor Market", *Handbook of Labor Economics*, 1999, 3B, 2567-2627, Elsevier, Ashenfleter O.C. and D. Card. eds.
- [25] Mortensen, Dale T. and Nagypal, Eva, "More on Unemployment and Vacancy Fluctuations," *Review of Economic Dynamics*, July 2007, 10(3), 327-347.
- [26] Petrongolo, Barbara and Pissarides, Christopher A., "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature*, June 2001, 39(2), 390-431.
- [27] Petrosky-Nadeau, Nicolas, 2009. "Credit, Vacancies and Unemployment Fluctuations", Carnegie Mellon University working paper 2009-E27.
- [28] Petrosky-Nadeau, Nicolas and Etienne Wasmer, 2010. "The Cyclical Volatility of Labor Markets under Frictional Financial Markets," GSIA Working Paper #2010-E70 and IZA working paper 5131.
- [29] Pissarides, Christopher A., "Short-run Equilibrium Dynamics of Unemployment, Vacancies, and Real Wages," *American Economic Review*, September 1985, 75(4), 676-90.

- [30] Pissarides, Christopher A., "Equilibrium Unemployment Theory," Oxford: Basil Blackwell, 1990.
- [31] Rogerson, Richard, 1988. "Indivisible labor, lotteries and equilibrium," *Journal of Monetary Economics*, Elsevier, vol. 21(1), pages 3-16, January.
- [32] Shimer, Robert, "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *American Economic Review*, March 2005, 95(1), 25-49.
- [33] Shleifer, Andrei, 1986. "Implementation Cycles." *Journal of Political Economy* 94(6), 1163-1190.
- [34] Wasmer, Etienne. (2009). A model of a non-walrasian economy with three imperfect markets: some economics of "multi-frictional economies, mimeo, NBER Summer Institute and European Economic Association Annual Meeting in Glasgow.
- [35] Wasmer, Etienne and Philippe Weil (2004). "The Macroeconomics of Credit and Labor Market Imperfections", *American Economic Review*, September, 94(4), pp 944-963.