The Macroeconomics of Labor, Credit, and Financial Market Imperfections*

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Abstract

Corporate loans are one of the most important avenues of credit for firms. Whereas banks keep a fraction of these loans on their books, about half are sold on a secondary over-the-counter loan market. Empirically, the size of this market is substantial and spreads therein are tightly correlated with real macroeconomic outcomes. We develop a general equilibrium, search-theoretic model with labor, credit, and financial secondary loan markets to study their linkages and the macroeconomic impacts of imperfections in these markets. We show analytically that the existence of a loan market dampens the volatility of unemployment and reduces its steady state level, whereas introducing a loan monitoring cost for banks raises steady state unemployment. Furthermore, convex monitoring costs act as an automatic stabilizer. Numerically, we find that the existence of a loan market reduces steady state unemployment by 2.7pp and amplifies the propagation of real and credit shocks in the economy. Financial shocks in the loan market can have sizable effect on real variables.

JEL Classification: E24, E44, E51, G11, G12, G21, J64

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1 Introduction

Loans from commercial banks constitute the most common avenue for firms to finance their borrowing needs (Gertler and Kiyotaki, 2010). Over the last two decades, an active secondary market for these corporate loans has developed in both US and Europe, where loans are traded over-the-counter like debt securities. This financial innovation may have important macroeconomic implications for at least two reasons. First, the spreads in the secondary market for corporate loans are strongly correlated with various real macroeconomic variables like output and unemployment (Saunders et al., 2021). Second, corporate loans play a large role in recent policy conversations about corporate indebtedness, since their value has doubled in size in the last 15 years (Kaplan, 2019; IMF, 2018).[1] Despite their theoretical and policy importance, however, the linkages of the corporate loans market with the real economy have not been studied in the macroeconomic literature.

In this paper, we fill this gap by developing a microfounded general equilibrium framework to analyze these linkages. Specifically, we build a model with three markets: a credit market, in which banks give loans to new and existing firms to finance their borrowing needs; a labor market, in which new firms match with workers to produce output; and a secondary financial market, in which dealers securitize and sell to investors loans acquired from commercial banks. The modeling of each market follows an established path from the search and matching literature: the credit market builds upon Wasmer and Weil (2004), the labor market features the classic Diamond-Mortensen-Pissarides frictions (Diamond, 1982; Mortensen and Pissarides, 1994), and the secondary market follows the over-the-counter structure of Duffie et al. (2005).

Our first contribution is to theoretically study the interactions between labor, credit, and financial market imperfections in a common framework. Our theoretical analysis proceeds in four steps: first, we show that our model features a financial accelerator that amplifies real shocks. This accelerator is similar to the one in the Wasmer and Weil (2004) economy and is due to the interaction of credit and labor market frictions. Second, we show that giving banks' access to a secondary loan market dampens the financial accelerator, because it increases the surplus generated from the match between the bank and the entrepreneur. Third, we show that introducing a monitoring cost for banks when they keep the loan on its books amplifies the financial accelerator for the exact opposite reason: it decreases

[1] The Federal Reserve even included the secondary market for corporate loans in the announcement of the Primary Market Corporate Credit Facility as a target market for its interventions on the eve of the Covid recession; see Boyarchenko et al. (2022) for details.

the surplus. Fourth, we show that introducing incumbent firms' financing gives banks an additional lending alternative which may either increase or decrease the financial accelerator, depending on parameter values. Intuitively, if labor market frictions are severe, lending to incumbent firms is more attractive to banks (because they already have a worker), which serves to increase the expected profits from entering the credit market. This dampens the accelerator. Alternatively, if incumbent firms do not represent an attractive lending partner, the banks expected profits is relatively lower which amplifies the financial accelerator. Our second contribution is to study the quantitative implications of the model. To do so, we calibrate our economy to US data and perform a series of numerical exercises. We find that frictions in the secondary loan market can have sizeable effects on the real economy, and that the loan market amplifies the effects of real and credit shocks.

The environment builds upon the seminal work of Wasmer and Weil (2004) who study frictions a la Diamond-Mortensen-Pissarides (DMP henceforth) in credit and labor markets. The economy is populated by entrepreneurs, workers, and banks. Entrepreneurs have access to a production technology, but need workers in order to produce output. Entrepreneurs and workers meet on the labor market, which is subject to frictions: finding a suitable counter-party takes time and resources. We model these frictions through the means of a matching function, a standard approach in the macro-labor literature. Moreover, entrepreneurs are liquidity constrained: they do not have the funds to finance the costly search for workers on their own. Thus, they first need to obtain financing from a bank. The entrepreneur and the bank participate in a credit market which is subject to similar search frictions: it takes time and resources to find a suitable counter-party with which to form a credit partnership. Once the entrepreneur secures funding from a bank, the bank finances the labor market search costs until the entrepreneur finds a worker. At that point, production begins and the entrepreneur starts repaying the loan. This environment is essentially the model in Wasmer and Weil (2004) and forms the core of the credit and labor markets in our model.

The model departs from the existing literature in three key dimensions. First, our goal is to study the interactions between the secondary loan market and the real economy, so we introduce such a financial market in the model. Specifically, after the entrepreneur and the worker form a match, the bank receives a stream of revenue from the loan. It can sell the claims to this revenue in a secondary market for securitized loans. The market is modeled as an over-the-counter (OTC henceforth) market in the spirit of Duffie et al. (2005). There are investors/customers who have heterogeneous marginal utilities for the asset (which is simply the claim on the loan repayment): some investors value the asset a lot but may not own it, while others who own the asset may value it less. Investors' preferences are periodically hit by shocks which change their valuation of the asset and generate incentives to trade. Because of frictions, however, investors cannot trade directly with each other and need access to dealers. Investors contact dealers at some exogenous rate and the dealers then execute orders on behalf of investors.

The second departure from the existing literature is the introduction of the need for financing by incumbent firms. In general, we think that the firms' borrowing needs consist of recruiting costs (as in the Wasmer and Weil (2004) model), as well as the purchase of other inputs necessary for production (e.g., capital equipment). In the case of an entrant firm, the bank finances both recruiting and capital expenses. In the case of an incumbent firm, we assume that the firm's capital depreciates and the firm needs financing to replace the depreciated equipment. As the firm is liquidity constrained, it has to enter the credit market again and search for financing for its capital replacement expenditures. Thus, there are two types of firms in the credit market: incumbent firms looking for capital financing, as well as entrant firms looking for both capital expenditures and recruiting cost financing.

The third departure from the model of Wasmer and Weil (2004) is the introduction of monitoring costs for the bank when it carries the loan on its books. In particular, if the bank chooses to keep the loan, then it has to devote some resources to monitor the borrower. We think of monitoring costs as a shortcut to capture banks' balance sheet costs associated with the loan due to liquidity management, default risk, and regulation considerations. In our baseline model, we treat those costs as strictly proportional to the size of the loan the bank keeps in its books. In the extended version of the model, we allow these costs to be convex, which generates a motive for banks to sell a fraction of the loans to the secondary market and keep the rest in their balance sheet. We use the extended version with convex monitoring costs for our quantitative analysis because it is more flexible and allows us to match key properties of the U.S. financial sector.

We then turn to the model's quantitative implications. To study the model numerically, we calibrate its parameters using a large set of labor, credit, and financial moments. Not only the model does an excellent job replicating the targeted moments, but it also does well in matching untargeted empirical statistics. In particular, we show that the model matches the causal estimates of credit disruptions on employment, as estimated in the influential work of Chodorow-Reich (2014). In our first numerical exercise, we shut down the OTC market and compare the levels of endogenous variables in the model with and without a secondary market. Shutting down the OTC market lowers the credit market surplus and increases monitoring costs for banks, which, in turn, leads to less credit and lower job creation. The unemployment rate is 6% in the model with an OTC market and increases to 8.7% in the model without an OTC market, a 2.7 percentage point increase.

The aim of our second numerical exercise is to understand the impact of the secondary loan market on the propagation of shocks. To do so, we consider various comparative statics exercises in the model with and without an OTC market. Our first finding is that the model with an OTC market features *stronger* propagation of real and credit shocks than the model without an OTC market. The reason lies in the behavior of monitoring costs. Access to a secondary market allows banks to easily rebalance their portfolios when real or credit shocks occur and, as a result, monitoring costs are barely affected by the shocks. Without a secondary market, however, banks' monitoring costs change sharply when shocks occur, which acts a financial stabilizer and dampens the effects of real and credit shocks.[2] In our final experiment, we study the impact of financial shocks hitting the OTC market on the real side of the economy. We find that changes in the investors' valuations for corporate loans have sizeable effects on the unemployment rate. When we lower investor' valuations to engineer an asset price drop in the model similar to the one observed in the 2008 financial crisis, the unemployment rate increases by 12%. This result provides a rationale for the policy worries identified in the beginning of the Introduction, since it shows that the real effects of shocks in the workings of the secondary loan market may be sizeable.

Related Literature Our paper contributes to several strands of the macroeconomic literature. First, we focus on imperfections in the credit and labor markets. As such, our model is closely related to a vast search-theoretic literature on the labor market. Some of the early seminal papers include Diamond (1982), Pissarides (1985), Mortensen (1982), Mortensen and Pissarides (1994), Moen (1997). Our work is more narrowly related to papers which investigate credit frictions within the Diamond-Mortensen-Pissarides class of models. Specifically, following the seminal work of Wasmer and Weil (2004) a large body of work has studied the macroeconomic impact of credit and labor market frictions. For example, Petrosky-Nadeau

[2]Here is a more detailed intuition for why endogenous monitoring costs act as an automatic stabilizer, developing an analogy to a progressive tax system in the baseline real business cycle model. In general, a negative output shock lowers wages, which tends to decrease labor supply. With progressive taxation, however, lower wages mean less income, hence the household's marginal tax rate is reduced. This creates a countervailing effect which tends to push the labor supply up. As a result, business cycle fluctuations are dampened. In our economy with monitoring costs, a negative output shock reduces the surplus from the match between a banker and an entrepreneur, hence the stream of repayment from the loan has a lower net present value to the bank. This decreases banks' profits and bank entry into the credit market. With endogenous monitoring cost, however, lower repayment means lower marginal monitoring costs, which tends to increase the bank's profits and, hence, acts as an automatic stabilizer.

and Wasmer (2013) provides a dynamic extension of the baseline model; Petrosky-Nadeau (2013) introduces firm heterogeneity to study the cyclical behavior of TFP; for a comprehensive list see Chapters 5 and 6 in Petrosky-Nadeau and Wasmer (2017) and the papers cited therein. We contribute to that strand of literature by introducing a secondary loan market, a monitoring cost for banks, and credit needs for incumbent firms.

A central feature of our paper is the secondary loan market which we model as an OTC market with search frictions. Our paper is thus related to a large search-theoretic literature which studies OTC markets following the seminal work in Duffie et al. (2005, 2007). For recent surveys see Lagos et al. (2017) and Weill (2020).[3] Most closely related to ours are models where investors have discrete asset holdings, their types are uncountably many, there is a perfectly competitive inter-dealer market, and search is random.[4] In particular, our OTC market closely follows the benchmark model surveyed in Weill (2020). The only point of departure is that assets mature at some exogenous rate and that the asset supply in our economy is endogenous. Our contribution to that literature is to study the linkages of an OTC financial market with the real economy.

Our paper studies the macroeconomic implications of frictions in a financial OTC market. As such it is related to a growing literature which investigates the impact of financial frictions in New Monetarist economies. See, for example, Geromichalos and Herrenbrueck (2016), Herrenbrueck and Geromichalos (2017), and Geromichalos et al. (2018) among others. In contrast to these papers we (i) study the market for loans; (ii) our economy dos not feature money; (iii) our economy features a frictional labor market. There exist papers that have studied the linkages between frictional credit markets a la Wasmer and Weil (2004) and frictional OTC markets in the context of the housing market. For example, Gabrovski and Ortego-Marti (2021b) study the impact of credit frictions when buyers on an OTC (housing) market are liquidity constrained and Gabrovski and Ortego-Marti (2022) analyze an economy with credit frictions on the seller's side of an OTC (housing) market, where creating new homes is costly and housing developers are liquidity constrained. Lastly, our work is connected, to a lesser extend, to a voluminous literature which studies the impact

[3] To a lesser degree, our paper is related to the search-theoretic literature on the housing market which operates over-the-counter and assets are discrete. See, for example, Wheaton (1990), Head et al. (2014), Gabrovski and Ortego-Marti (2019, 2021a,b), Albrecht et al. (2016), and Garriga and Hedlund (2020).

[4] The literature has also studied models which have only some of these properties as well. For example, Lester (2010) studies a model with unconstrained asset holdings and directed search; Gabrovski and Kospentaris (2021) analyzes an economy with directed search and no competitive inter-dealer market; Lagos and Rocheteau (2009) studies a model with unconstrained asset holdings and countably many investor types; Üslü (2019) studies unrestricted asset holdings; Hugonnier et al. (2022) study a model without a perfectly competitive inter-dealer market.

of financial frictions on the real economy in the New Keynesian class of models. See, for example, Bernanke and Gertler (1995), Kiyotaki and Moore (1997), Gertler and Karadi (2015), Gertler and Kiyotaki (2010), and the papers cited therein.

2 The Model

Our theoretical structure is similar to that in Wasmer and Weil (2004) with two extensions: (i) we incorporate a secondary over-the-counter loans market à la Duffie et al. (2005); (ii) not only new firms but also existing firms may require financing. The first extension is central to our research question which studies the real effects of frictions in the securitized loans market. The second extension allows our model to more closely capture the real-world financing needs of firms and thus makes our theoretical structure richer and better able to reproduce key quantitative features of the economy once we calibrate the model. Moreover, this second extension allows us to uncover new channels through which both credit frictions and financial frictions affect the real economy.

2.1 Environment

Time, agents, and preferences Time is continuous and runs forever. The economy is populated by continuums of five types of agents: workers, entrepreneurs, bankers, dealers, and investors. While the masses of workers, dealers and investors are exogenously fixed, the masses of entrepreneurs and bankers are determined endogenously in equilibrium through free entry. All agents but investors enjoy linear utility over the numeraire good, with a marginal utility normalized to one. Investors, on the other hand, have a marginal utility δ that is periodically drawn from a distribution $G(\delta)$ with support $[\underline{\delta}, \bar{\delta}]$. At a rate γ, investors experience idiosyncratic preference shocks which makes them draw a new utility type δ. This shock is meant to capture the idea that investors may need to re-balance their portfolios periodically, creating incentives for trade with one another. All agents share the same rate of time preference r.

Production Each entrepreneur has access to a productive project, i.e., a technology that produces a flow output $y > 0$. The technology requires one worker and one unit of capital stock to operate. Workers can be hired in a frictional labor market a la Diamond-Mortensen-Pissarides, where entrepreneurs must spend time and resources to open a vacancy and search for a suitable job candidate. Specifically, an entrepreneur attempting to find a worker faces a pecuniary flow search cost χ. Following Pissarides (2000), we assume matching is random and occurs through the means of a matching function $M^L(\mathcal{U}, \mathcal{V})$, where $\mathcal{U}$ is the number of unemployed workers and $\mathcal{V}$ is the number of vacancies. We further follow the literature and assume the matching technology exhibits constant returns to scale and is strictly increasing in both arguments. The matching rate for entrepreneurs is $q(\theta) \equiv M^L(\mathcal{U}, \mathcal{V})/\mathcal{V} = M^L(\mathcal{U}/\mathcal{V}, 1)$, where $\theta \equiv \mathcal{V}/\mathcal{U}$ represents the labor market's tightness. This implies that the job-finding rate for a worker is $\theta q(\theta)$. The wage paid by an entrepreneur to a worker, w, is fixed exogenously.[5] Capital stock can be purchased at a cost F per unit. Operating projects are terminated at Poisson rate s_J, in which case the entrepreneur loses both the worker and the capital stock. In addition, when not backing a loan—which we will describe in more details later, capital stock can experience a depreciation shock at rate σ. After such a shock, the entrepreneur must finance the purchase of a new unit of capital stock. Until then, the project faces a higher risk of failure, with termination occurring at Poisson rate $s_J + d$ where $d > 0$.[6]

Financing As in Wasmer and Weil (2004) entrepreneurs are liquidity constrained and cannot finance the costly job-filling search activities. In our setting entrepreneurs need to secure credit to finance the purchase of capital as well—both when setting up production initially and when needing to replace depreciated capital stock. Each banker has deep pockets and the ability to issue exactly one loan to an entrepreneur. The credit market is subject to search and matching frictions similar to the frictions present in the labor market: it takes time and effort for entrepreneurs to find financing and for banks to find suitable projects to which to extend said financing. Entrepreneurs searching for financing occur a non-pecuniary flow search cost c. Bankers searching for a worthwhile project to finance incur flow costs κ, which can be interpreted as the cost of screening applicants and keeping liquidity idle. Matching between bankers and entrepreneurs occurs randomly and is represented by the matching

[5] Although wages are often determined by bilateral bargaining in search-theoretic models of the labor market, we prefer to abstract from this mechanism here. Indeed, as showed by Wasmer and Weil (2004) and Petrosky-Nadeau and Wasmer (2013), doing so allows to identify and analyze the interesting theoretical mechanisms behind the relationship of the credit and labor markets in a much cleaner and more intuitive way. Because one of our main goals is to highlight the theoretical mechanisms in the model, this approach seems appropriate. In addition, we argue that if wages were wages bargained over, the resulting general equilibrium effect would be unlikely to alter our numerical results in a significant way.

[6] An alternative specification would be to assume that a depreciation shock induces the capital to break down and halts production until it is replaced. Then, the project may be permanently terminated if capital is not replaced soon enough, under the rationale that the entrepreneur may not able to keep the worker on payroll indefinitely without producing. The specification we follow assumes that production continues after a depreciation shock, but that not replacing the capital increases the risk of a permanent shutdown of the project. One interpretation could be that the technology has become obsolete and must be updated to remain competitive.

function $M^C(\mathcal{B}, \mathcal{E})$, where $\mathcal{B}$ and $\mathcal{E}$ are respectively the mass of banks and the mass of entrepreneurs. Note that the market is not segmented: $\mathcal{E}$ includes both entrepreneurs with a new project, looking to finance both vacancy costs and capital costs, and entrepreneurs who already have a running project but need to finance new capital. We denote π the proportion of entrepreneurs with new projects among all entrepreneurs looking for financing. The matching function satisfies the usual properties: it is increasing and concave in both arguments and it exhibits constant returns to scale. We denote the matching rate for entrepreneurs by $p(\phi) \equiv M^C(\mathcal{B}, \mathcal{E})/\mathcal{E} = M^C(1/\phi, 1)$, where $\phi \equiv \mathcal{E}/\mathcal{B}$ is the credit market tightness. Hence, the matching rate for banks is given by $\phi p(\phi)$. When a banker and an entrepreneur match, they bargain bilaterally over the terms of the loan, which include the size of the loan and the flow repayment R that the entrepreneur will owe once production begins. Bankers have the ability to enforce loan repayment, but doing so requires costly monitoring: every unit of repayment costs the banker $\xi^B \in (0, 1)$.[7] This cost captures the intuition that keeping a loan on one's books is associated with risk. Finally, we assume that when liable to repay a loan, the entrepreneur ensures the upkeep of his unit of capital, thereby rationalizing that capital only experiences depreciation shocks when entrepreneurs are debt free.[8]

Securitization and secondary loan trade A banker can choose to sell a loan issued to an entrepreneur on a secondary loan market. More precisely, she has the ability to split the original asset promising a flow repayment R until maturity into R units of an asset that repays a unit of the good at every instant until maturity. She can then choose how many of these securities to sell, keeping the remaining on her books. The banker does not have to occur monitoring costs for the units of securitized asset she parts with. We model the secondary loan market as an OTC market in the spirit of Duffie et al. (2005). There is an exogenously fixed mass of investors denoted by $\mathcal{L}$ who can either hold 0 or 1 unit of the asset. Trade takes place through the help of dealers: at a rate λ, an investor meets with a dealer who has access to a perfectly competitive inter-dealer market. The dealer can execute buy and sell orders for the investor in exchange for a fee which the two parties bargain over. The

[7]We specify linear monitoring costs for simplicity of exposition when deriving analytical results. In equilibrium, this results in bankers choosing to either securitize loans in their entirety, or not at all. We augment the cost parameter ξ^B to be an increasing function of the size of the repayment when we conduct our numerical exercises, allowing us to match the fact that in the data only a fraction of all loans are securitized.

[8]This can be interpreted as capital being used as collateral, with a loan covenant requiring its maintenance. Abstracting away from the possibility of capital depreciating while the firm is repaying the loan allows us to derive analytical results: we would otherwise need to keep track of the distribution of the number of loans held by entrepreneurs.

dealer executes these orders by trading in the inter-dealer market. In that market, the price of the asset is P and it is set such that the order flows for buy and sell orders are equated. One departure we make from Duffie et al. (2005) is that we allow for infinitely many investor types. This description of an OTC market is standard in the search-theoretic literature.[9]

Graphical summary Due to the richness of the model, it may be helpful to summarize the model graphically before turning to solving for equilibrium outcomes. Figure 1 highlights the structure of the model, focusing on the different types of agents, the states they may be in, and the markets in which they are able to trade. The orange double-sided arrow spotlights the key novelty of this paper: the transmission channel between the real side of the economy and the secondary loan market. Note that Figure 1 abstracts from details regarding transitions. In particular, it does not show job destructions nor capital depreciation shocks. Figure 2 zooms in on these shocks and transitions. The figure also provides some new notation for the masses of projects in each state, which will be helpful when we formally write laws of motion in Section 2.5.

2.2 Life of a project and value of an entrepreneur

As illustrated in Figure 2, the life of a project begins with an entrepreneur searching for financing in the credit market. The lifetime discounted value of doing so is denoted by E_C and is given by

$$rE_C = -c + p(\phi)(E_V - E_C). \tag{1}$$

The entrepreneur pays the flow search cost c for every instant spent searching on the credit market. At a rate $p(\phi)$ he finds financing and transitions to searching for a worker. The lifetime discounted value of searching for a worker is given by E_V, which satisfies

$$rE_V = q(\theta)[E_J(R_V) - E_V]. \tag{2}$$

Since the entrepreneur does not pay for any of the search costs in the labor market, E_V is comprised of the matching rate $q(\theta)$ and the capital gain the entrepreneur can expect after

[9] Alternative characterizations of the market include, among others, competitive search instead of random search (Lester, 2010), a frictional inter-dealer market (Hugonnier et al., 2020), a combination of the two (Gabrovski and Kospentaris, 2021), as well as unrestricted asset holdings (Lagos and Rocheteau, 2009). For a recent survey see Weill (2020).

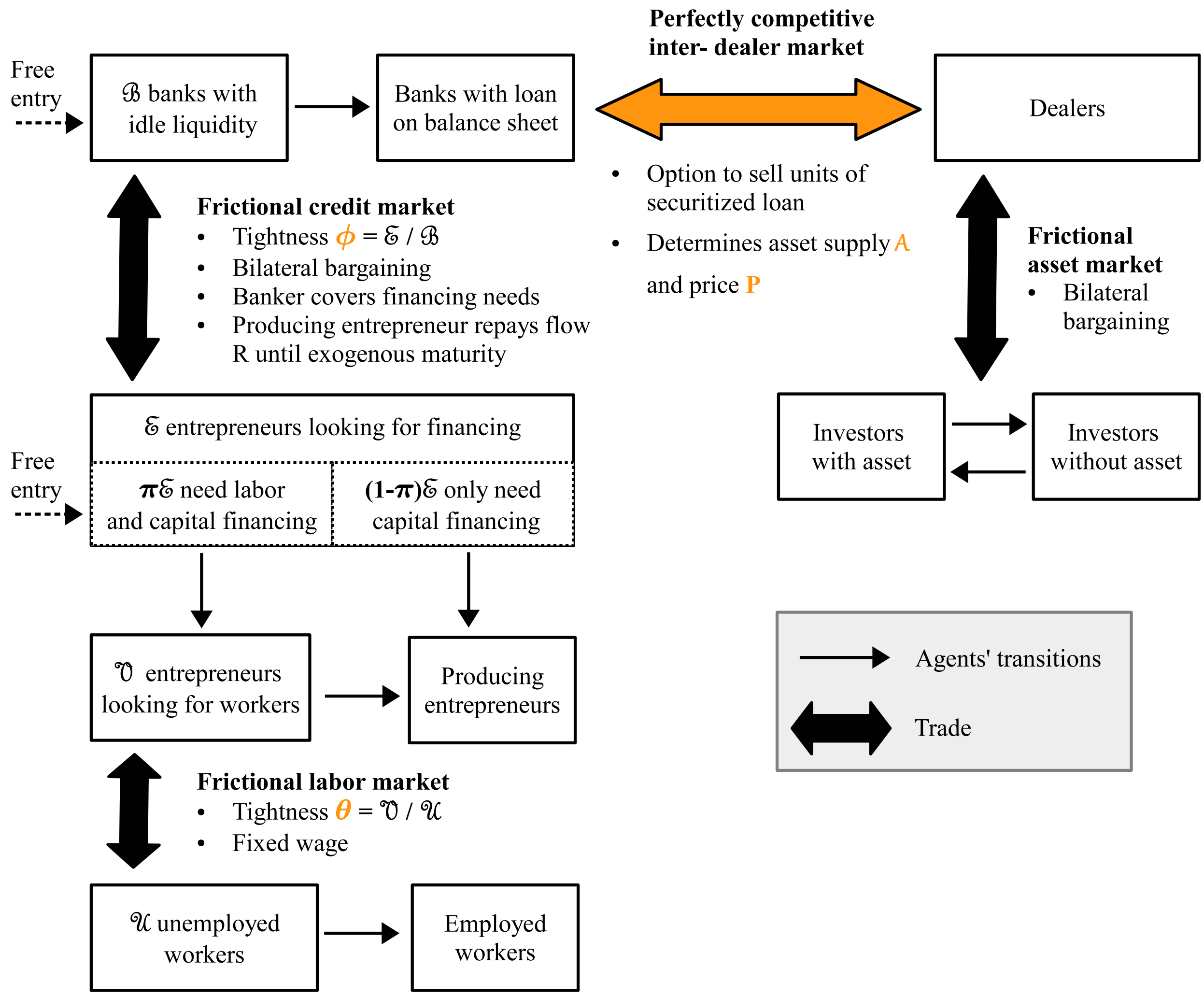


Figure 1: Agents, states, and markets

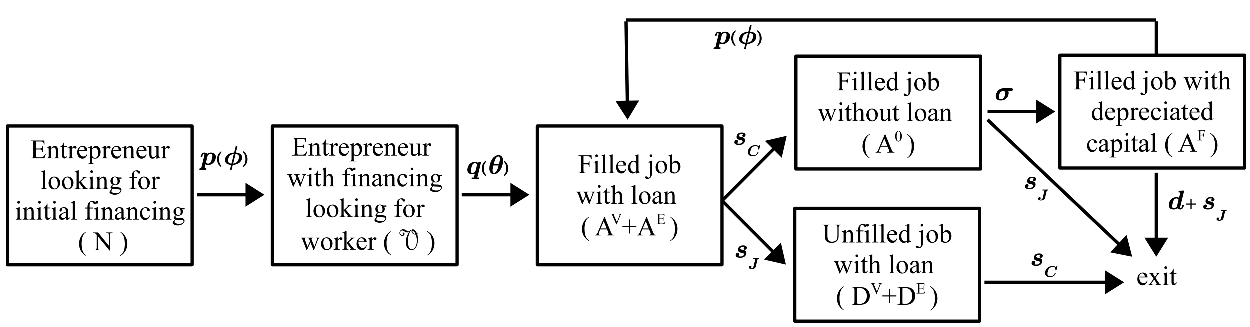


Figure 2: Life of a new project

matching with a worker. Specifically, this capital gain corresponds to the value of having a newly created job and being liable for a flow repayment R_V, $E_J(R_V)$, net of the value of having an open vacancy, E_V. The notation $E_J(R_V)$ makes explicit that the value of an operating job depends on the negotiated repayment. Specifically, it is given by

$$rE_J(R) = y - w - R + s_C[E_J^0 - E_J(R)] + s_J[E_N(R) - E_J(R)]. \tag{3}$$

The flow profits that the entrepreneur enjoys are given by the output y, net of the wages w and the loan repayment R. At a rate s_J the project is permanently terminated, so the value of the job transitions to E_N, where the subscript N denotes that the entrepreneur has no worker. Yet, he still has to make repayments to the bank until the loan matures. At a rate s_C the loan matures, so the value of the job transitions to E_J^0, where the subscript denotes the entrepreneur has zero debt. We now detail both cases. The lifetime discounted value of making flow repayments R after the project is terminated satisfies

$$rE_N(R) = -R - s_C E_N(R). \tag{4}$$

Notice that once repayments are complete, the project's value becomes null.[10] The lifetime discounted value of operating the job after having repaid the original loan is given by

$$rE_J^0 = y - w + \sigma(E_J^F - E_J^0) - s_J E_J^0. \tag{5}$$

The entrepreneur still enjoys the flow profits $y - w$. Like before, the project is terminated at a rate s_J. In addition, at a rate σ, the capital of the firm receives a depreciation shock and the entrepreneur needs to secure financing to update the capital stock. The lifetime discounted value of being in this stage, E_J^F, is given by

$$rE_J^F = y - w + p(\phi)[E_J(R_E) - E_J^F] - (s_J + d)E_J^F. \tag{6}$$

In that state the firm can still produce output, but the capital is in a depreciated state and the project faces the risk of being terminated at the higher rate $s_J + d$. At a rate $p(\phi)$ the firm is matched with a bank that is willing to extend credit. In that event the firm transitions to producing with non-depreciated capital but is burdened by a new loan repayment R_E.

[10]One implication is that the entrepreneur would need to expand time and effort to find another banker ready to extend a loan if he wanted to restart operating his technology.

2.3 Life of a loan and value of a banker

The life of a loan begins with a banker looking to finance a new project or the renewal of depreciated capital. The value for a banker of being in this stage is denoted B_C and it is given by

$$rB_C = -\kappa + \phi p(\phi)\left\{\pi(B_V - B_C) + (1-\pi)\left[\max_{R\in[0,R_E]}\{B_L(R) + P(R_E - R)\} - F - B_C\right]\right\}. \tag{7}$$

At a rate $\phi p(\phi)$ the bank meets with an entrepreneur and extends credit to her. With probability π the entrepreneur is a new entrant, so the bank has to fund the labor market recruitment costs in addition to capital, which has a value B_V. With the complement probability the bank meets with an entrepreneur who already has a worker but needs financing to replenish his depreciated capital. In that event the banker finances the costs of capital acquisition F and gets to securitize the loan into R_E pieces. She chooses how many units to keep on her books, $R \in [0, R_E]$, selling the remaining $(R_E - R)$ units on the secondary loan market at price P. The banker's lifetime discounted value of having R units of the asset on her balance sheet, $B_L(R)$, is given by

$$rB_L(R) = (1-\xi^B)R - s_C B_L(R). \tag{8}$$

The banker receives the repayment R every instant until the loan matures, at Poisson rate s_C. Note that she only enjoys $(1-\xi^B)R$ units of utility due to the associated monitoring costs. The lifetime discounted value of financing a vacancy for an entrepreneur with a new project is given by

$$rB_V = -\chi + q(\theta)\left[\max_{R\in[0,R_V]}\{B_L(R) + P(R_V - R)\} - F - B_V\right]. \tag{9}$$

The banker has to finance the search activities on the labor market, so she experiences a flow cost $-\chi$. At the rate $q(\theta)$, the entrepreneur finds a worker and production begins. In that event the bank finances the capital purchase, F, and experiences a capital gain due to being owed the loan repayment. Again, the banker can securitize the repayment she is owed, R_V, optimally choosing how many to keep on her books, $R \in [0, R_V]$, and how many units to sell to investors, $(R_V - R)$.

2.4 Value of an investor

The lifetime discounted value of holding one unit of asset, for an investor of type δ, is denoted $V_1(\delta)$ and is given by

$$rV_1(\delta) = \delta + \gamma \int [V_1(\delta') - V_1(\delta)]\mathrm{d}G(\delta') + \lambda \max\{B(\delta) - \Delta V(\delta), 0\} - s_C \Delta V(\delta). \tag{10}$$

When the investor has the asset she enjoys the utility flow δ. At a rate γ the investor experiences a utility shock and draws an new utility level δ' from the distribution. If an investor meets a dealer she has the option to trade the asset at the negotiated bid price, $B(\delta)$. She will do so if the bid price is higher than her reservation value $\Delta V(\delta) \equiv V_1(\delta) - V_0(\delta)$. In that event she receives the transfer, but loses her reservation value, i.e. she becomes an investor with no asset. This can also happen if the loan matures, an event that occurs at a rate s_C. The lifetime discounted value of having no asset is $V_0(\delta)$, which satisfies

$$rV_0(\delta) = \gamma \int [V_0(\delta') - V_0(\delta)]\mathrm{d}G(\delta') + \lambda \max\{\Delta V(\delta) - A(\delta), 0\}. \tag{11}$$

The interpretation is similar: the investor can experience a preference shock or she can meet a dealer. When the latter event happens she can purchase the asset at the negotiated ask price, $A(\delta)$, or choose to remain with zero asset holdings.

2.5 Laws of motion

In our economy projects can find themselves into one of several states, as depicted in Figure 2. Let N denote the number of new projects requiring financing; A^V filled jobs which are repaying their initial loan; B filled jobs without any loans; C filled jobs looking for financing; A^E filled jobs which are repaying an incumbent loan; D^V firms that have separated from the worker but are still repaying their initial loan, and D^E those repaying an incumbent loan. The number of firms looking for a workers is equal to the number of vacancies in the labor market, $\mathcal{V}$. Then, the laws of motion are given by:

$$\dot{\mathcal{V}} = p(\phi)N - q(\theta)\mathcal{V}, \tag{12}$$
$$\dot{A}^V = q(\theta)\mathcal{V} - (s_J + s_C)A^V, \tag{13}$$
$$\dot{B} = s_C(A^V + A^E) - (\sigma + s_J)B, \tag{14}$$
$$\dot{C} = \sigma B - (s_J + d + p(\phi))C, \tag{15}$$
$$\dot{A}^E = p(\phi)C - (s_C + s_J)A^E, \tag{16}$$
$$\dot{D}^E = s_J A^E - s_C D^E, \tag{17}$$
$$\dot{D}^V = s_J A^V - s_C D^V. \tag{18}$$

The laws of motion equate the flows in and out of any given state. For example, looking at equation (15), the mass of filled jobs looking for financing increases by σ, the rate at which capital depreciates, times the mass of producing jobs without a loan, B. It decreases by an amount corresponding to all those firms that have found financing $p(\phi)C$ plus all those firms who have exited the market due to separation with a worker, $s_J C$, or due to their capital becoming unproductive, dC. The other laws of motion are interpreted analogously, so we omit their interpretation for succinctness.

The law of motion for unemployment takes a similar form. The flow into unemployment comprises all the workers who are matched with a firm but experience a separation shock, $s_J(A^V + B + A^E) + (s_J + d)C$. The flow out of unemployment is simply all the unemployed workers who find a job, $\theta q(\theta)\mathcal{U}$. Thus,

$$\dot{\mathcal{U}} = s_J(A^V + B + C + A^E) + dC - \theta q(\theta)\mathcal{U}. \tag{19}$$

Next we turn to the laws of motion for the investor types. Given the structure of our secondary market, it is straightforward to show that there exists a reservation type δ^* such that investors of type δ^* are indifferent between holding the asset or not, investors of type $\delta > \delta^*$ who do not hold the asset buy it when they meet a dealer, and investors of type $\delta < \delta^*$ who hold the asset sell it when they meet a dealer. Let $g(\delta)$ denote the density of customers of type δ, and $\psi_0(\delta)$ and $\psi_1(\delta)$ denote the densities of investors with type δ that respectively do and do not have the asset. Then the following two equations hold:

$$g(\delta) = \psi_0(\delta) + \psi_1(\delta), \tag{20}$$

$$\dot{\psi}_1(\delta) = \lambda\psi_0(\delta)\mathbb{I}_{\delta\geq\delta^*} + \gamma\left[\int \psi_1(\delta')d\delta'\right] g(\delta) - \lambda\psi_1(\delta)\mathbb{I}_{\delta<\delta^*} - \gamma\psi_1(\delta). \tag{21}$$

The first equation simply comes from the fact that any investor either holds or does not hold the asset. The second equation is the law of motion for the density of investors of type δ holding the asset. For any δ, there is a positive flow into that state from investors who already held the asset with different preference type, and are now of type δ following a preference shock (second term). There is a corresponding negative flow from investors holding the asset who used to be of type δ but now have a different preference type δ' (fourth term). When $\delta \geq \delta^*$ there is an additional positive flow from investors of type δ who previously did not hold the asset but matched with a dealer, allowing them to purchase it (first term). Conversely, when $\delta < \delta^*$, there is a negative flow from investors of type δ who previously had the asset and met with a dealer, allowing them to offload it (third term). Lastly, all of the asset supply, $\mathcal{A}$, must be held by some investor, adding the constraint $\int \psi_1(\delta)\mathrm{d}\delta = \mathcal{A}$. Combining these equations yields the following investor density functions in steady state:

$$\frac{\psi_1(\delta)}{g(\delta)} = \begin{cases} \frac{\gamma}{\lambda+\gamma+s_C}\mathcal{A} & \text{if } \delta < \delta^*, \\ \frac{\gamma}{\lambda+\gamma+s_C}\mathcal{A} + \frac{\lambda}{\lambda+\gamma+s_C} & \text{if } \delta \geq \delta^*. \end{cases} \tag{22}$$

2.6 Bargaining

The bid and ask prices in the secondary loan market as well as the repayments in the credit market are determined by Nash Bargaining. Let the dealer's bargaining power be α_D. Then, the bid and ask prices solve the Nash products given below:

$$B(\delta) = \arg\max\left[B - \Delta V(\delta)\right]^{1-\alpha_D}\left[P - B\right]^{\alpha_D}, \tag{23}$$

$$A(\delta) = \arg\max\left[\Delta V(\delta) - A\right]^{1-\alpha_D}\left[A - P\right]^{\alpha_D}. \tag{24}$$

Similarly, the negotiated repayments the entrepreneur makes to the banker solve

$$R_V = \arg\max\left[B_V - B_C\right]^{\alpha_C}\left[E_V - E_C\right]^{1-\alpha_C}, \tag{25}$$

$$R_E = \arg\max\left[\max\{B_L(R), PR\} - F - B_C\right]^{\alpha_C}\left[E_J(R) - E_J^F\right]^{1-\alpha_C}, \tag{26}$$

where α_C is the bargaining power for the bank.

2.7 Equilibrium

The block structure of the model allows us to solve for the general equilibrium by combining two distinct partial equilibrium analyses. In a first block, we can characterize equilibrium outcomes in the secondary loan market (e.g., inter-dealer price, marginal investor preference, etc.) as a function of the asset supply $\mathcal{A}$, which depends on the quantity and size of loans made in the real economy. In a second block, we can characterize equilibrium outcomes in the labor and credit markets (e.g., loan supply, unemployment rate, etc.) as a function of the interdealer asset price P, which depends on activity in the secondary loan market. Combining the two allows us to close the model.

Secondary loan market and asset price Let us first characterize the equilibrium in the secondary loan market. To begin with, we focus on the price of the asset in the inter-dealer market, P. First, plugging the solution for the bid and ask prices, $B(\delta) = A(\delta) = \alpha_D \Delta V(\delta) + (1 - \alpha_D)P$, into the Bellman equations for the investor when she does and does not have the asset, (10) and (11), and combining the two yields an expression for the investor's reservation value

$$\begin{aligned}(r + s_C)\Delta V(\delta) = \delta + \gamma \int [\Delta V(\delta') - \Delta V(\delta)]\mathrm{d}\delta' + \lambda(1 - \alpha_D) \max\{P - \Delta V(\delta), 0\} \\ - \lambda(1 - \alpha_D) \max\{\Delta V(\delta) - P, 0\}. \qquad (27)\end{aligned}$$

This expression has a standard interpretation: the left-hand side of the equation is the annualized reservation value. The first term on the right-hand side is the utility flow of holding the asset, the second term is the flow of expected net utility from a type change, the third term captures the net utility flow of selling the asset, and the last term is the negative of the utility flow from purchasing the asset. Using that $\max\{P - \Delta V(\delta), 0\} - \max\{\Delta V(\delta) - P, 0\} = P - \Delta V(\delta)$, one can express the reservation value of the investor by

$$(r + s_C)\Delta V(\delta) = \delta + \gamma \int [\Delta V(\delta') - \Delta V(\delta)]\mathrm{d}\delta' + \lambda(1 - \alpha_D)[P - \Delta V(\delta)]. \qquad (28)$$

Taking the expectations of both sides of the above expression and substituting it back yields an explicit solution for the reservation value:

$$\Delta V(\delta) = \frac{r+s_C}{r+s_C+\lambda(1-\alpha_D)}\left[\frac{r+s_C+\lambda(1-\alpha_D)}{r+s_C+\gamma+\lambda(1-\alpha_D)}\frac{\delta}{r+s_C}\right.$$
$$\left. + \frac{\gamma}{r+s_C+\gamma+\lambda(1-\alpha_D)}\int \frac{\delta'}{r+s_C} g(\delta')\mathrm{d}\delta'\right] + \frac{\lambda(1-\alpha_D)}{r+s_C+\lambda(1-\alpha_D)}P. \tag{29}$$

Conditional on contacting a dealer, investors find it optimal to hold the asset if and only if $\delta > \delta^*$. Thus, $P = \Delta V(\delta^*)$. Hence, the price satisfies

$$P = \frac{1}{r+s_C}\left[\frac{r+s_C+\lambda(1-\alpha_D)}{r+s_C+\gamma+\lambda(1-\alpha_D)}\delta^* + \frac{\gamma}{r+s_C+\gamma+\lambda(1-\alpha_D)}\mathbb{E}(\delta)\right]. \tag{30}$$

At first glance, it may seem like the price does not depend on the real side of the economy. Upon further inspection, however, it becomes evident that the real economy affects the inter-dealer price through the supply of the asset, which ultimately determines the reservation investor type δ^*. In particular, all of the asset must be held by some investors, so $\mathcal{A} = \int \psi_1(\delta)\mathrm{d}\delta$. Using the steady state expression for $\psi_1(\delta)$ from (22) yields

$$\mathcal{A} = \frac{\lambda}{\lambda + S_C}[1 - G(\delta^*)], \tag{31}$$

implicitly characterizing the marginal investor valuation δ^* as a function of the asset supply $\mathcal{A}$. Note that the marginal investor type is such that in the absence of frictions ($\lambda \to \infty$) there is just enough investors who are willing to hold the asset as there are units of the asset.

Real economy and asset supply We turn to the relationship between the real economy and the asset supply, taking the secondary loan market block as given. We first derive the equilibrium conditions which determine the market tightnesses θ and ϕ in a similar way as WW. This approach makes the equilibrium depiction clearer and also allows us to compare our economy to that of WW in a transparent fashion. To this end we derive the so-called EE and BB locii. The EE locus equalizes the cost for an entrepreneur with a new project to search for financing (backwards-looking) with the expected value of obtaining such financing (forward-looking). Free entry of entrepreneurs ensures this condition holds: were the cost of looking for financing smaller than its expected value, more entrepreneurs would enter the market, thereby increasing competition for banks, and driving the cost of financing up until the net value of entering is zero. Similarly, the BB locus equalizes he cost for a banker to finance a project with the expected value of providing such financing—and the free entry of bankers ensures that this condition always holds.

First, let $\Psi \equiv (y - w - s_C E_J^0)/(r + s_C + s_J)$ denote the firm's expected revenue net of wages and future capital expenditures. Then, using the Bellman equation (3), the firm's flow value when it has a loan with repayment R is this expected revenue net of wages and future capital expenditures, less the discounted expected loan repayments, i.e. $E_J(R) = \Psi - R/(r + s_C)$. This notation is useful for our analysis for two reasons. First, because the job may enter several different stages the expression for the net present value of expected future profits is cumbersome. Second, our notation makes it explicit that when a firm negotiates the terms of a loan with a bank, all other loans potentially taken in the future are treated as exogenous.

Then, free entry together with the Bellman equations (2) and (9) imply that $E_V = c/p(\phi)$ and $B_V = \kappa/[\phi p(\phi)]$. These are the same conditions as in WW, which implies that the new channels in our economy operate through the forward-looking expected value of finding financing for the entrepreneur and the forward-looking expected value of providing financing for the bank. Using the Bellman equations (1) and (7) these can be shown to be:

$$E_V = \frac{q(\theta)}{r + q(\theta)} \left[\Psi - \frac{R_V}{r + s_C} \right], \tag{32}$$

$$B_V = \frac{q(\theta)}{r + q(\theta)} \left[\frac{R_V}{r + s_C} \max\left\{ P(r + s_C), 1 - \xi^B \right\} - \left(F + \frac{\chi}{q(\theta)} \right) \right]. \tag{33}$$

The term in brackets relies on the fact that, after simplifying the Bellman equation for the value of the loan to the bank, (8), we obtain $B_L(R) = (1 - \xi^B)R/(r + s_C)$. Thus, the bank will choose to securitize all of the loan if $P \geq (1 - \xi^B)/(r + s_C)$ and none of the loan otherwise.[11]

Next, we need to characterize the repayment R_V and R_E as a function of market tightness. Solving for the Nash Bargaining problem in (25) and (26) implies the two first order conditions: $B_V/E_V = \max\{P(r + s_C), 1 - \xi^B\}\alpha_C/(1 - \alpha_C)$ and $[\max\{(1 - \xi^B)/(r + s_C), P\}R_E - F]/[E_J(R_E) - E_J^F] = \max\{P(r + s_C), 1 - \xi^B\}\alpha_C/(1 - \alpha_C)$. Plugging in for E_V and B_V from

[11] In the latter case no loans are securitized and the economy's equilibrium is the same as the equilibrium in an economy without a secondary loan market, i.e. asset supply is zero.

(2) and (9), and rearranging yields the implicit equilibrium solutions for the loan repayments:

$$\frac{R_E}{r+s_C} = \alpha_C(\Psi - E_J^F) + (1-\alpha_C)\frac{F}{\max\{P(r+s_C), 1-\xi^B\}}, \tag{34}$$

$$\frac{R_V}{r+s_C} = \alpha_C\Psi + (1-\alpha_C)\frac{F+\chi/q(\theta)}{\max\{P(r+s_C), 1-\xi^B\}}. \tag{35}$$

The net present values of loan repayments are a weighted average of two terms. First, there is the firm's net revenue less the outside option for the entrepreneur. In the case of a vacancy loan this is simply Ψ because free entry drives the value to the entrepreneur of searching for credit, E_C, to zero. In the case of an incumbent firm loan it is $\Psi - E_J^F$ because the firm's outside option is to continue searching for financing. Note that this first term represents the maximum amount of repayments the entrepreneur could make while keeping a non-negative surplus. The second term it is the value of the loan, either F for an incumbent firm loan or $F + \chi/q(\theta)$ for a vacancy loan, divided by the bank's marginal utility. In particular, if the firm transfers one more unit of repayment to the bank each period the bank can do one of two things. It can keep the loan on its books, in which case it will enjoy only $1 - \xi^B$ units of utility for the extra unit of repayment. Alternatively, it can sell the asset, in which case it will receive the equivalent of a $P(r + s_C)$ extra units of flow utility. Since the bank acts rationally, the marginal utility is $\max\{P(r + s_C), 1 - \xi^B\}$. The lower this value, the higher the repayments that the bank requires. This second term can also be interpreted as the minimum repayments the entrepreneur could make to leave the banker whole. Because both the banker and the entrepreneur have bargaining power, the negotiated repayment falls in between the minimum and the maximum values it could take. Observe that the existence of a secondary loan market implies the bank will always require weakly less of a repayment than what it would if it had to always keep the loan on its books. Lastly, the repayment for a vacancy loan is larger than that of an existing loan. This is the case for two reasons. First, the vacancy loan features a higher principal. Second, the outside option when negotiating a vacancy loan is zero. In the case of an incumbent loan, however, the entrepreneur has a weakly better outside option. She is already in a match with a worker and has no loans on its books. Because of frictions, there is a positive surplus of being matched with a worker and subsequently E_J^F is weakly positive.

Plugging in for R_E and R_V into (32) and (33) and equating them to their backwards-looking analogs yields the EE and BB locii:

$$\text{EE}: \qquad \frac{c}{p(\phi)} = (1-\alpha_C)\frac{q(\theta)}{r+q(\theta)}\left[\Psi - \frac{F+\chi/q(\theta)}{\max\{P(r+s_C), 1-\xi^B\}}\right], \tag{36}$$

$$\begin{aligned} \text{BB}: \qquad \frac{\kappa}{\phi p(\phi)} =& \alpha_C \left\{ \frac{\pi q(\theta)}{r+q(\theta)}\left[\Psi \max\{P(r+s_C), 1-\xi^B\} - \left(F + \frac{\chi}{q(\theta)}\right)\right]\right. \\ &\left. + (1-\pi)\left[(\Psi - E_J^F)\max\{P(r+s_C), 1-\xi^B\} - F\right]\right\}, \end{aligned} \tag{37}$$

where $E_J^F = [y - w + p(\phi)(\Psi - R_V/(r+s_C))]/[r+s_J+d+p(\phi)]$, as implied by the Bellman equations (3) and (6). These two equations jointly determine θ and ϕ conditional on P, Π, and Ψ. These three objects are absent from WW, so that the two locii entirely characterize their equilibrium. We provide a more in-depth comparison in Section 3.

We now characterize π and Ψ. By definition, π is the fraction of entrant firms looking for financing on the credit market $\pi = N/(N+C)$. Manipulating the laws of motion (12) - (16) yields, after some straightforward but tedious algebra, the following expression for π at steady state:

$$\pi = 1 - \frac{s_C}{s_C + s_J}\frac{\sigma}{s_J+\sigma}\frac{p(\phi)}{d+s_J+p(\phi)}. \tag{38}$$

It turns out that π admits a very intuitive representation. It is the complement of the fraction of incumbent firms on the credit market. This fraction is, in turn, given by the probability for an incumbent firm with a loan to secure a loan in the future. In particular, the fraction $s_C/(s_C+s_J)$ is the probability that the loan matures before the entrepreneur and worker separate, i.e. the chance the job will enter a state with no loan. The second fraction $\sigma/(s_J+\sigma)$ is the probability the capital will depreciate before the pair separates. Thus, the product of the first two fractions is the chance a firm which currently has a loan will find its self in a position to look for new financing. Similarly, the last fraction is the probability the firm secures financing before the firm-worker separate and before the capital becomes unproductive. Thus, the product of all three fractions is the chance a firm which currently has a loan will secure a loan some time in the future. Turning to Ψ, using equations

(3)-(6), it is straightforward to show that

$$\Psi = \frac{a(\phi)}{[1-a(\phi)]p(\phi)}(y-w)\left[1+\frac{r+s_J+d+p(\phi)}{\sigma}\left(1+\frac{r+s_J+\sigma}{s_C}\right)\right]-\frac{a(\phi)}{1-a(\phi)}\frac{R_V}{r+s_C}, \tag{39}$$

where $a(\phi) \equiv s_C\sigma p(\phi)/[(r+s_J+s_C)(r+s_J+\sigma)(r+s_J+d+p(\phi)]$. Recall that R_V is a function of θ and Ψ. Altogether, equations (36), (37), (38) and (39) jointly determine θ, ϕ, Ψ and π given P.

With θ and ϕ in hand, evaluating the laws of motion (12)-(18) at steady-state gives the masses of projects in each state as a function of P. This allows us to solve for the steady-state level of unemployment, $\mathcal{U}$, also as a function of P, using (19).

Finally, we can solve for the asset supply given P. Recall that conditional on the price being high enough, banks securitize all of the asset, so the aggregate asset supply is equal to $R_E(A^E+D^E)+R_V(A^V+D^V)$. Intuitively, the supply of the asset depends on both the size of the repayments and on the number of firms that were able to secure financing for their projects. This yields the following equilibrium condition:

$$\mathcal{A} = \frac{(s_J+s_C)\sigma(1-\mathcal{U})}{(s_J+\sigma+s_C)(d+s_J+p(\phi))+s_C\sigma}\left\{\frac{s_J+s_C}{p(\phi)}R_E + \left[\frac{(s_J+\sigma)(d+s_J+p(\phi))}{s_C\sigma}-\frac{s_J+s_C}{p(\phi)}\right]R_V\right\}, \tag{40}$$

where R_V and R_E, which we showed are perfectly identified given P, are left as implicit for succinctness

General equilibrium Together, equations (30) and (31) solve for P as a function of $\mathcal{A}$. In addition, (40) solves for $\mathcal{A}$ as a function of $\mathcal{U}$, θ and ϕ, which we showed we jointly determined given P. These two mappings allow us to solve for P and $\mathcal{A}$ jointly, thereby bridging the two sides of the model.

3 Model Mechanisms

Our economy differs from the existing literature in three ways. First, we introduce a secondary loan market on which investors can trade bank loans that originate from the real side of the economy. As a result, the model features a novel link between the real and financial side of the economy. This link operates through the inter-dealer price P on the one hand and through the endogenously determined supply of bank loans on the other. We investigate this connection in detail in next subsection 3.1. Our economy further departs from existing studies on labor markets and credit frictions by introducing financing to incumbent firms. This model feature impacts the real economy and its link with the secondary market for loans both because new entrants and incumbent firms search for credit on the same market, which generates congestion in the credit market, but also because our economy features endogenous separations that depend on the conditions in both the real and the financial side of the economy. The paper analyzes the effect of incumbent financing in detail in subsection 3.2. Third, in our numerical exercises we use an extension of our model which features endogenous monitoring costs. These have significant implications for the model's quantitative predictions which we analyze in great detail in section 5.

3.1 Comparison with Wasmer and Weil (2004)

We first compare equilibrium mechanisms in our model to those in Wasmer and Weil (2004). To this end, we abstract from depreciation shocks and the associated need to refinance by setting σ to zero. As a result, we can focus on the exact role played by the possibility for bankers to sell loans in a secondary loan market. Note that while this is the main difference with WW, there are three additional departures from their environment. First, WW assume that loan repayments occur until the job disappears. In other words, loan maturation coincides with job separation, $s_C = s_J$. In our model, this is not necessarily the case. Second, bankers in their model face no monitoring fees, $\xi^B = 0$, while we impose strictly positive monitoring fees. Third, entrepreneurs in WW only need financing to cover vacancy costs, while we also require them to finance a fixed capital cost. This section highlights the role played by each of these additions.

Partial equilibrium: fixed P. We again make use of the block structure of our model and begin our comparison with WW by taking the price at which bankers can sell loan securities to dealers, P, as fixed. Since P is the only channel linking the secondary loan market to the real economy, we can then solve for the outcomes in the labor and credit markets in isolation, in a similar fashion to WW.

Under the assumption of $\sigma = 0$, the firm's net revenue Ψ simplifies to the standard expression $(y - w)/(r + s_J)$ found in WW, which only depends on exogenous parameters.

Then, conditional on the loan repayment R_V, the forward-looking expected value of finding financing for an entrepreneur (32) becomes all but identical to the value of financing a project in WW,

$$E_V^{WW} = \frac{q(\theta)}{r + q(\theta)} \frac{y - w - R_V}{r + s_J}, \tag{41}$$

the only difference being that the repayment is now discounted by $(r+s_C)$ instead of $(r+s_J)$. Indeed, in our setup, the loan maturity is not necessarily aligned with the life of a job. All else equal, the faster the loan matures, the higher the value of financing to the entrepreneur. Recall that the left-hand side of the EE locus is identical to WW in our model. Then, because the right-hand side of our EE locus is also identical to WW up to the repayment (abstracting away from the separation rates), the interpretation of the EE locus in our model is identical to that in WW. The forward-looking value of financing a project for the entrepreneur is a decreasing function of the labor market tightness. The tighter the labor market, the more costly the search for a worker will be, decreasing the expected benefits from operating a job. The zero-profit condition implies that, as the labor market gets tighter, entrepreneurs must be compensated by more favorable credit conditions. This means a slacker market, i.e., a decrease in θ. Graphically, this generates a downwards-sloping EE locus in the (θ, ϕ) plane. One important takeaway from this first comparison is that the only channel through which the secondary loan market may impact the entry decision of entrepreneurs is through its impact on the repayment. Recall that the loan repayment includes the principal and a "markup" that can be considered as interest. Since the principal is exogenous (from the point of view of the entrepreneur and the bank), the impact of the secondary loan market on entrepreneurs' decisions is determined by the gains that the banker enjoys from being able to sell the loan scaled by their passthrough to the interest charged to the entrepreneur. As we describe in more details later, this passthrough is largely influenced by the distribution of bargaining power between the two agents.

Now turning to bankers, the forward-looking value of extending financing to an entrepreneur remains unchanged from (33) when $\sigma = 0$. There are two differences between our equation and the corresponding one in the WW economy,

$$B_V^{WW} = \frac{q(\theta)}{r + q(\theta)} \left(\frac{R_V}{r + s_J} - \frac{\chi}{q(\theta)} \right). \tag{42}$$

First, the loan amount now includes the capital costs F in addition to the expected recruitment costs $\chi/q(\theta)$. Second, the value of the expected repayment is scaled by a factor that depends on whether the bank sells the loan to a dealer on the secondary loan market. If it does, the repayment is scaled by $P(r+s_C)$, since each unit of repayment can be sold at price P. If not, the repayment is scaled down by $1-\xi^B$ since the banker must pay monitoring costs, which are absent from WW. If the asset is price too low for the banker to sell the loans, then the existence of a secondary loan market has no impact on the banker's equilibrium behavior. If, on the other hand, the secondary loan market is active, its existence may impact the behavior of bankers both directly through the sale price P and through the loan repayment R_V. In this regime, the higher the sale price, the higher the value of financing an entrepreneur for a given R_V, and thus banks find it more beneficial it is to enter the market. Note that like in WW, the BB locus remains upwards-sloping in the (θ, ϕ) plane. A tighter labor market, reducing the forward-looking value of financing, must be offset by an equivalent decrease in the backwards-looking costs of financing, which requires a tighter labor market.

Adding up the forward-looking values of the entrepreneur and banker yields an expression for the joint value of the entrepreneur-bank pair, providing some deeper intuition. In the WW economy this expression is

$$F_V^{WW} = \frac{q(\theta)}{r+q(\theta)} \left[\frac{y-w}{r+s_J} - \frac{\chi}{q(\theta)} \right]. \tag{43}$$

The value for the pair is simply the discounted sum of expected profits from the job, net of the costs of filling the vacancy. In our setup, combining (32) and (33) and making use of the simplification $\Psi = (y-w)/(r+s_J)$, the forward-looking value for the entrepreneur-banker pair instead turns out to be

$$F_V = F_V^{WW} - \frac{q(\theta)}{r+q(\theta)} F - \min\left\{\xi^B, 1-P(r+s_C)\right\} \frac{R_V}{r+s_C}. \tag{44}$$

Thus, the value is equal to that in the WW economy with two additional terms which decrease the joint surplus. First, there is the additional capital cost required to run the job, F. Second, and more importantly, the repayment R_V is not a simple transfer from the entrepreneur to the banker anymore, but instead directly impacts the surplus. If the banker keeps the loan on her books, one unit of repayment from the entrepreneur is worth $1-\xi^B$ units to the banker, thereby decreasing the joint surplus by ξ^B. The banker can recoup some of this cost by selling the loan to the secondary loan market if P is large enough, in which case the unit will be worth $P(r+s_C)$. However, any extra unit of repayment remains a net loss for the surplus, since we assume that $P(r+s_C) < 1$.[12] Now, note that although the repayment decreases the joint surplus through the channel we just highlighted, setting the repayment to zero would mean that the banker receives no surplus. A positive repayment is necessary for financing to happen and for the banker's and the entrepreneur's surpluses to reflect their bargaining powers.

We showed earlier that the impact of the secondary loan market on the repayment R_V is a key channel through which the former may impact bankers' and entrepreneurs' behavior. The next step is therefore to compare the repayment under our setup to that under the WW setup,

$$R_V^{WW} = \alpha_C(y-w) + (1-\alpha_C)\frac{\chi}{q(\theta)}. \tag{45}$$

In our simplified model, it is still given by (35) with Ψ reduced to $(y-w)/(r+s_J)$. Hence, the only channel through which the secondary loan markets impacts the repayment is through P. Further setting $s_C = s_J$ and $F = 0$, like in WW, the only remaining difference with the repayment obtained in the WW economy is the presence of $\max\{P(r+s_C), 1-\xi^B\} < 1$ in the last term. This term scales the repayment up: all else equal, the entrepreneur must now repay more to take into account the cost for bankers of holding a loan. The additional repayment is lower if the banker gets to sell the loan, and further diminishes as P increases. Since we noted earlier that the value of financing for an entrepreneur is a negative function of R_V, and we just showed that R_V decreases in P, we can easily see that the value of financing for an entrepreneur increases in P ceteris paribus. For the banker, the analysis is slightly more nuanced. On one hand, a higher P directly increases the value of financing, but it negatively impacts R_V, which puts downwards pressure on the banker's profits. We can easily check analytically which of these two forces is the greatest by plugging for R_V into (33). Overall, a higher P is beneficial to the banker. Indeed, while the repayments decrease, the decrease does not entirely offset the direct gain from the higher loan sale price. This is intuitive: as visible in the repayment equation, the passthrough from P to the repayment is not one-to-one due to the banker holding bargaining power.

Now that we have highlighted the differences in the forward-looking values for the bank and the entrepreneur, we combine those with the free entry conditions and thus turn our

[12] Otherwise, the contract between the banker and the entrepreneur would not be optimal. Indeed, if a larger repayment increased the joint surplus, it would be optimal for the pair to maximize the repayment, setting $R_V = y-w$, rather than use the repayment as a way to split the surplus. The entrepreneur could then be compensated via another transfer. While we do not use the condition $P(r+s_C) < 1$ in our calibration strategy, we verify that it indeed holds in the calibrated equilibrium.

attention to the EE and BB locii. They are given by equations (36) and (37) with Ψ simplified to $(y-w)/(r+s_J)$ and $\pi = 0$, and illustrated in Figure 3. The black curves represent the EE and BB locii in the WW world. The red and blue curves represent these same locii in our world (with monitoring costs and $F > 0$, but $\sigma = 0$) under two different regimes. The blue curves are drawn assuming that $P(r + s_C) < 1 - \xi^B$, so that bankers choose to keep loans on their books. The red curves are drawn such that, on the other hand, P is large enough to incentivize bankers to sell loans on the secondary market. The corresponding equilibrium outcomes are denoted by the superscripts WW, ξ and P.

We can formally establish the following rankings: $\theta^{\xi} < \theta^P < \theta^{WW}$ and $\phi^{\xi} > \phi^P > \phi^{WW}$. The ranking for market tightness allows us to rank the unemployment rate since in our simplified environment the unemployment rate is simply given by $\mathcal{U} = s_J/[s_J + \theta q(\theta)]$. Since the unemployment rate is a decreasing function of θ, it must be that $u^{\xi} > u^P > u^{WW}$. The addition of fixed capital costs and monitoring costs worsen the financial frictions highlighted by WW in their Corollary 1, pushing labor market tightness further down from the level it would take if entrepreneurs did not need financing. WW describe the mechanism at work as a "financial accelerator". Financial frictions reduce bankers' entry, making it harder for firms to find financing and therefore discouraging entrepreneurs' entry as well. This increases the difficulty for bankers to find investments projects to finance, further reducing their entry, etc. This accelerator is magnified by the monitoring costs. The possibility for bankers to sell loans at a profit, however, mitigates the accelerator. By construction, this is not sufficient to revert to the WW equilibrium even if fixed costs F were equal to zero as long as $P(r + s_C) < 1$, which we assume is always true. Note that when $P(r + s_C) > \xi^B$, increases in P shift EE^P and BB^P locii towards EE^{WW} and BB^{WW} in such a way that θ^P increases and ϕ^P decreases. Intuitively, the higher P, the higher the gains from trade between a bank and an entrepreneur, and the weaker the financial accelerator.

WW also study the impact of shocks to credit search costs (κ and c) and to the firms' profits ($y - w$). In the case of higher search costs for banks (due for example to tighter monetary policy), they find that labor market tightness, θ^{WW} decreases (increasing unemployment) while credit market tightness ϕ^{WW} increases. These equilibrium object react in the same direction in our simplified model, albeit in a stronger fashion due to the stronger accelerator. When bankers sell their loans, the reaction get milder and milder as P increases, although it remains, once again, stronger than in WW.

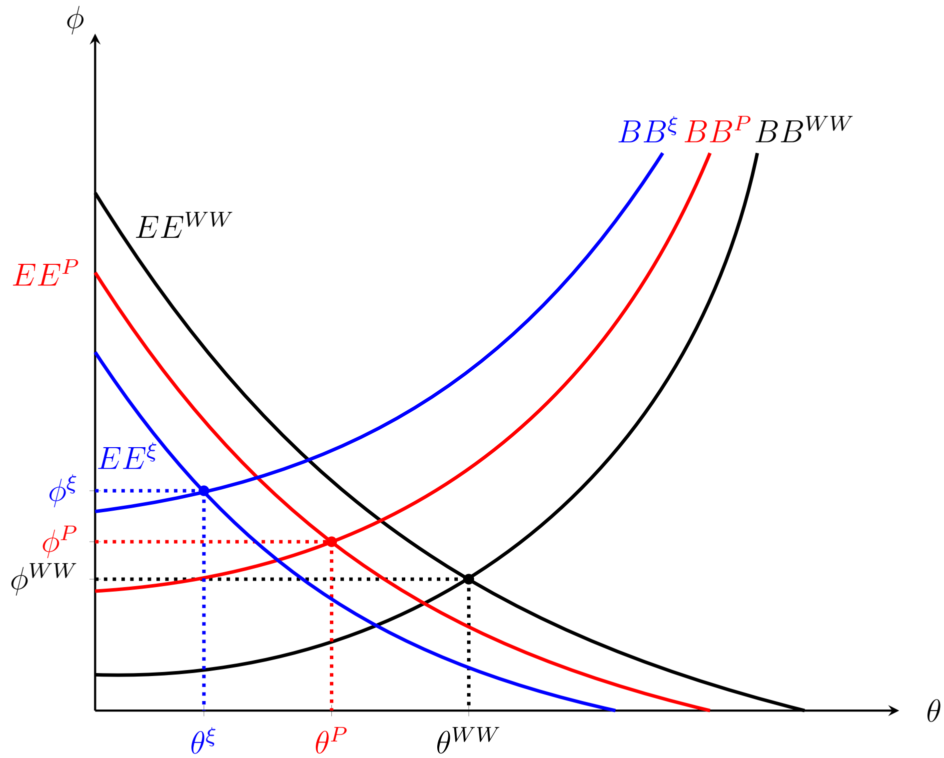


Figure 3: Determination of θ and ϕ in the WW world (in black) and in our simplified model ($\sigma = 0$) given P. The blue curves represent an equilibrium with $P(r + s_C) < 1 - \xi^B$ while the red curves represent an equilibrium where $P(r + s_C) > 1 - \xi^B$.

General equilibrium: Feedback effect from the secondary loan market Previous results were derived taking P as given. In general equilibrium, the real economy feeds back into the secondary loan market through the asset creation channel: the real economy determines how many units of the asset are created, which in turn impacts the asset price P.

In our simplified economy, and assuming $P(r + s_C) > 1 - \xi^B$, the asset supply is given by $\mathcal{A} = R_V \theta q(\theta) \mathcal{U} / s_C$. Consider the increase in the search costs faced by bankers κ studied above in partial equilibrium. The decrease in θ and implies that following the shock, the number of new loans, $\theta q(\theta)\mathcal{U}$, diminishes, while the repayment for each loan, R_V, goes up. The impact on asset supply is ambiguous, depending on whether the increase in repayments is larger than the decrease in the number of projects to finance. If the asset supply were to increase, the asset price P would decrease, magnifying the financial accelerator. In this case, there would be a positive feedback loop between the real economy and the secondary loan market, amplifying financial frictions. Conversely, were the asset supply to decrease following the shock to κ, the asset price would increase, acting as a dampener. Identifying the direction of the response of the asset supply to shocks to the real economy is therefore key to assess whether the feedback effect between the real economy and the secondary loan market amplifies or dampens shocks.

3.2 The Impact of Loans for Existing Firms.

Now that we have highlighted the impact of the secondary loan market in our economy on the equilibrium prices and allocations, we turn to our next point of departure from the literature: requiring existing firms to finance periodic capital expenditures. To this end, we set the distribution of investor values $G(\delta) = 0$, so that $P = 0$ and no loans are ever securitized. Further, we set $\xi^B = 0$ and $s_C = s_J$.[13] Thus, the only point of departure from WW's economy is that $\sigma > 0$ and $F > 0$. Hence, the EE and BB loccii simplify to

$$\frac{c}{p(\phi)} = (1 - \alpha_C)\frac{q(\theta)}{r + q(\theta)}\left[\Psi - \left(F + \frac{\chi}{q(\theta)}\right)\right], \tag{46}$$

$$\frac{\kappa}{\phi p(\phi)} = \alpha_C\left\{\frac{\pi q(\theta)}{r + q(\theta)}\left[\Psi - \left(F + \frac{\chi}{q(\theta)}\right)\right] + (1 - \pi)\left[(\Psi - E_J^F) - F\right]\right\}. \tag{47}$$

Comparing these equations to the ones in WW highlights several differences. Firstly, $F > 0$ so the principal of the loan for the entrant firm is higher. Second, firms may experience a capital depreciation shock, so their expected net revenue Ψ is less than that in WW which is given by $(y - w)/(r + s_J)$. The reason is twofold and evident from equation (39): (i) the depreciation shock decreases the expected duration of the match between the firm and the worker (as captured by the first term on the right-hand side); (ii) the need to secure future financing reduces the firm's expected revenue as the bank will extract some of the surplus through the means of repayment fees (as captured by the second term on the right-hand side). This serves to shift the EE locus to the left (from EE^{WW} to EE) as depicted in Figure 4.

Next, let us focus on the BB locus. The bank shares in the surplus with the entrepreneur, so the increased loan principal and the decreased expected net revenue decrease the bank's forward-looking value of providing financing which serves to shift the BB locus up. In

[13]Note that even though the rate with which loans mature is set to equal the rate of exogenous separations these are still independent Poisson processes, so the loan may mature before the entrepreneur-worker separate and the job will transition to state E_0.

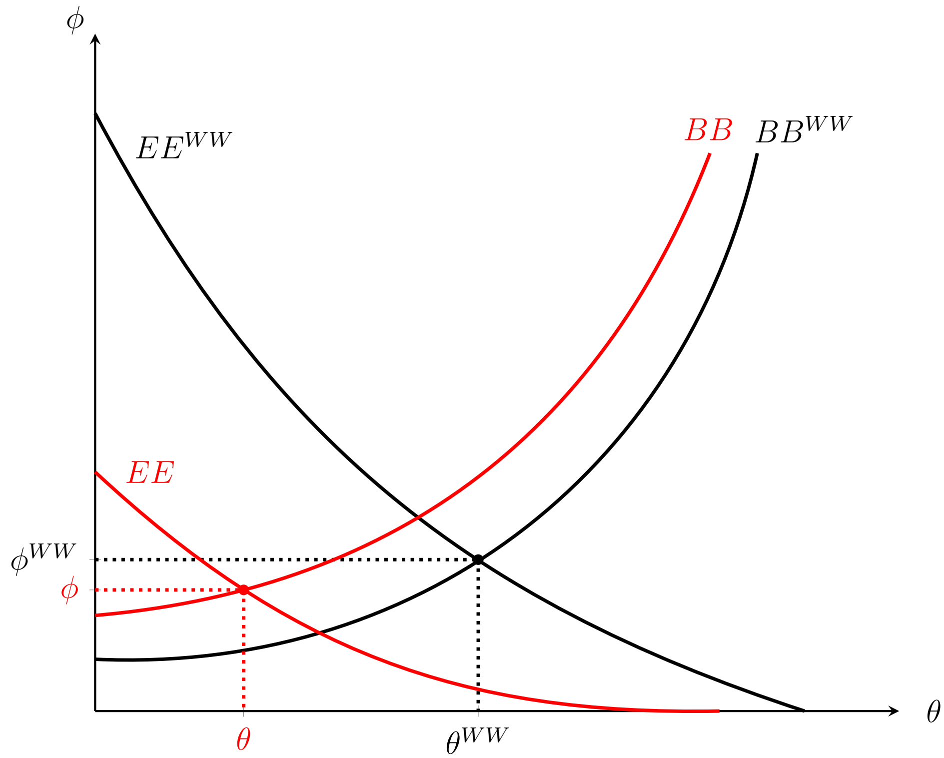


Figure 4

addition, there is a composition effect: the bank expects to sometimes meet incumbent firms looking for financing. These firms generally have a weakly better outside option than new entrants, so the bank does not share all of the net revenue Ψ but only what is above and beyond the firm's outside option E_J^F. This tends to make lending to incumbent firms not as profitable. At the same time incumbent firms (i) require lower loan amounts and (ii) begin repayment right away (as opposed to entrants who only begin repayment after they find a worker, which may take a long time). Both of these tend to increase the surplus between a bank and an incumbent firm and tend to make lending to existing firms more attractive. Overall, either channel may dominate depending on parameter values. Thus, the compositional effect may either dampen or amplify the financial accelerator. Overall, the compositional effect combined with the decreased expected net revenue and the increase in the loan principal tend to shift the BB locus up (BB^W to BB in Figure 4). As a result the labor market tightness is lower, but the effect on the credit market tightness depends on parameter values. Intuitively, if for example the separation rate s_J is large, then lending to incumbent firms is not as attractive, so the BB locus shifts up relatively more. This tends to further disincentivize entry of banks and thus results in a higher equilibrium ϕ as compared to the one in the WW economy. Alternatively, if the bargaining power of banks, α_C, is low then the entrepreneur extracts a higher fraction of the surplius. As a result, her forward-looking value of obtaining financing is more responsive to changes in the surplus. Hence, the entry of entrepreneurs is impacted relatively more in that case, EE locus shifts relatively more than the BB locus and ϕ has a lower equilibrium value relative to the one in the WW economy.

Apart from its effect on the equilibrium tightnesses, the incumbent firm financing channel affects unemployment directly because separations are endogenous in that setting. In particular, once a firm's capital depreciates the chance that it finds financing before its capital becomes unproductive is $p(\phi)/[d+p(\phi)]$. This probability is endogenous and depends on the level of congestion in the credit market: if firms find it hard to secure financing, then it is less likely they will find the funds in time which results in a higher aggregate separation rate. To see this clearly, focus on the steady state unemployment level. Applying straightforward algebra to equations (13) - (19) leads to the following expression

$$u = \frac{s_J + \frac{d s_C \sigma}{(s_J+\sigma+s_C)(d+s_J+p(\phi))+s_C\sigma}}{\theta q(\theta) + s_J + \frac{d s_C \sigma}{(s_J+\sigma+s_C)(d+s_J+p(\phi))+s_C\sigma}}. \tag{48}$$

The endogenous component of separations is then $\frac{d s_C \sigma}{(s_J+\sigma+s_C)(d+s_J+p(\phi))+s_C\sigma}$, which is strictly decreasing in the loan-finding rate as expected. Moreover, if frictions vanish, i.e. $p(\phi) \to \infty$, then firms always find financing and the endogenous component of the separation rate converges to 0. With frictions, however, conditions on the credit market affect separations. We further investigate this channel numerically in section 5.

4 Calibration

We calibrate the model at a monthly frequency. Several parameters are set exogenously to their direct empirical counterparts or by following the literature. We set the discount rate r to 0.0042, consistent with an annual interest rate of 5%. The exogenous wage $\bar{w}$ is set to 0.667 to be consistent with a two thirds labor share from the well-known Kaldor facts (Gollin, 2002). Next, the maturity rate for the securitized loans, s_C, is set to 0.0181 to match an average maturity of 4.6 years for loans traded in the secondary market (Saunders et al., 2021). Regarding matching functions, we follow Shimer (2005) for the labor market and Petrosky-Nadeau and Wasmer (2013) for the credit market. In both papers, the matching function has

Parameter	Description	Value
r	Discount Rate	0.0042
$\bar{w}$	Wage	0.667
s_C	Maturity Rate	0.0181
α_L	Labor Market Matching Elasticity	0.72
α_C	Credit Market Matching Elasticity	0.5
η_D	Dealer's Bargaining Power	0.97
$G(\delta)$	Distribution of Investor Valuations	$\mathcal{U}[\underline{\delta}, \overline{\delta}]$
y	Firm-Worker Match Output	1
$\mathcal{L}$	Measure of Investors	1
$\underline{\delta}$	Lower Bound of Investors' Valuations	0

Table 1: Externally Calibrated Parameters

the Cobb-Douglas functional form: $M^L(\mathcal{U}, \mathcal{V}) = \mu_L \mathcal{U}^{\alpha_L} \mathcal{V}^{1-\alpha_L}$ and $M^C(\mathcal{B}, \mathcal{E}) = \mu_C \mathcal{B}^{\alpha_C} \mathcal{E}^{1-\alpha_C}$. Shimer (2005) calibrates the elasticity $\alpha_L = 0.72$, while Petrosky-Nadeau and Wasmer (2013) work with a symmetric elasticity of $\alpha_C = 0.5$.

Turning to the OTC parameters, both Feldhütter (2012) and Hugonnier et al. (2020) estimate the bargaining power of dealers to be 0.97 in the corporate and municipal bond market, respectively. In lack of direct evidence for corporate loans and given the similarities of the two markets (Saunders et al., 2021), we set η_D to this value. Next, we impose that the distribution of asset valuations in the OTC market, G, is uniform, as in Hugonnier et al. (2020). Finally, we normalize the following variables: i) y, the output of a firm-worker match, to 1; ii) $\mathcal{L}$, the measure of investors in the OTC market, to 1; and iii) $\underline{\delta}$, the lowest possible investor valuation in the OTC market, to 0. The externally calibrated parameters are collected in Table 1.

This parameterization leaves us with thirteen parameters to be calibrated through the lens of the model. Moreover, we endogenize the banks' monitoring cost as a function of the loan's size. That is, in our complete quantitative model, the bank faces a cost $\xi^B(R) = \tilde{\xi} R^{\epsilon}$ for keeping a loan with total repayment R in its books. In total, we have fifteen parameters to calibrate internally to make the model consistent with the data. The model features "block recursivity" (Menzio and Shi, 2010), a typical feature of search models, that guides our calibration strategy: the OTC market is connected with the real side of the model only through the price of securitized loans, P. Hence, the model structure suggests the following

Parameter	Description	Value
μ_L	Labor Market Matching Efficiency	0.48
χ	Cost of Vacancy Creation	0.50
μ_C	Credit Market Matching Efficiency	0.17
s_J	Unconditional Firm Exit Rate	0.02
d	Firm Exit Rate for Matched Firms	0.16
σ	Rate of Capital Replacement Shock	0.11
F	Size of Capital Replacement Shock	1.44
η_C	Bank's Bargaining Power	0.99
κ	Banks' Participation Cost	0.68
c	Entrepreneurs' Participation Cost	0.01
$\overline{\delta}$	Higher Bound of Investor Valuations	0.73
γ	Investor Valuations' Change Rate	2.11
λ	Meeting Rate in the OTC Market	0.03
$\tilde{\xi}$	Monitoring Cost Constant	0.15
ϵ	Monitoring Cost Slope	2.13

Table 2: Internally Calibrated Parameters

strategy: first, calibrate the real side of the model and use the implications of the calibrated parameters for P to pin down the relevant financial parameters; then, complement with other statistics to pin down the remaining parameters of the model.

We start with three empirical moments that are salient features of the US labor market: a long-run unemployment rate of 6%, a monthly separation rate of 3% (Shimer, 2005; Bethune and Rocheteau, 2021), as well as a long-run job-filling rate of 50%.[14] Using the Beveridge curve, these three numbers pin down the level of labor market tightness, θ, in the model which, in turn, pins down μ_L. To determine the cost of vacancy creation, χ, we employ the measurements of Michaillat and Saez (2021) which imply vacancy costs in the order of 3% of aggregate output. To pin down μ_C we follow a similar approach: we combine information on the average search duration in the credit market (four months, based on Petrosky-Nadeau and Wasmer 2013) that determines the credit market tightness ϕ, together with information

[14]For a Cobb-Douglas matching function, the job-filling rate is the product of the unemployed per vacancy ratio (available in JOLTS) times the job-finding rate (computed from CPS data following Goensch et al. 2021). We compute the monthly job-filling rate and use the average from 2001 to 2019 as its long-run value. To be consistent, we calculate the average value of monthly unemployment rates for the same time interval.

Target	Data	Model
Unemployment Rate	6%	6%
Job Separation Rate	3%	3%
Job Filling Rate	50%	50%
Vacancy Creation Cost over GDP	3%	3%
Bank Search Duration	4 months	4 months
Firm Search Duration	3 months	3 months
Fraction of Firms With Completed Borrowing Needs	32%	32%
Fraction of Firms Seeking Capital Replacement	86%	86%
Total Corporate Debt over GDP	45%	45%
Securitized Fraction of Corporate Loans	50%	50%
Bank Discount for Securitized Loans	137 bps	137 bps
Bid/Ask Spread in the Secondary Market	1.01%	1.01%
Turnover in the Secondary Market	70%	70%
Yield to Maturity of Securitized Loans	7%	6.42%
Bid/Par Ratio of Securitized Loans	0.98	0.79

Table 3: Targets and Model Performance

on waiting time for loan approval that determines the credit meeting rate $p(\phi)$.[15]

Next, to pin down the remaining credit parameters we utilize the Small Business Credit Survey (SBCS) conducted by several regional branches of the Federal Reserve System. The SBCS contains, among other interesting variables, information regarding the reasons firms need credit, credit availability, as well as the uses of credit funds. We pool together all waves of the survey (2014-2021) to maximize the number of observations and compute two moments. First, the fraction of firms that received all financing they sought is 42%, consistent with the waiting time for loan approval (see footnote 15). Together with $p(\phi)$, this moment pins down d (the additional exit rate for filled jobs seeking credit) in the model. Second, 14% of firms that applied for credit did so to finance repairs or replace their capital. We use this as a target for $1-\pi$, that is the fraction of incumbent firms in the credit market. Using the model's accounting equations at steady state for π and total separations, combined with

[15]Information on waiting times for loan approval comes from the National Federation of Independent Business (NFIB) Small Business Survey. Specifically, we pooled together the 2014-2019 waves of the survey and computed the average percentage of businesses whose borrowing needs were entirely satisfied with credit *in the last three months*. The average fraction is 30%, varying from 28 to 35% over time.

the moments from the credit surveys and labor market, identifies the exit rate, s_J, and the capital replacement shock for incumbent firms, σ.

We continue by pinning down three more parameters from the real side of the model: the size of the capital replacement shocks, F, the bargaining power of banks in the credit market, η_C, and the flow cost of searching in the credit market κ. To calibrate F, we target the unconditional average of total corporate debt over GDP for the US economy after 2009, using data from the Federal Reserve's Board of Governors. To calibrate η_C, we target the fraction of corporate loans that are securitized and traded in the secondary market. As explained above, the vast majority of loans traded in the secondary market are leveraged loans (Borowicz, 2021; Marsh and Virmani, 2022). The volume of leveraged loans is roughly half of the total corporate lending in the US (Bochner et al., 2020; Marsh and Virmani, 2022), and we use 50% as a target for the total fraction of loans that banks supply to the secondary market in the model. Finally, to calibrate κ, we use the evidence provided by Gupta et al. (2008) who estimate that banks charge 137 bps lower rates for loans traded in the secondary market. Through the lens of the model, this statistic speaks directly to the value of repayment for the banks, R_V, and, as a result, it informs the value of κ.

It is important to notice that at this stage of the calibration process many endogenous variables (θ, ϕ, π) have been pinned down. As a result, and due to the block recursive nature of the model, the asset price P is also determined at this stage. Put it differently, since the asset price is pinned down by the real part of the model, it operates as a targeted moment for the calibration of the financial part of the model. Given the strong relationship between investor valuations and the asset price, this moment identifies the highest valuation, $\overline{\delta}$. Moreover, the equilibrium values of θ and ϕ, together with the calibrated values for κ and P, pin down the coefficient of firms' monitoring costs, $\tilde{\xi}$.[16]

The calibration of the remaining parameters is straightforward. We use a bid/ask spread of 1.01%, estimated by Saunders et al. (2021), to pin down the rate of valuation switches in the OTC market, γ. For the remaining parameters, we use information found in recent reports by the Loan Syndications and Trading Association (LSTA), which is the main platform for trading in the syndicated loans market. First, an annual turnover of 70% identifies the frequency of meetings in OTC market, λ.[17] Second, an annual yield to maturity of 7%

[16] In equilibrium, the monitoring costs make the banks indifferent between holding the marginal loan on their books vis-a-vis selling it in the secondary market. Hence, the equilibrium price of the loan and the cost of of participating in the credit market are informative about the size of monitoring costs.

[17] The average turnover for corporate bonds in the TRACE is also very close to 70%, as reported by He and Milbradt (2014).

pins down the remaining parameter of the banks' monitoring cost, ϵ. Third, a bid/par ratio of 0.98 provides information to recover the entrepreneurs' cost for participating in the credit market, c.[18]

The values of internally calibrated parameters are collected in Table 2 and the performance of the calibrated model versus the empirical targets can be found in Table 3. The tractability of the model allows us to pin down most of the model's parameters exactly, since we are able to analytically solve the equilibrium equations for the parameters and use the targeted moments as inputs directly in the equations. We have to numerically solve the model to match only the last three OTC moments, for which the model matches the turnover perfectly but slightly underestimates the yield to maturity and bid/par ratio. In general, the model match with the targeted moments is excellent, making the model a reliable laboratory for quantitative explorations.

To check the model's external validity, we follow the advice of Nakamura and Steinsson (2018) and consider "identified moments". The identified moments we employ are the causal estimates of the effects of bank lending frictions on firms' employment and credit availability, estimated in the influential work of Chodorow-Reich (2014). These statistics are "identified" because they are derived from empirical strategies designed to uncover the causal effects of shocks in the syndicated loans market on credit availability and employment. As Nakamura and Steinsson (2018) point out, the advantage of using identified moments is that they provide direct evidence for the causal mechanisms of the model. Importantly, one of the exogenous shocks Chodorow-Reich (2014) considers affected the syndicated loans market, making his estimates particularly well-suited for our model.

Chodorow-Reich (2014) uses banks' exposure to Lehman Brothers bankruptcy through the syndicated market as an instrument for banks' credit supply. Next, he estimates the effects of this shock on the probability of firms receiving loans from the affected banks, on the interest rate firms paid for the loans, and on firms' employment growth.[19] We interpret this exercise through the lens of the model as a change in the banks' cost of participation in the credit market, κ. To pin down the size of the shock in the model, we adjust the level of κ

[18] The high value of η_C and the low c in Table 2 paint an intuitive picture of the credit market. Entrepreneurs are almost indifferent, indicating that it is easy for them to finance their borrowing needs, while banks have high bargaining power and get most of the surplus from a match. Given that most parameters are pinned down analytically in our calibration, there are no worries of numerical issues. We could, however, follow Petrosky-Nadeau and Wasmer (2013) and set $c = \kappa$, instead of internally calibrating c. We would not be able to match the bid/par ratio but the rest of the parameter values stay almost identical with this alternative strategy.

[19] Our analysis is in steady state, hence we focus on employment levels instead of employment growth.

such that the model matches the magnitude of Chodorow-Reich's estimate for the probability of a firm receiving a loan and compare the predictions of the model with respect to the other two estimates. The model generates a response equal to 11% of the estimate for interest rate increase and an almost equal employment level drop as the Chodorow-Reich estimates (only 2% higher, to be precise). That is, the model perfectly replicates the impact of credit shocks on employment and delivers interest rate increases reasonably close to the estimates from Chodorow-Reich (2014), even though it does not include any risk considerations.

5 Quantitative Exercises

In this Section, we study the quantitative implications of the model. Our first goal is to understand the role of the secondary loan market for the real economy. To do so, we shut down the OTC market, and compute the values of the endogenous variables in the new steady state without a secondary market (Section 5.1). Our second goal is to understand how the OTC market affects the propagation of shocks in the model. To do so, we consider changes in the values of exogenous parameters and report the effects on endogenous variables in model economies with and without an OTC market. We study three types of shocks: i) real shocks in Section 5.2 (changes in match output, y, and firms' unconditional exit rate, s_J), ii) credit shocks in Section 5.3 (changes in banks' cost of participation on the credit market, κ), and iii) financial shocks in Section 5.4 (changes in investor valuations, δ, and the meeting frequency in the OTC market, λ).

5.1 Steady State Effects

We begin by computing the steady state values for several endogenous variables in the complete model, as well as a model without a secondary OTC market.[20] The model without a secondary OTC market includes credit and labor market frictions, as the model of Wasmer and Weil (2004), but with the additional feature that incumbent firms also need to borrow. The difference in the levels of endogenous variables between the steady state with and without an OTC market quantifies the role of OTC markets for the real economy. The results are collected in Table 4.

[20]For these computations, we hold all other relevant parameters fixed at the steady state levels of Tables 1 and 2.

Endogenous Variables	P	ξ	ϕ	θ	s	u
Model with OTC market	16.61	0.40	2.10	0.94	3%	6%
Model without OTC market	0	0.85	2.54	0.24	3.02%	8.67%

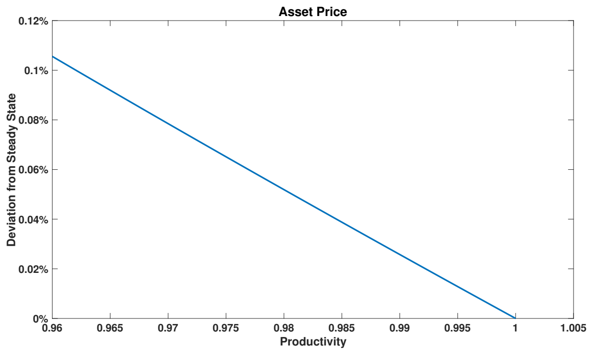
Table 4: Endogenous Variables of Different Model Variants

In the benchmark calibrated model, the price of securitized loans in the secondary market is $P = 16.61$. The option to sell a loan to the secondary market raises the surplus shared by banks and entrepreneurs in the credit market. Shutting down the secondary market implies that the return to securitizing a loan is zero, and banks keep all loans in their balance sheets. In turn, this increases the banks' total monitoring costs, ξ, since now banks have to monitor twice as many loans as before (50% of loans are securitized in the equilibrium of the benchmark model). The zero return to securitization together with the larger monitoring costs lower the surplus in the credit market and less entrepreneurs and banks seek a credit partnership. Banks respond more, however, since they are directly affected by the OTC market, and the ratio of entrepreneurs to banks, ϕ, increases. Having less banks per entrepreneur implies less credit available for vacancy creation, which lowers the labor market tightness, θ, and increases the total separation rate, s.[21] As a result, the unemployment rate, u, is higher in the model without an OTC market.

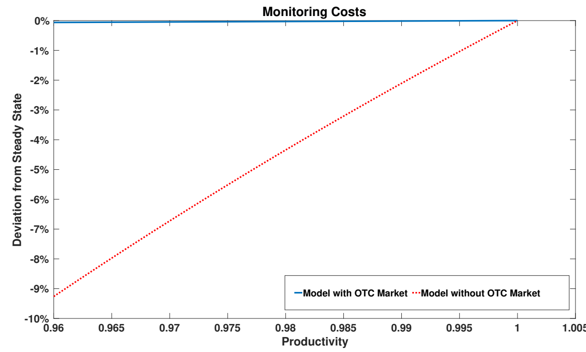
To sum up, the secondary OTC market for securitized loans has large effects on the credit and labor market in our model. Shutting down the OTC market affects real variables through two channels. First, the zero return to loan securitization directly lowers the match surplus in the credit market, which in turn decreases labor market tightness and increases total separations. Second, and more subtle, the disappearance of the OTC market raises the banks monitoring costs, which also adds to the direct effect of the asset price. Intuitively, the OTC market provides an extra margin to banks to offload loans to the secondary market at a good price and save on monitoring costs. In the next Sections, we study how these mechanisms affect the responses of the economy to various shocks. Since the economies with and without OTC markets have different benchmarks steady states, in what follows we express the endogenous variables as percentage deviations from their benchmark steady state levels.

[21] We define a total separation rate the numerator of the Beveridge curve equation (48): $s = s_J + \frac{d s_C \sigma}{(s_J+\sigma+s_C)(d+s_J+p(\phi))+s_C\sigma}$.

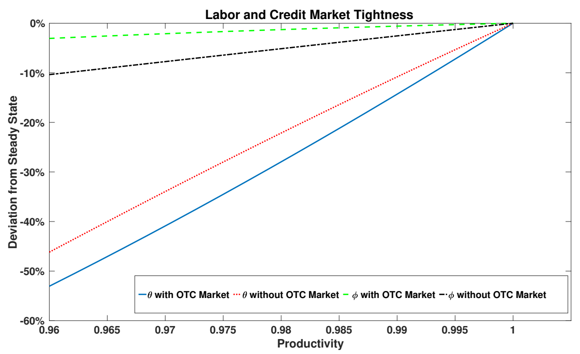
5.2 Real Shocks



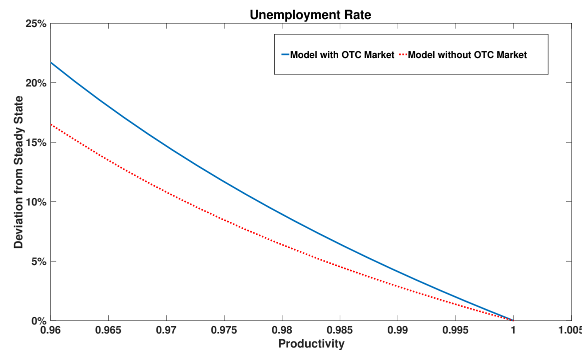
(a) Asset Price Response



(b) Monitoring Cost Response



(c) LM and CM Tightness Response



(d) Unemployment Rate Response

Figure 5: The Effects of Shocks to Match Output (y)

Figure 5 plots the effects of comparative statics with respect to match output in the full model, as well as a model without a secondary asset market. The endogenous variables of interest are the price of securitized loans (Figure 5a), the total monitoring costs (Figure 5b), the labor and credit market tightness (Figure 5c), and the unemployment rate (Figure 5d). The first thing to notice is that lower values of match output generate an increase in the price of securitized loans. This is due to lower asset supply: as the real value of entrepreneurial projects drops, banks provide less credit, and, in turn, there is a lower supply of loans in the secondary market. As a result, and given that asset demand remains constant, the equilibrium price of securitized loans increases (Figure 5a).

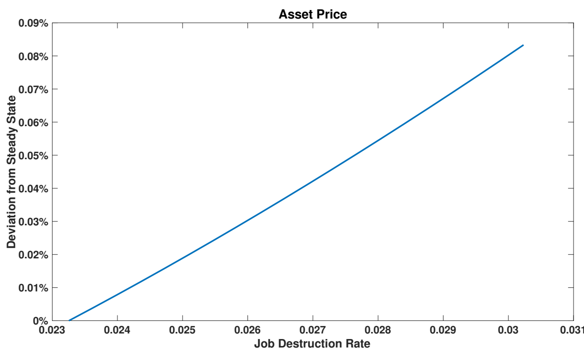
The second relevant channel connecting real and financial variables operates through monitoring costs. Since banks provide less credit, they have less loans to monitor, and monitoring costs decrease. Importantly, this happens only in the model without an OTC market; in the model with a secondary market, monitoring costs barely move (Figure 5b).

With an OTC market, banks can easily adjust their balance sheet as needed and offload as many loans as needed in the secondary market to take advantage of the higher price. Without an OTC market, banks have to keep all loans in their balance sheet and monitoring costs drop sharply.

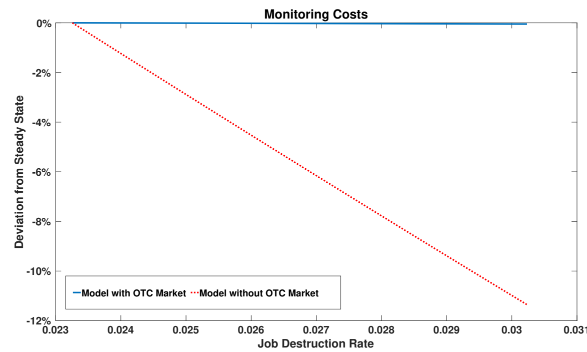
In total, there are two channels that may differentiate the effects of changes to match output in the two models: the rise in P, and the behavior of ξ. The increase in the asset price raises the credit market surplus and makes the drop in credit less severe, as discussed in Section 5.1. This channel implies that the existence of a secondary market should dampen the effects of real shocks (that is, the model with an OTC market should feature lower credit and higher labor market tightness). This is not the case, however, and the reason lies in the behavior of monitoring costs. As explained above, monitoring costs drop sharply in the model without an OTC market. This compensates banks from the drop in match output and implies that the number of banks in equilibrium is relatively larger without an OTC market. Thus, credit market tightness decreases more while labor market tightness decreases less in the model without an OTC market (Figure 5c). As a result, the unemployment rate rises less sharply in the model without an OTC market (Figure 5d).

The same mechanics operate in the case of job destruction shocks (Figure 6): as s_J increases, banks give and securitize less loans, since matches have shorter durations. As before, the price of securitized loans increases because of lower supply (Figure 6a). With an OTC market, banks take advantage of the asset price increase, and their monitoring costs barely change since they can easily rebalance their portfolios by offloading loans in the secondary market. Without an OTC market, banks save on the lower monitoring costs, which leads to a relatively larger measure of banks in equilibrium: ϕ drops relatively more, θ relatively less, and u increases relatively less in the model without an OTC market (Figures 6c and 6d).

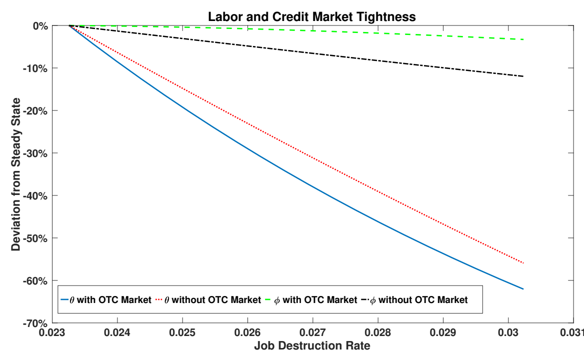
To sum up the lessons of this experiment, the existence of an OTC market creates an asset price channel, which tends to dampen the effects of real shocks, and a monitoring cost channel, which tends to amplify the effects of real shocks. In our calibrated model, the monitoring cost channel is an order of magnitude stronger than the asset price channel and the model with an OTC market features stronger propagation than the model without an OTC market.



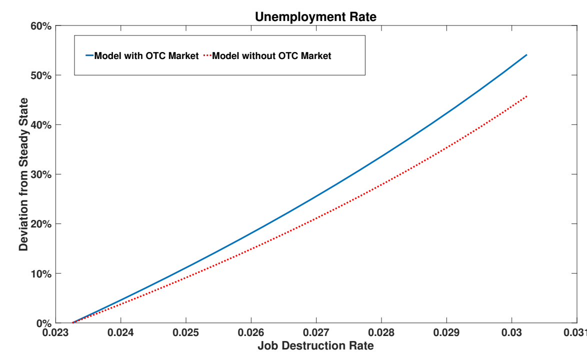
(a) Asset Price Response



(b) Monitoring Cost Response



(c) LM and CM Tightness Response



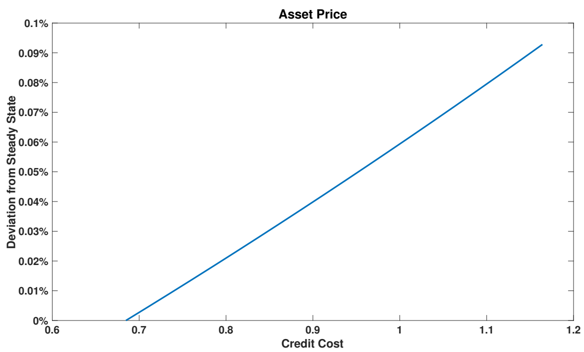
(d) Unemployment Rate Response

Figure 6: The Effects of Shocks on Firm Exit Rate (s_J)

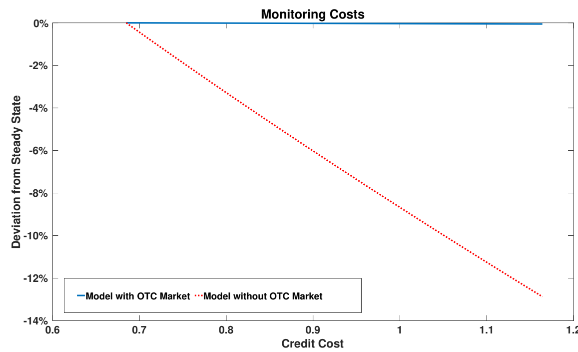
5.3 Credit Shocks

In Figure 7, we present the results for the case of credit shocks. We model an exogenous change in the supply of credit as a shock to κ, the banks' cost for credit market participation. Based on our discussion in Section 4, we think of κ as a measure of the banks' balance sheet or screening costs required to initiate a new credit relationship with an entrepreneur or a firm. Increasing κ makes lending more costly and, as a result, banks give and securitize less loans, leading to an increase in the secondary market price (Figure 7a). In turn, banks have to monitor less loans and monitoring costs decrease in the model without OTC market, in which banks keep all loans in their books (Figure 7b). Again, with OTC markets, monitoring costs are unresponsive because banks utilize the secondary market to take advantage of the higher asset price and costlessly readjust their balance sheet.

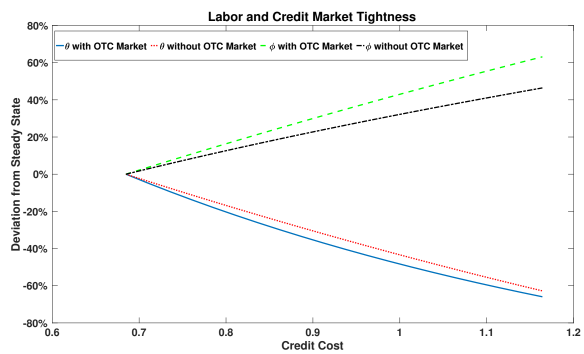
Turning to the real side of the model, Figure 7c illustrates that ϕ increases (since bank entry is strongly affected by higher κ) and θ decreases (since less credit leads to lower vacancy creation). These affects are more pronounced in the model with an OTC market exactly for



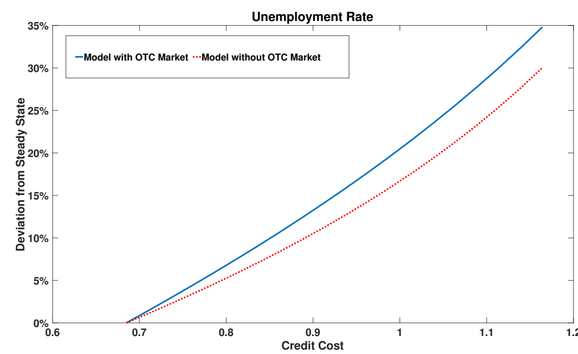
(a) Asset Price Response



(b) Monitoring Cost Response



(c) LM and CM Tightness Response



(d) Unemployment Rate Response

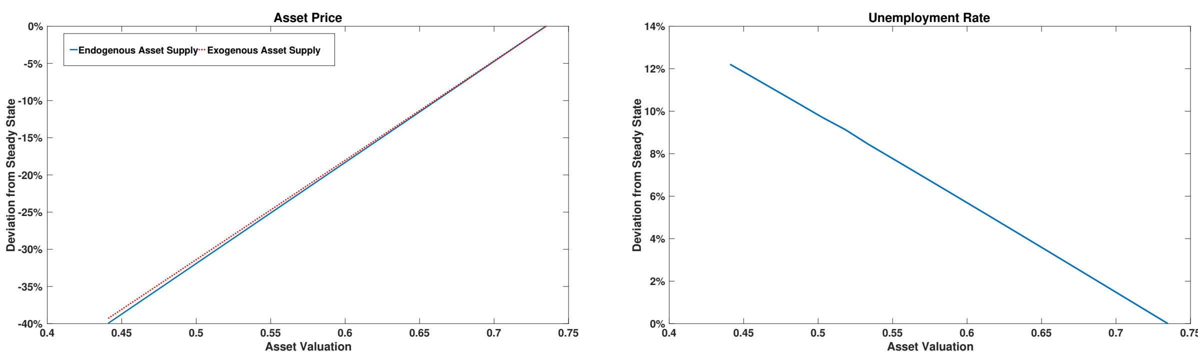
Figure 7: The Effects of Shocks to Credit Availability (κ)

the same reasoning we developed in Section 5.2. Even though the increase in the asset price tends to dampen the effects of credit shocks, the absence of monitoring costs' adjustment in the model with an OTC market amplifies their effects. The monitoring cost channel dominates and leads to stronger shock propagation: the unemployment rate increases more in the model with an OTC market (Figure 7d).

To connect our results with the literature, consider Petrosky-Nadeau (2013) who also studies changes in banks' participation costs. Petrosky-Nadeau (2013) uses steady state changes in κ to simulate a "credit crunch" in a variant of the Wasmer and Weil (2004) model and he shows that this model produces large responses of real variables to credit shocks. The economic lesson of our model is that the existence of secondary markets further increases the sensitivity of real variables to a credit shock. The reason is that OTC markets allow banks to easily adjust their balance sheets and this stimulates the propagation of a credit crunch to the rest of the economy.

5.4 Financial Shocks

In this Section, we study the implications of the model for shocks to the secondary financial market. Since we focus our attention to the economy with an OTC market, the only channel at work is the asset price channel (monitoring costs barely change). Moreover, we consider another variant of the model, this time with an exogenous asset supply (fixed at the level of the calibrated full model). This environment features a frictional OTC market with fixed asset supply in which the only endogenous variable of interest is the asset price, as in Duffie et al. (2005) and Weill (2020). We present results for the behavior of the unemployment rate (which quantifies the role of financial shocks for real variables), as well as the price of securitized loans (which quantifies the role of endogenous supply for asset prices).



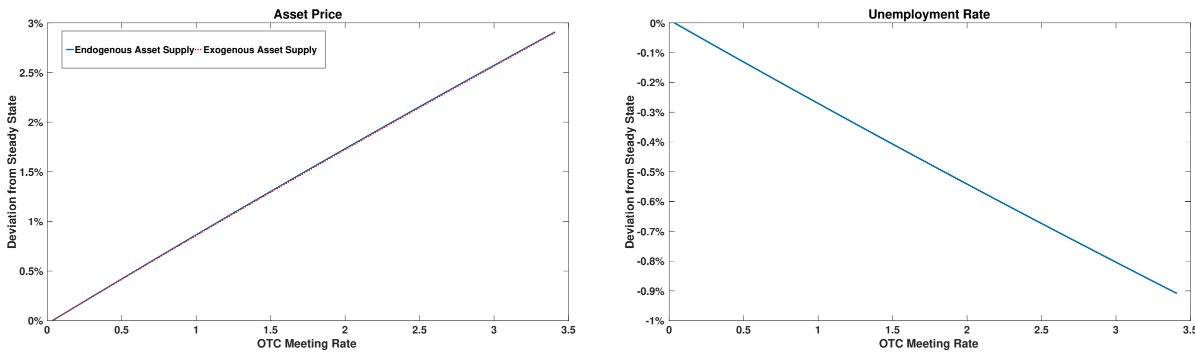
(a) Asset Price Response

(b) Unemployment Rate Response

Figure 8: The Effects of Shocks to Asset Valuations ($\bar{\delta}$)

Figure 8 illustrates the results for changes in $\bar{\delta}$, the highest valuation of OTC investors. By changing $\bar{\delta}$, while holding $G(\delta)$ to uniform and $\underline{\delta}$ to zero, we manipulate the value of securitized loans for investors. We choose the lowest value of $\bar{\delta}$ in the experiment to engineer a 40% drop in the asset price, which was the magnitude observed in the secondary market during the financial crisis of 2009 (Irani and Meisenzahl, 2017). The main result of Figure 8 is that this drop in investors' valuations creates a sizeable increase in the unemployment rate (Figure 8b). A simple back-of-the-envelope calculation can provide some context: during the Great Recession, the US unemployment rate increased from roughly 6% to 10%, a 67 percentage points increase. Our model implies that the drop in the price of securitized loans *alone* can explain almost a fifth of the unemployment rate increase.

Figure 9 illustrates the second result of this Section: shocks to the frequency of OTC meetings have modest effects on the real side of the model. In our experiment, we raise λ by a factor of 100 and this lowers the unemployment rate by less than 1% (Figure 9b). Our finding



(a) Asset Price Response

(b) Unemployment Rate Response

Figure 9: The Effects of Shocks to Trading Frictions (λ)

here is that, in the context of search models of OTC markets, the notion of a "financial shock" is better captured by a change in investors valuations than in the efficiency of meetings.[22] Finally, both Figures 8a and 9a illustrate another result: adding endogenous asset supply from the real economy seems to matter little for asset prices. The price implications of the model with endogenous and exogenous supply are almost identical. Without incorporating default (He and Milbradt, 2014) or risk (Cui and Radde, 2020) considerations, it seems particularly challenging to make endogenous supply have a strong effect on asset prices.

6 Conclusion

We develop a general equilibrium search-theoretic model with a labor, credit, and financial corporate loan market in order to study the macroeconomic impact of imperfections in those markets. In particular, our model follows Wasmer and Weil (2004) and models frictions in the credit and labor markets through the means of a matching function as in the baseline DMP model. Our model departs from the literature in four key ways. First, we model a secondary corporate loan market in the spirit of Duffie et al. (2005). This allows banks to either keep the loan on their books or sell it to dealers on the secondary market. Second, we introduce monitoring costs for banks if they do decide to keep the loan on its books. Third, we introduce financing needs to incumbent firms: at some exogenous rate firms' capital may depreciate. At that point they need to secure financing from a bank, otherwise the match becomes unproductive and the firm and worker separate.

[22] This interpretation is consistent with the work of Lagos et al. (2011) who model a financial crisis as a shock that reduces investors' willingness to hold the asset.

We show analytically that our mode features a similar financial accelerator to that found in Wasmer and Weil (2004) due to the credit and labor frictions in the model. Moreover, the presence of a secondary loan market dampens this accelerator and, at the same time, reduces steady state unemployment. Intuitively, this is the case because the option to sell the loan makes banks weakly better off, which increases the surplus of the match between the bank and the entrepreneur. Monitoring costs work in the opposite direction: they reduce the surplus and, as a result, increase steady state unemployment and amplify the financial accelerator. Lastly, when incumbent firms need to apply for financing this creates a compositional effect: banks will sometimes match with new entrants on the credit market and sometimes they will match with incumbent firms. The compositional effect may either amplify or dampen the accelerator, depending on parameter values. For example, if frictions in the labor market are severe, then the bank finds it more profitable to match with an incumbent. Because of this banks' expected profits are higher than what they would have been had all firms on the credit market been new entrants. This tends to incentivize bank entry and consequently dampen the accelerator and reduce steady state unemployment.

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