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The Macroeconomics of Labor and Credit Market Imperfections

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Credit market imperfections influence the labor market and aggregate economic activity. In turn, macroeconomic factors have an impact on the credit sector. To assess these effects in a tractable general-equilibrium framework, we introduce endogenous search frictions, in the spirit of Peter Diamond (1990), in both credit and labor markets. We demonstrate that credit frictions amplify macroeconomic volatility through a financial accelerator. The magnitude of this general-equilibrium accelerator is proportional to the credit gap, defined as the deviation of actual output from its perfect credit market level. We explore various extensions, notably endogenous wages. (*JEL* J64, G24, E51)

Labor market frictions and wage rigidities are not the only deviation from the Arrow-Debreu paradigm. Modern economies are plagued with a variety of informational imperfections in financial markets. These imperfections, which may stem from moral hazard, adverse selection, and search externalities, are relevant not only for corporate finance—an area in which they have extensively been studied—but also for macroeconomics. This is, of course, the foundation of the credit channel view of the transmission of monetary policy: new businesses, having poor access to credit markets, are the primary victims of monetary contractions.[1]

Beyond monetary issues, the financial sector plays a crucial role in the determination of economic activity. On the one hand, finance contributes, in a Schumpeterian view of growth, to the development of new sectors and products. Note, however, that the causality between finance and macroeconomic activity might run in reverse. For instance, Joan Robinson (1952, p. 86), cited by Ross Levine (1997), suggests that "where enterprise leads, finance follows."[2] On the other hand, financial intermediation generates macroeconomic volatility. In particular, Nobuhiro Kiyotaki and John Moore (1997) and Bernanke et al. (1999) argue that a "financial accelerator" amplifies macroeconomic fluctuations as the value of collateral varies over the cycle.

The objective of this paper is to build a simple macroeconomic model of credit and labor market imperfections which sheds light, in a tractable way, on the interaction between macroeconomic activity and finance, and to demonstrate the existence of a *financial accelerator* based on the general-equilibrium feedback between credit and labor markets. To that effect, we develop a theory of job creation and job destruction in an environment in which new entrepreneurs have no wealth of their own, and

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[1] See, for instance, Ben S. Bernanke and Mark Gertler (1989) and Gertler and Simon Gilchrist (1994).

[2] There have been several attempts to clarify empirically the links between finance and growth. Robert G. King and Levine (1993) examine cross-country evidence on the role of financial intermediaries in capital accumulation. Raghuram G. Rajan and Luigi Zingales (1998) argue that causality goes both ways, but establish that the growth of employment due to the number of establishments is twice as large as the growth due to existing firms. This suggests that financial intermediaries indeed mitigate informational asymmetries, and thus contribute to growth.

must raise funds on *imperfect* credit market before they enter the labor market to search for workers.

To introduce credit market imperfections, we use a modeling strategy that has proved tractable and fruitful in thinking about the macroeconomics of labor markets: search theory. We focus on the credit and labor rationing that arises, when agents are imperfectly aware of economic opportunities, from the stochastic matching between creditors and borrowers, and between workers and entrepreneurs. Thus, we take a leaf from the macro-labor literature, and follow, in the credit market, the lead taken by Christopher A. Pissarides (2000) in the labor market. Accordingly, we model capital market imperfections and labor market imperfections in a perfectly symmetric way, and summarize at an abstract level the properties of the credit and labor matching processes by a pair of matching functions.

The benefit of our symmetric, search-theoretical formalization is that it eschews the microeconomic detail associated, often at the cost of substantial complexity, with macroeconomic models that introduce credit market imperfections through moral hazard and/or adverse selection.[3]

Several pieces of empirical evidence can be adduced for our formalization of credit markets imperfections. David G. Blanchflower and Andrew J. Oswald (1998) report that raising capital constitutes the principal difficulty encountered by potential entrepreneurs. For instance, 20 percent of the respondents of the 1987 U.K. National Survey of the Self-Employed report that *where* to get finance was the biggest obstacle to self-employment.[4] On top of that, 51 percent of the participants in the British Social Attitudes Survey who say they failed to become self-employed report, over the period 1983–1986, that lack of capital or money was the main culprit.[5] Since 40 to 60 percent of jobs are held in small firms (less than 100 employees),[6] a theory of job creation and unemployment must deal with difficulties in *locating* credit. Furthermore, Mitchell A. Petersen and Rajan (2002) document how "information closeness" impinges on the efficiency of credit markets. In addition, the survey of Levine (1997, p. 715) indicates that "the durability of the bank-borrower relationship is valuable." We take this as evidence of match specificity which is most simply modeled as the outcome of a search-matching process. Finally, Giovanni Dell'Ariccia and Pietro Garibaldi (2000) argue that matching models of the capital market are a promising way to rationalize the empirical evidence on gross credit flows.

Our symmetrical model of credit and labor market imperfections is parsimonious, yet rich. It enables us to show, in a framework reminiscent of IS/LM, that financial imperfections increase volatility, in the sense that they magnify the response of the economy to exogenous shocks. This amplification mechanism is not based, as it is in Bernanke et al. (1999) or Kiyotaki and Moore (1997), on fluctuations in the value of collateral, but instead on a general-equilibrium interaction: the state of the credit market affects the state of the labor market, but the state of the labor market itself affects the state of the credit market. We summarize this interaction by providing a simple measure of the financial accelerator, which depends on the *credit gap,* defined as the percent deviation of actual output from the level that would prevail absent credit market imperfections.

Beyond our basic framework, we extend the model to endogenous wages and to endogenous destruction. In the former case, the equilibrium outcome is crucially affected by the institutional arrangement that govern bargaining between financiers, entrepreneurs, and workers—the central organizational problem of capitalism. We establish, for instance, that financiers and bankers have a common incentive to inflate the firm's debt beyond what is strictly necessary in order to decrease the wage that will ultimately be negotiated between entrepreneurs and workers,[7] but that incentive compatibility considerations limit the use of debt as a strategic variable. In the latter extension, we establish that endogenous job destruction generates financial

[3] See, for instance, Joseph E. Stiglitz and Andrew Weiss (1981) for microeconomic foundations, and Carl Shapiro and Stiglitz (1984), or Philippe Aghion et al. (1999), for macroeconomic applications.

[4] Blanchflower and Oswald (1998), Table 8.

[5] Blanchflower and Oswald (1998), Table 6.

[6] These numbers are based on industry and market services. See OECD (1994).

[7] See Stephen G. Bronars and Donald R. Deere (1991) and Enrico C. Perotti and Kathryn E. Spier (1993).

fragility, in the spirit of Wouter J. den Haan et al. (2003).

The paper is organized as follows. Section I introduces the model. Section II presents the model and derives the long-run equilibrium with exogenous wages. Section III highlights the existence of a financial accelerator. Section IV extends the basic model by examining the effects of endogenous wages, and of endogenous destruction. The conclusion summarizes and outlines directions for future research.

I. The Model

In this section, we first describe the three types of agents in our economy. We then characterize optimal behavior during the four stages of the life of a firm.

A. *Entrepreneurs, Workers, and Financiers*

There are three types of agents: entrepreneurs, workers, and financiers. Entrepreneurs have ideas but they cannot work in production, and have no capital of their own. Workers, who have neither entrepreneurial skills nor capital, toil on the production line, and transform the entrepreneurs' ideas into output. Finally, financiers have access to the financial resources required for the concretization of the entrepreneurs' ideas, but have no ideas and cannot work on the production line.[8] In the real world, there is a bit of the entrepreneur, the worker, and the financier in each agent, and people can choose in which activity they want to specialize. In our model, however, this is not the case, and entrepreneurship, working, and financing are assigned, for simplicity, to mutually exclusive and exogenously assigned types of agents.

Entrepreneurs and Workers.—Producing output in a firm requires a team of one entrepreneur and one worker. There are labor market frictions, so that entrepreneurs and workers cannot meet easily. An entrepreneur must search for the worker that will enable him to carry out his idea. We adopt the now standard device of Pissarides (2000), and subsume the process of matching workers to firms (which in principle involves heterogeneity, together with informational difficulties) into a simple constant-returns-to-scale technology $h(\mathcal{U}, \mathcal{V})$ that "produces" a flow of matches between firms and workers with two "inputs:" job vacancies $\mathcal{V}$ posted by firms, and available (i.e., unemployed) workers $\mathcal{U}$.[9] Measuring *labor market tightness* (from the point of view of firms) by the index $\theta = \mathcal{V}/\mathcal{U}$, the instantaneous probability that an entrepreneur will find a worker is thus

$$\frac{h(\mathcal{U}, \mathcal{V})}{\mathcal{V}} = h(\theta^{-1}, 1) \equiv q(\theta).$$

The tighter the labor market, the less probable it is that an entrepreneur meets an available worker ($q'(\theta) < 0$).

Financiers and Entrepreneurs.—Since an entrepreneur must expend resources to search for a worker *before* production even starts, the entrepreneur must be able to finance his recruitment efforts. Traditional models of the labor market, such as Pissarides (2000), focus solely on labor market frictions, and thus assume away credit market frictions. As a result, entrepreneurs have no problem whatsoever financing their search for a worker, whether they finance it on their own, or borrow the cost of posting vacancies on a perfect capital market. But if credit markets are imperfect, an entrepreneur with an idea but without any capital will encounter some impediments when he turns to credit markets to find the funds required to post a vacancy.[10]

We could try, in line with the rest of the

[8] We will hereafter interchangeably refer to financiers or bankers.

[9] We impose, as usual, that marginal products in matching are positive but decreasing: $h_1 > 0$, $h_2 > 0$, $h_{11} < 0$, $h_{22} < 0$. Because of homogeneity, there is no scope for on-the-job search.

[10] This sequencing also captures the well-documented fact that financiers often play a crucial role in the composition of the management team of a firm, and that they thus have an essential role to play in production. Studying the reverse sequencing—labor search, *then* credit search—is interesting only in cases where credit frictions are relatively unimportant (e.g., the start-ups in the Silicon Valley where skilled labor was much scarcer than venture capital). Accordingly, we focus exclusively in this paper on the "credit search, then labor search" model.

literature,[11] to describe in detail the microeconomic nature of these credit market frictions. Instead, we note that credit markets frictions do not differ much from those encountered in labor markets: moral hazard, heterogeneity, and specificity are the hallmark of both credit and labor markets imperfections. As a result, we chose to describe credit market frictions symmetrically to the way we model labor market frictions, and introduce a credit market matching function.[12]

Formally, let $\mathcal{B}$ be the number of bankers looking for entrepreneurs, and denote by $\mathcal{E}$ the number of entrepreneurs looking for financing. Each of these $\mathcal{E}$ entrepreneurs is searching for one the $\mathcal{B}$ available bankers.

The flow of loan contracts successfully signed between financiers and entrepreneurs is determined by the constant-returns-to-scale credit market matching function $m(\mathcal{B}, \mathcal{E})$.[13] From the point of view of firms, *credit market tightness* can be measured by $\phi = \mathcal{E}/\mathcal{B}$. Equivalently, $1/\phi$ is an index (for firms) of the *liquidity* of the credit market.[14]

The instantaneous probability that an entrepreneur/borrower will find a suitable financier is thus

$$\frac{m(\mathcal{B}, \mathcal{E})}{\mathcal{E}} = m(\phi^{-1}, 1) \equiv p(\phi),$$

which is decreasing in credit market tightness ($p'(\phi) < 0$).

[11] See, for instance, Roger Farmer (1985) or Ricardo J. Caballero and Mohamad Hammour (1998).

[12] Dell'Ariccia and Garibaldi (2000) and den Haan et al. (2003) also represent credit market frictions using a matching function, but they do not focus on the labor market. Den Haan et al. (2003) investigate the average distance between borrowers and lenders, and justify credit matching functions by the relevance of geographical considerations in financing decisions. Finally, Petersen and Rajan (2002) argue empirically that the IT revolution and the Internet have substantially affected the geography of financial relationships, a fact which again is consistent with the existence a credit market matching function.

[13] We impose $m_1 > 0$, $m_2 > 0$, $m_{11} < 0$, $m_{22} < 0$.

[14] Our concept of liquidity is the *willingness* of financiers to part from their resources to lend them to firms. It is similar to the notion of liquidity used in stock markets. There are of course other (more aquatic ...) meanings of liquidity studied in the literature—such as the *volume* of funds available for lending. For a leading analysis of liquidity as the availability of financial instruments able to transfer wealth across periods, see Bengt Holmstrom and Jean Tirole (1998).

B. *Four Stages in the Life of a Firm*

The life of a firm can be decomposed into four successive stages of stochastic length: fund raising, recruitment, creation, and destruction.

- *Fund-raising.* In stage 0, prospective entrepreneurs are looking, at a flow search cost c, for a bank willing, in exchange for future repayments, to finance the posting of a job vacancy. In line with the assumption that entrepreneurs have no wealth, the cost c is assumed to be nonpecuniary, e.g., a private sweat cost reflecting the time it takes an entrepreneur to find a financier. At the same time, financiers are searching for clients at a flow search cost k. The probability of a match, and of moving on to the recruitment stage, is $p(\phi)$.
- *Recruitment.* In stage 1, entrepreneurs have found a financier and are looking (at a flow search cost γ borrowed from their financier) for the worker that will enable them to start operating their firm. The probability that an entrepreneur meets a worker, and that the financing stage ends, is $q(\theta)$. The repayment ρ that the entrepreneur will make to the entrepreneur once the firm starts operating is negotiated between the financier and the entrepreneur.
- *Creation.* In stage 2, the firm has found a worker and is generating exogenous flow output y. It uses this output to pay its workers an exogenous wage ω,[15] and to pay back to its financier a flow amount ρ as long as the productive unit operates.
- *Destruction.* In the final stage 3, the match between firm and worker is destroyed. We assume that destruction is exogenous—i.e., that the transition from stage 2 to 3 occurs with a probability s.[16]

Throughout, we assume that their are no commitment problems for financiers, firms, or workers. All agents are risk neutral, with discount rate $r > 0$. Output, as well as wages and

[15] We study in subsection A what happens when the wage is instead negotiated between entrepreneurs and workers.

[16] We introduce endogenous destruction in subsection B.

all search costs, are assumed for simplicity to be constant through time.[17]

The Value of a Bank.—Call B_i, $i = 0, 1, 2, 3$, the value of a bank in the fund-raising, recruitment, creation, and destruction phases. Focusing for the moment on long-run equilibria (we will discuss the short run below), the Bellman equations describing the evolution of the steady-state values of the bank over these four stages are:

$$rB_0 = -k + \phi p(\phi)(B_1 - B_0), \tag{1}$$

$$rB_1 = -\gamma + q(\theta)(B_2 - B_1), \tag{2}$$

$$rB_2 = \rho + s(B_3 - B_2). \tag{3}$$

The financier suffers a cash outflow k in the fund-raising stage while it is looking for a client. It pays out a flow γ in the recruitment stage, while it finances the entrepreneur's posting of a job vacancy. Once the firm is created, the bank enjoys a cash inflow ρ that corresponds to the repayment by the firm of its debt. We assume, for simplicity, that the destruction of the match between firm and worker with probability s entails a loss of the specificity of all matches, so that $B_3 = B_0$.[18]

The Value of an Entrepreneur.—Let E_i, $i = 0, 1, 2, 3$, denote the steady-state value of an entrepreneurial unit in the fund-raising, recruitment, creation, and destruction phases. It evolves as follows:

$$rE_0 = -c + p(\phi)(E_1 - E_0), \tag{4}$$

$$rE_1 = q(\theta)(E_2 - E_1), \tag{5}$$

$$rE_2 = y - \omega - \rho + s(E_3 - E_2). \tag{6}$$

The entrepreneur expends a flow sweat cost c in the first stage, nothing during the recruitment phase (the cost of posting a job vacancy is borne by the financier), and receives a cash flow $y - \omega - \rho$ in the operating stage (output net of wage and financial costs). We again assume that destruction with probability s of the match between firm and worker destroys all specificity, so that $E_3 = E_0$.[19]

C. *Bargaining Between the Financier and the Entrepreneur*

The contract between financier and entrepreneur is negotiated when they meet. The terms of the contract are (i) that the bank will finance the recruitment cost of the entrepreneur (γ per unit of time) for as long as it takes to find a worker, and that, in exchange, (ii) the entrepreneur will repay the financier a constant amount ρ per unit of time as long as the firm operates.[20] Note that we refer to this financial contract as a "loan" although it has equity-like aspects. The return to the financier depends on how quickly the firm finds a worker and on how long the firm will operate.

Financier and entrepreneur share the surplus of their relationship according to a generalized Nash bargaining rule

$$\rho = \arg\max(B_1 - B_0)^{\beta}(E_1 - E_0)^{1-\beta},$$

where $\beta \in (0, 1)$ measures the bargaining power of bankers in the credit relationship.[21] It follows that the stipulated loan repayment ρ must satisfy

$$\beta(E_1 - E_0) = (1 - \beta)(B_1 - B_0). \tag{7}$$

[17] Were output and wages to grow exogenously at a common rate, search costs (which represent the opportunity cost of time) would have to grow at the same rate. It is thus straightforward to extend our model to allow for balanced growth.

[18] An alternative formulation would impose $B_3 = B_1$, so that the value of the bank remains positive after the dissolution of the match between firm and worker. This would substantially complicate the model without affecting its main insights. This is similar to what happens in labor matching models when, in spite of free entry, the value of firms remains positive after the destruction of the match when there is, say, a fixed capital stock.

[19] This assumption is symmetrical to the condition $B_3 = B_0$ we imposed above, and is subject, mutatis mutandis, to the caveat of footnote 18.

[20] An alternative to this loan contract would be a loan schedule that would make repayment to the financier contingent on accumulated debt and on the time it took the entrepreneur to find a worker. This alternative contract would force us to introduce *ex post* heterogeneity between entrepreneurs—which we want to avoid.

[21] In a Rubinstein game of alternating offers and counteroffers, the parameter β reflects the relative impatience of the negotiating parties.

II. Equilibrium

Assume it is costless to set up a bank or a firm in stage 0. Free entry of financiers and entrepreneurs on the credit and labor market then ensures that, in equilibrium:[22]

$$B_0 = 0 \quad \text{and} \quad E_0 = 0. \tag{8}$$

A. *Equilibrium Credit Market Tightness*

From the fund-raising stage value functions (1) and (4), it follows from reading period 0 Bellman equations backwards in time that

$$B_1 = \frac{k}{\phi p(\phi)}, \tag{9}$$

while

$$E_1 = \frac{c}{p(\phi)}. \tag{10}$$

In a less liquid credit market (higher ϕ), the equilibrium value of a (matched) financier is lower, while the value of a (matched) firm is higher—as financiers have to search less and firms more when there are more firms relative to banks.

Since the surplus of the banking relationship is split between financier and entrepreneur according to the sharing rule (7), we immediately have:

PROPOSITION 1: *In equilibrium, the tightness of the credit market is*

$$\phi^* = \frac{1-\beta}{\beta}\frac{k}{c}.$$

PROOF:

Substitute (9) and (10) into (7).

The lower the flow cost k for financiers looking for a suitable lender, and the higher the flow cost c for entrepreneurs searching for a banker, the lower ϕ^* (i.e., the higher the number of available financiers relative to the number of entrepreneurs raising funds). Moreover, the less profitable the sharing of the surplus of the credit relationship is to the bank (low β), the tighter the credit market (higher ϕ^*). Remarkably, ϕ^*, and hence the equilibrium value of the financier and of the entrepreneur, is constant in equilibrium, and depends only on technological (c and k) and institutional (β) features of the credit market. This feature, which is built by design into the model by our assumptions, allows for a convenient recursive solution.

B. *Equilibrium Financial Contract*

Banker and entrepreneur split the expected present discounted value of output, net of wages, that the firm will generate once it starts operating. The stronger the bargaining power of the bank relative to the firm, the larger the equilibrium repayment of the firm to the financier in the production stage:

PROPOSITION 2: *In equilibrium, the repayment flow from entrepreneur to financier is*

$$\rho = \beta(y - \omega) + (1-\beta)(r+s)\gamma/q(\theta).$$

PROOF:

The proof is by forward substitution of the Bellman equations. From equations (9) and (10), the Bellman equations in the recruitment stage, (2) and (5), imply that, in equilibrium,

$$B_1 = \frac{-\gamma + q(\theta)B_2}{r + q(\theta)}, \tag{11}$$

and

$$E_1 = \frac{q(\theta)E_2}{r + q(\theta)}. \tag{12}$$

Similarly, the "exit" equations $B_3 = B_0 = 0$ and $E_3 = E_0 = 0$ imply, from equations (3) and (6), that,

$$B_2 = \frac{\rho}{r+s}, \tag{13}$$

and, from equations (5) and (6), that

[22] These free-entry conditions are very convenient to obtain closed-form solutions. They are not necessarily realistic and may not hold if entry is associated to a fixed cost, or if agents are heterogenous. In either case, the simplicity of the solutions we exhibit here would be lost.

$$E_2 = \frac{y - \omega - \rho}{r + s}. \tag{14}$$

By forward substitution of (13) into (11), and of (14) into (12), we find, using the (equilibrium) Nash bargaining condition $\beta E_1 = (1 - \beta) B_1$, that the value of ρ must be the one given in the proposition.

Once multiplied by the discount factor $q/[(r + q)(r + s)]$, the equilibrium Nash bargaining loan contract described in Proposition 2 can be interpreted as stipulating that the expected present discounted value of repayments from the entrepreneur to the financier is a weighted average of the expected present discounted value of the firm's output net of wages, and of the expected present discounted value of the loan made by the financier to the entrepreneur, with weights given by the respective bargaining power of financier and entrepreneur.

The stronger the bargaining power of the financier in the credit contract negotiation (i.e., the larger β), the larger the share of the expected present discounted value of output net of wages that he can extract from the entrepreneur, and the further away the value of the firm's repayment from the expected present discounted value of what it has borrowed. Finally, note that, since $q'(\theta) < 0$, the entrepreneur on average repays more when labor markets are tight—for it takes on average longer for the firm to find a worker in a tight labor market.

Should we conclude from Proposition 2 that our model predicts that the equilibrium loan contract depends on the state of the labor market θ but not on the tightness of the credit market? No, because, as we shall now see, equilibrium θ itself depends on ϕ^*.

C. *Equilibrium Labor Market Tightness*

In a free-entry equilibrium, the expected search costs that financiers and entrepreneurs incur by entering the credit market must equal the expected benefits that they will eventually derive from forming a financial relationship. Therefore:

PROPOSITION 3: *Equilibrium credit market tightness* $\phi^* = [(1 - \beta)/\beta](k/c)$ *and labor market tightness* θ^* *are the solution to the pair of equations*

$$\frac{k}{\phi p(\phi)} = \beta \frac{q(\theta)}{r + q(\theta)} \left\{\frac{y - \omega}{r + s} - \frac{\gamma}{q(\theta)}\right\}, \tag{15}$$

$$\frac{c}{p(\phi)} = (1 - \beta) \frac{q(\theta)}{r + q(\theta)} \left\{\frac{y - \omega}{r + s} - \frac{\gamma}{q(\theta)}\right\}. \tag{16}$$

PROOF:

Equations (9) and (10) provide us with backward-looking expressions for B_1 and E_1 that depend solely on ϕ: it is these expressions that we read on the left-hand side of equations (15) and (16). Now, forward substitutions of equation (13) into (11), and of equation (14) into (12) give us two alternative formulas B_1 and E_1 that depend on the endogenous parameters ρ and θ. Substituting ρ out of these formulas using Proposition 2, we get alternative expressions for B_1 and E_1 that depend only on θ: we find these expressions on the right-hand side of equations (15) and (16). Equilibrium requires that the backward and forward expressions for B_1 and E_1 coincide—whence Proposition 3.

To understand this proposition, note that the total surplus value of a job vacancy (to both the banker and the entrepreneur) is expected present discounted value of output net of wages and search costs,[23] i.e.,

$$V(\theta) = \frac{q(\theta)}{r + q(\theta)} \left\{\frac{y - \omega}{r + s} - \frac{\gamma}{q(\theta)}\right\}. \tag{17}$$

Using equations (9) and (10), the equilibrium conditions (15) and (16) are just another way of writing $B_1 = \beta V(\theta)$ and $E_1 = (1 - \beta)V(\theta)$ or that, as described, the surplus $V(\theta)$ is split in proportions β and $1 - \beta$ between banker and entrepreneur.

As depicted in Figure 1, equation (15) defines an upward-sloping iso-value ($B_0 = 0$) locus BB in (θ, ϕ) space with a vertical asymptote at $\bar{\theta}$ defined as the unique solution to the equation $V(\theta) = 0$. If the expected cost of entry for a bank is higher because the credit market is looser (i.e., there are many financiers chasing few entrepreneurs), zero profits can only be

[23] See Pissarides (2000).

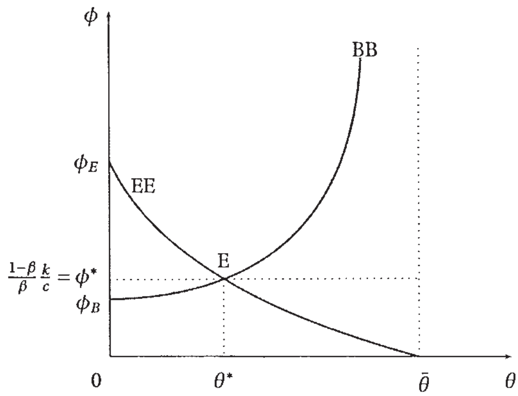

FIGURE 1. EQUILIBRIUM CREDIT AND LABOR TIGHTNESS

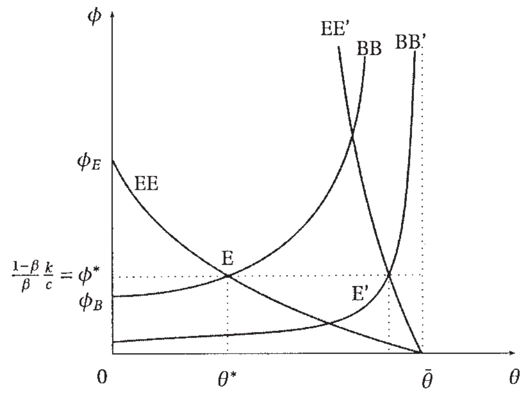

FIGURE 2. MORE EFFICIENT CREDIT MATCHING

maintained by more slack in the labor market (i.e., more vacancies relative to unemployment), which shortens the expected duration of the recruiting stage. Similarly, equation (16) defines a downward-sloping iso-value ($E_0 = 0$) locus EE in (θ, ϕ) space, depicting the trade-off for the entering firm between a tighter credit market (which raises the expected cost of searching for a bank) and a looser labor market (which lowers the expected cost of finding a worker). Consistent with Proposition 2, the BB and EE loci intersect at $\phi^* = [(1 - \beta)/\beta]/[k/c]$. Moreover, Figure 1 shows that existence and uniqueness of equilibrium are easy to guarantee.[24]

As credit markets become more efficient in matching borrowers and lenders [this can be modeled as an increase in the matching probability $p(\phi)$ at all levels of ϕ], the BB curve shifts down and to the right. As a result, θ^* rises, but equilibrium ϕ^* remains unchanged as long as c and k remain unchanged and positive. Figure 2, which illustrates these features, therefore suggests that policies that shift the EE curve to the right are more effective in raising θ^* the stronger credit frictions are. We elaborate on this remark in the next section.

In the limit, as credit matching becomes instantaneous [$p(\phi) = +\infty$ for all ϕ], equilibrium labor market tightness tends to $\bar{\theta}$, so that $V(\bar{\theta}) = 0$. This is nothing but the Pissarides (2000) free-entry condition for firms in the absence of credit frictions. Our framework thus nests the Pissarides equilibrium without credit market frictions. How does θ^* compare with $\bar{\theta}$? The answer is provided by inspection of Figure 1, or more formally by:

COROLLARY 1: *Credit market imperfections lower equilibrium labor market tightness: $\theta^* < \bar{\theta}$.*

PROOF:

From either equation (15) or (16), and using Proposition 1, equilibrium labor market tightness satisfies

$$(18)\quad \gamma/q(\theta^*) = \gamma/q(\bar{\theta}) - \frac{c}{1-\beta}\left[p\left(\frac{1-\beta}{\beta}\frac{k}{c}\right)\right]^{-1} < \gamma/q(\bar{\theta}).$$

Since $q'(\cdot) < 0$, it follows that $\theta^* < \bar{\theta}$.

These results about equilibrium labor market tightness translate directly into statements about equilibrium unemployment and gross output, since unemployment declines and gross output rises when θ rises.[25] The EE/BB curves drawn in Figure 1 are thus reminiscent of IS/LM, although they rest on very different theoretical foundations: on the horizontal axis, gross output rises with θ, while on the vertical axis ϕ is a measure of the tightness of credit markets.

[24] Let ϕ_B be such that $k/[\phi_B p(\phi_B)] = \beta(y - \omega)/(r + s)$, and ϕ_E be such that $c/[p(\phi_E)] = (1 - \beta)(y - \omega)/(r + s)$. Figure 1 shows that a necessary and sufficient condition for existence and uniqueness of equilibrium is $\phi_B < \phi_E$. We assume that this restriction on the parameters of the model is satisfied.

[25] See subsection D for a proof.

One might be tempted at this stage to argue that the result that credit frictions raise equilibrium unemployment relative to the Pissarides model is not surprising, and that all we have done is to prove that credit frictions shift the labor demand curve to the left, resulting in more equilibrium unemployment. But the mechanism at work in our model is much richer and subtler. Credit market frictions reduce the number of financiers. This discourages entry by firms, who find it harder to finance themselves. The reduced number of firms in turn discourages financiers from entering the credit market, as it is more difficult for banks to find an entrepreneur. This discourages entry by firms, which discourages entry by financiers, and so on. Hence, rather than an inward shift in the labor demand curve, what is really at work here is a *financial accelerator* stemming from general-equilibrium effects. As in Bernanke et al. (1999), credit markets frictions "amplify and propagate shocks to the macroeconomy." To be sure, the nature of the amplification mechanism in our double search model is different from the collateral/net worth effects at the heart of Kiyotaki and Moore (1997) or Bernanke et al. (1999). Ours is based on the general-equilibrium interaction between credit and labor markets, while theirs rests on the equilibrium link between current and future credit markets. But both mechanisms point out that a general-equilibrium analysis of the impact of credit frictions, rather than the study of shifts in the labor demand curve, is required to assess the effectiveness of economic policy. We return to this theme in Section III.

D. *A Beveridge Curve Representation*

To characterize the effects of credit market imperfections on job vacancies and unemployment, we can represent equilibrium as the intersection of the Beveridge curve and of the ray representing equilibrium labor market tightness in the $(\mathcal{U}, \mathcal{V})$ plane.

Let u denote the unemployment rate. Normalize the mass of workers to 1, so that $u = \mathcal{U}$. In steady state, flows in and out of the unemployment pool must equilibrate, so that

$$s(1 - u) = \theta q(\theta)u. \tag{19}$$

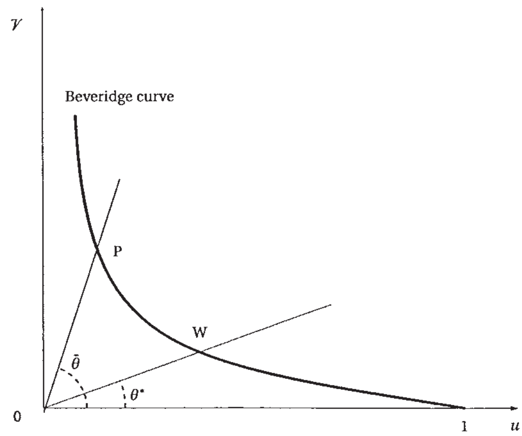

FIGURE 3. BEVERIDGE CURVE

Notes: P = Pissarides equilibrium; W = equilibrium with credit market imperfections.

As a result, u is decreasing in θ, and so is gross output $(1 - u)y$. Since $\theta = \mathcal{V}/u$, the equation of the Beveridge curve is $u = s/[s + (\mathcal{V}/u)q(\mathcal{V}/u)]$, which can be shown, given our assumptions, to be decreasing and convex. Now, we know that in the equilibrium with credit market imperfections $\mathcal{V} = \theta^* u$ while $\mathcal{V} = \bar{\theta} u$ in the Pissarides equilibrium without credit frictions. Equilibrium job vacancies and unemployment with and without credit frictions are thus determined in Figure 3 by the intersections W and P of the Beveridge curve with these two rays from the origin.

III. A Financial Accelerator

We have suggested above that credit market frictions amplify shocks in the economy. We now document in two ways the existence in our model of a financial accelerator. First, we return to the long-run equilibrium described in the previous section and describe, both qualitatively and quantitatively, how this accelerator operates. Second, we establish that macroeconomic volatility is amplified even further in the short run (i.e., before entry by banks takes place) by credit market frictions.

A. *The Long Run*

We first show that the amplitude of the response of shocks to search costs and profits is magnified by the existence of credit market frictions. We will exhibit this long-run financial accelerator graphically, and then quantify its magnitude.

Qualitative Comparative Statics.—Let us look first at the effect on equilibrium of higher search costs for banks, of lower search costs for firms, and of improved firms' net output.

Higher Search Costs for Banks.—What happens if the banks' search cost k rises? Inspection of equations (15) and (16) reveals that the BB curve shifts up and to the left (for any given level θ, a higher k induces exit by financiers and raises ϕ), while the EE curve stays put (firms entry decisions are not directly affected by k). As a result, the credit market tightens and the labor market slackens. The economic mechanism underlying this result is the following: higher search costs make some financiers exit the credit market. This induces some firms to exit, which lowers θ and mitigates the tightening of the credit market—through a move along the EE curve. If we think of higher search costs for banks as being induced by tighter monetary policy or more restrictive credit conditions, these comparative statics are quite similar qualitatively to that associated with contractionary monetary policy in the IS/LM model.

Lower Credit Search Costs for Entrepreneurs.—What happens if the firm's fund-raising cost goes down? Lower credit search cost c for firms induces entry of new entrepreneurs at any given level of credit market tightness: the EE curves shifts out and to the right. The banks' entry decisions are not directly affected by c, so that BB does not move.

In equilibrium, entry of new firms tightens both the credit and labor markets (a move along the BB curve), but the tightening of the credit market is mitigated by the entry of new financiers trying to take advantage of the increase in the number of entrepreneurs looking for credit.

Improvement in the Firm's Profits.—Imagine output net of wages $y - \omega$ increases. This improved profitability directly affects the entry decisions of *both* firms and financiers by raising the size of the surplus that entering banks and firms will eventually split. As a result, for any given credit tightness ϕ, more firms are willing to search when $y - \omega$ is higher, so that the EE curve shifts out and to the right. At the same time, for any given labor market tightness, more financiers are willing to search when $y - \omega$ is high, so that the BB curve shifts down and to the right. Figure 4 depicts the equilibrium: credit market tightness is ultimately unchanged,[26] but the labor market tightens and unemployment declines.

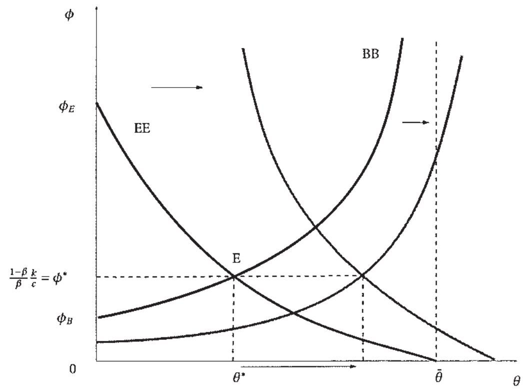

FIGURE 4. INCREASE IN NET OUTPUT $y - \omega$

Examination of Figure 2 shows that the effect of these cost or profit shocks on θ is amplified by credit market frictions as we move away from the Pissarides equilibrium. The magnitude of the financial accelerator thus depends on the strength of credit market frictions.

Measuring the Financial Accelerator.—To get a quantitative feeling for the size of the effects we have been discussing, we now log-linearize the main equations of the model around equilibrium. We proceed under the simplifying assumption that the discount rate r is zero.[27]

Labor Market Tightness.—Call

$$\Pi = (y - \omega)/(r + s) = (y - \omega)/s$$

the expected present discount value of output net of wages at the time the firm meets its worker. Denote by $\hat{x}$ the proportional deviation of a variable x from its equilibrium value x^*, i.e., $\hat{x} = (x - x^*)/x^*$. Call ε and η the elasticities of the credit and labor matching functions at equilibrium:

[26] This is a result of Proposition 1.

[27] The generalization to the case $r > 0$ is uninstructive.

$$\eta \equiv -\frac{q'(\theta^*)\theta^*}{q(\theta^*)}, \qquad \varepsilon \equiv -\frac{p'(\phi^*)\phi^*}{p(\phi^*)}.$$

Under the assumptions we have made on the matching functions, $\varepsilon \in (0, 1)$ and $\eta \in (0, 1)$. Elementary algebraic manipulations of equation (15), using Proposition 1,[28] tell us how equilibrium labor market tightness responds to changes in c, k, γ, and Π when $r = 0$:

$$(20) \quad \hat{\theta} \approx \frac{1}{\eta} \Big\{ (1 + \mu)\hat{\Pi} - \mu[\varepsilon \hat{k} + (1 - \varepsilon)\hat{c}] - \hat{\gamma} \Big\},$$

where

$$(21) \quad \mu = \frac{B_1}{\beta\Pi - B_1} = \frac{q(\theta^*)}{q(\bar{\theta})} - 1 \geq 0$$

is a measure of credit market tightness—i.e., a measure of the departure of equilibrium labor market tension from the Pissarides model. The coefficient μ ranges from 0 when $\theta^* = \bar{\theta}$ (no credit frictions) to $+\infty$ when credit frictions go to infinity and θ^* goes to zero. We conclude that:

- The elasticity of equilibrium labor market tightness with respect to the *present discounted value of net output* is $(1 + \mu)/\eta > 1$. Credit market frictions thus *amplify* by a factor $1 + \mu$ the effect of changes in profits on labor market tightness relative to the Pissarides case ($\mu = 0$). The coefficient μ is thus a measure of the *financial accelerator*.
- The elasticity of θ^* with respect to the *search cost of banks k* is $-\mu\varepsilon/\eta$, while its elasticity with respect to the credit search cost of firms is $-\mu(1 - \varepsilon)/\eta$. Both elasticities are negative: credit frictions slacken the labor market. These elasticities are larger in absolute value the tighter the credit market.
- The elasticity of θ^* with respect to the labor search cost γ is exactly the same, $-1/\eta$, as in the Pissarides model.

Unemployment.—Using equation (19), the unemployment rate and employment rate $e = 1 - u$ respond to changes in θ according to:

$$(22) \quad \hat{u} \approx -(1 - u^*)(1 - \eta)\hat{\theta},$$

$$(23) \quad \hat{e} \approx (1 - e^*)(1 - \eta)\hat{\theta}.$$

As in the Pissarides model, the proportional effect of labor market tightness on the (un)employment rate thus depends on the level of employment—a reflection of the convexity of the Beveridge curve. A similar result of course holds for gross output per head, which is proportional to $1 - u$.

Now note that, for $\bar{\theta}$ close to θ^*, a first-order Taylor expansion of equation (21) around θ^* yields $\mu \approx \eta\hat{\theta}^*$. Combining this approximation with equation (23) hence provides us with a way to quickly gauge empirically the magnitude of the financial accelerator close to the Pissarides equilibrium:

$$(24) \quad \mu \approx \frac{1 - \eta}{\eta} \frac{1}{1 - e^*} \hat{e}.$$

Now $\hat{e}$ is the percentage decline in the equilibrium employment rate (equivalently, in gross output per head) that is due to credit frictions. Call it the *credit gap*. For moderate credit frictions, the financial accelerator is thus proportional to the credit gap. The coefficient of proportionality equals 10, for instance, if the elasticity of the labor matching function is $\eta = 0.5$, and the employment rate is 90 percent. As a result, if the credit gap is 7 percent, the financial accelerator μ equals 70 percent, implying that the financial accelerator amplifies, say, the elasticity of equilibrium labor market tension with respect to profit shocks by 70 percent relative to the Pissarides equilibrium.[29]

Excess Return.—Finally, define the internal rate of return of loans to firms, as the interest rate R that equalizes the expected present discounted value of the loan $\gamma/[R + q(\theta^*)]$ and the expected present discounted repayment on the

[28] Alternatively, we could use both (15) and (16).

[29] Formula (24) relates two obviously endogenous variables, and is only provided for back-of-the-envelope calculations. A proper equilibrium computation is performed in the next subsection.

TABLE 1—EQUILIBRIUM UNEMPLOYMENT

	Credit	
u (percent)	$p_0 = +\infty$	$p_0 = 1$
Labor		
$q_0 = 1.5$	5.6	9.3
$q_0 = 1.1$	9.9	16.0

loan $\{q(\theta^*)/[R + q(\theta^*)]\}\{\rho/(R + s)\}$. Using Proposition 2, we find that

$$R - r = \beta(r + s)\mu. \quad (25)$$

The excess return $R - r$ on business loans is increasing in β (the share of the bank) and in μ (credit market imperfections). Credit market imperfections affect the excess return on commercial paper by increasing the duration of the (costly) first stage, and by increasing the cost of credit (and therefore μ). Furthermore, an increase in the destruction probability s increases R by decreasing the expected length of the repayment period.

Numerical Evaluation.—To get a feel for the equilibrium levels predicted by our model, we adopt the following parameterizations for matching functions:

$$q(\theta) = q_0\theta^{-\eta}$$

$$p(\phi) = p_0\phi^{-\varepsilon},$$

where q_0 and p_0 are (scale) measures of the intensity of the matches in labor and credit markets.

Table 1 reports equilibrium unemployment rates in four different cases that correspond to possible combinations of "high" and "low" credit and labor market frictions.[30] Traditional explanations (based solely on labor market imperfections) must rely on a high degree of mismatch on the labor market, as measured by q_0, to explain high unemployment: they are captured by the southwestern cell of Table 1. The northeastern cell of Table 1 suggests an alternative perspective: high unemployment might result from the combination of moderate labor *and* moderate credit frictions.

This exercise confirms the macroeconomic relevance of intermediation or financial costs, already documented by Pierfederico Asdrubali et al. (1996), and suggests that credit costs are a good way to improve the calibration of the matching model.[31]

Consistent with our earlier back-of-the-envelope computations based on equation (24), the financial accelerator μ equals 0.74, so that the elasticities of tightness to profits Π, search costs c or k, and γ are respectively, using (20), 3.4, -1.74, and -2. The internal rate of return on loans to the firms is 22.4 percent a year, i.e., an excess return of 17.4 percent over the riskless rate $r = 5$ percent. In other terms, the internal rate of return on loans is 17.4 percent higher than it would be absent credit market imperfections—which we view again as an improvement over standard calibrations.

B. *The Short Run: Overshooting*

We have so far only discussed equilibria in which free entry of banks or firms drives down to zero the value of yet inactive financiers or entrepreneurs. In these equilibria, which can be viewed as describing long-run outcomes, financial liberalization, modeled as a policy that lowers the search cost k of banks, always has unambiguous expansionary effects: lower search costs for banks attract more financiers into credit; this attracts more entrepreneurs, which reduces equilibrium unemployment.

What if, by contrast, we lived in a short run in which the total number of banks were fixed and did not respond to improved profit incentives? If the free entry of banks that is at the heart of the expansionary long-run effects of a lower k is blocked, lowering k simply increases the value of existing banks B_0, instead of attracting more

[30] We assume $\beta = 0.5$ and $c = k = 0.35$, so that $\phi^* = 1$. Furthermore, we specify $\gamma = 1.5$, $y = 1$, $s = 0.15$, $r = 0.05$, $\eta = \varepsilon = 0.5$, and $\omega = 0.66$.

[31] See Monika Merz (1995), and Harold L. Cole and Richard Rogerson (1999) for more on calibration issues. For the parameters of the northeastern cell of the table, it takes about one year to find a credit line, and eight months to recruit a worker. Total pecuniary credit costs, excluding the sweat cost for the entrepreneur of finding a financier, represent 7 percent of total discounted output $y/(r + s)$. Equivalently, flow pecuniary costs $\mathcal{B}k$ represent 5.3 percent of annual GDP.

banks. This strengthens the bargaining power of existing banks in their negotiation with firms (as entrepreneurs are now facing a given number of banks that have more favorable outside options). As a result, the equilibrium repayment from firms to banks rises when k falls. This deterioration of the firms' financial condition leads some entrepreneurs to leave the credit market. This in turn must result in *higher* unemployment in the short run.

It is easy to confirm formally that, as a result of financial liberalization, the unemployment rate *overshoots* its long-run value: a lower k first raises, but then eventually lowers equilibrium unemployment.[32] This rationalizes the belief that financial liberalization might generate short-run volatility, and reinforces the message that an understanding of the effects of financial imperfections requires going beyond demand and supply. The mechanism at play is straightforward, and it is at the heart of the economics of imperfect markets: reducing the incumbents' costs when, in the short run, all barriers to entry have not yet been removed, only increases the incumbents' rents. Consequently, financial reform raises short-run unemployment when there are still obstacles to entry in the banking sector.

IV. Extensions

We now demonstrate, by exploring possible extensions and applications, that our basic framework is well-suited to study two macroeconomic questions at the junction of labor and financial economics. What are the effects of financial imperfections on bargained wages and on the incentives of entrepreneurs to recruit suitable workers? What happens when a firm experiences episodes of negative cash flows?

A. *Endogenous Wage*

We have assumed up to now that the wage paid to workers was exogenous. We now examine what happens when, more generally and perhaps more realistically, the wage is negotiated between workers and entrepreneurs.

Endogenous wages gives rise to "ménage à trois" between workers, entrepreneurs, and bankers. How the final output of the firm is split between its three partners, and which institutional arrangements are put in place to organize their conflicting interests, is the central problem of capitalist economies. Our model provides a simple framework in which to think about the macroeconomic impact of various arrangements—a theme often associated with Marxian economics.

We show that the fact that entrepreneurs and bankers meet before entrepreneurs and workers does affect financial and wage bargaining. The parties who bargain first (the financier and the entrepreneur) anticipate in their financial dealings the later arrival of workers in the firm. Debt thus becomes a strategic instrument that financiers and entrepreneurs can use to reduce the wage that workers will eventually negotiate with their employer.[33] However, we argue that incentive compatibility considerations limit, in practice, the use of debt as a strategic variable.[34]

Sequential Bargaining.—There are now two types of contracts in our economy: loan contracts negotiated between financiers and entrepreneurs, and wage contracts bargained between entrepreneurs and workers. Consistent with the necessity for an entrepreneur to find a banker before she can look for a worker, these contracts are negotiated *sequentially.* The loan contract is struck in stage 1, when financier and entrepreneur meet. The wage contract is then negotiated in stage 2 when entrepreneur and worker find each other.

Entrepreneurs and workers take as given the loan contract which was written before they met. Bankers and entrepreneurs know that the result of their financial bargaining will influence the terms of the eventual labor contract.

[32] As long as there is free entry in the entrepreneurial sector, there is of course no such contrast between long-run and short-run effects of decreasing the search cost c of entrepreneurs.

[33] The use of debt as a device to decrease the share of workers has been studied empirically and formalized theoretically by Bronars and Deere (1991) and Perotti and Spier (1993). The existence of this problem is recognized by Caballero and Hammour (1998) but assumed away by the assumption of block bargaining (workers against bankers and entrepreneurs).

[34] Another limit, which we do not explore here because it would take us too far into contract theory, is the possibility that workers might refuse to work in a highly levered firm paying too low wages. This might induce the firm's bankers to accept *ex post* a debt reduction. The anticipation of this renegotiation might constrain *ex ante* the use of debt as a strategic variable.

Wage Bargaining.—We proceed backwards, and start with a description of wage bargaining between entrepreneur and worker, *given* the terms of the financial contract ρ struck earlier between the entrepreneur and his financier.

Let W denote the value for a worker of being employed, U the value of being unemployed, and b unemployment benefits. Then W and U satisfy the following steady-state Bellman equations:

$$rW = \omega + s(U - W), \tag{26}$$

$$rU = b + \theta q(\theta)(W - U), \tag{27}$$

since $\theta q(\theta)$ is the probability that an unemployed worker will get out of the unemployment pool by finding a job. Assume that entrepreneur and worker share the surplus $(E_2 - E_0) + (W - U)$ generated by their relationship according a general Nash bargaining rule.[35] Then

$$\omega = \arg\max(E_2 - E_0)^{1-\alpha}(W - U)^{\alpha},$$

where $\alpha \in (0, 1)$ measures the bargaining power of workers in the labor relationship. This enables us to establish:

PROPOSITION 4: *The wage schedule in any individual firm is given by*

$$\omega = \alpha(y - \rho) + (1 - \alpha)rU.$$

PROOF:

Using the free-entry condition $E_0 = 0$, the first-order condition for optimal surplus sharing is $\alpha E_2 = (1 - \alpha)(W - U)$. Substituting equations (6), (26), and (27) into this first-order condition yields the expression in the proposition.

The larger the firm's output net of repayment to the financier, the larger the wage. The more pleasant the prospect of unemployment looks to the worker (i.e., the larger U), the larger the wage must be. If workers have all the bargaining power ($\alpha = 1$), they extract all the surplus of the relationship by claiming what is left of output once the financier has been repaid ($\omega = y - \rho$). If workers have no bargaining power, they are just paid the annuity value of the utility they would get if they were unemployed ($\omega = rU$).

We will need below the following characterization of the effect of the repayment ρ on the wage contract in the firm:

COROLLARY 2: *A unit increase in repayments to the firm's financier decreases the wage by* α *(i.e.,* $\partial\omega/\partial\rho = -\alpha$*).*

The more the entrepreneur has promised to repay its financier, the smaller the total surplus that remains available to the firm and its worker. Since the workers get all the surplus when they have all the bargaining power ($\alpha = 1$), it is in such a case that an increased repayment to the banker affects them most.

We obtain an alternative characterization of the optimal wage contract by using equations (26) and (27) to compute U in Proposition 4. This yields:

COROLLARY 3: *The optimal wage contract is:*

$$\omega = \alpha_\theta(y - \rho) + (1 - \alpha_\theta)b, \tag{28}$$

where $\alpha_\theta \equiv \alpha[r + s + \theta q(\theta)]/[r + s + \alpha\theta q(\theta)]$.

The weight α_θ increases from α to 1 when θ rises from 0 to ∞: increased labor market tightness improves the workers' outside options, and raises their share α_θ of output net of repayment to the financier. In the limit, when $\theta = +\infty$, the workers' outside option is the same as their current net value, and they capture all the surplus ($\alpha_\theta = 1$).

Loan Bargaining.—Since the loan contract between financier and entrepreneur is written before the entrepreneur meets his worker,

[35] As in the exogenous wage section (see footnote 18), we make the assumption that the relation between banker and entrepreneur is destroyed in case of a separation between entrepreneur and worker. Alternative specifications are possible (e.g., an outside option of E_1 instead of E_0), but they have the unappealing feature that the bank would continue to finance the firm's job search beyond a breakdown of the wage negotiation. It is thus in the interest of the bank to commit *ex ante* to dissolve its relationship with the firm should the latter fail to hire a worker after a match—whence our assumption that the fallback option of the firm is E_0. In any case, both assumptions (E_0 or E_1) lead to similar qualitative results.

banker and entrepreneur take into account the effect of the bargain they strike now on the later negotiation between entrepreneur and worker. While it is still true that $\rho = \arg\max(B_1 - B_0)^{\beta}(E_1 - E_0)^{1-\beta}$, the outcome of bargaining is now given by

PROPOSITION 5: *The financial contract between financier and entrepreneur is*

$$\rho = \beta_\alpha(y - \omega) + (1 - \beta_\alpha)(r + s)\gamma/q(\theta), \tag{29}$$

where $\beta_\alpha \equiv \beta/[1 - \alpha(1 - \beta)] > \beta$.

PROOF:

Using Corollary 2 to track the effect of ρ on the firm's future wage, the first-order condition for optimal sharing of the surplus is, using the exit conditions $B_0 = E_0 = 0$:

$$(1 - \beta_\alpha)B_1 = \beta_\alpha E_1. \tag{30}$$

The expression in the proposition follows immediately, using equations (2), (3), (5), and (6).

The equilibrium Nash-bargaining loan contract is formally similar to the one described by Proposition 5 in the exogenous wage case. However, it is now the higher *effective* bargaining power β_α of the banker that matters for the equilibrium outcome. For instance, when $\alpha = \beta = 0.5$, β_α equals 2/3, which represents a nonnegligible increase in the effective bargaining power of financiers.

Equilibrium.—Since sequential financial and wage bargaining effectively reinforces the hand of the banker in financial negotiations, we should expect the credit market to be *less tight* in the equilibrium with endogenous wages. Indeed, we have:

PROPOSITION 6: *When wages are endogenous, equilibrium credit market tightness is*

$$\phi^*_\alpha = \frac{1 - \beta_\alpha}{\beta_\alpha}\frac{k}{c} < \frac{1 - \beta}{\beta}\frac{k}{c} = \phi^*. \tag{31}$$

PROOF:

By straightforward analogy with the proof of Proposition 1.

Equilibrium credit market tightness is denoted ϕ^*_α to emphasize its dependence, in the endogenous wage case, on the parameter α that governs the sharing of the surplus between entrepreneurs and workers.

For any α, the credit market is less tight when the wage is endogenous than when it is exogenous. A higher α has two effects. First, a size-of-the-cake effect. When workers have more bargaining power, there is less remaining surplus to be shared by bankers and entrepreneurs. However, as in the case of exogenous wages, size-of-the-cake effects, which affect entry margins for financiers and entrepreneurs equally, are irrelevant for the determination of equilibrium credit market tightness. Second, a distributive effect that tilts the allocation of output, net of wages, in favor of bankers to the detriment of entrepreneurs (see Proposition 5). Proposition 6 shows that only the latter effect matters for equilibrium credit market tightness. Indeed, if α were equal to zero, we would have $\beta_\alpha = \beta$ and $\phi^*_\alpha = \phi^*$ as the distributive effect would then disappear.

We now compute the equilibrium labor market tightness θ^*_α:

PROPOSITION 7: *Equilibrium labor market tightness* θ^*_α *and credit market tightness* $\phi^*_\alpha = [(1 - \beta_\alpha)/\beta_\alpha][k/c]$ *are the solution to the pair of equations:*

$$\frac{k}{\phi p(\phi)} = \beta_\alpha(1 - \sigma_\theta)\frac{q(\theta)}{r + q(\theta)} \times \left(\frac{y - b}{r + s} - \frac{\gamma}{q(\theta)}\right),$$

$$\frac{c}{p(\phi)} = (1 - \beta_\alpha)(1 - \sigma_\theta)\frac{q(\theta)}{r + q(\theta)} \times \left(\frac{y - b}{r + s} - \frac{\gamma}{q(\theta)}\right).$$

with $\sigma_\theta \equiv [\alpha_\theta(1 - \beta_\alpha)]/[1 - \alpha_\theta\beta_\alpha]$.

PROOF:

Similar to the proof of Proposition 3.

Using this proposition, equilibrium wage and financial contracts can in turn be computed from Corollary 3 and Proposition 5.

Debt as a Strategic Variable?—We have so far assumed that entrepreneurs borrow exactly γ per unit of time, and repay the corresponding ρ. However, since increasing the value of ρ is a way to decrease the share of workers in the wage bargaining problem, it is in the interest of both bankers and firms to *use debt as a strategic variable to expropriate workers*, and to stipulate a flow loan larger than γ and, accordingly, a repayment larger than the ρ we have computed above. It is therefore natural to wonder whether the cash flow from financier to entrepreneur might rise, beyond γ, up to the point where wages have been reduced to their reservation level b.[36] We now show, by contradiction, that this is ruled out if we introduce incentive compatibility considerations.

Suppose that the debt of the firm is so high that the negotiated wage rate equals its reservation level: $\omega = b$. From Corollary 3, this can only occur, since $\alpha_\theta > \alpha > 0$, if $y - \rho = b$. But then equation (14) implies the value of the firm in stage 2 is zero:

$$E_2 = \frac{y - \omega - \rho}{r + s} = 0,$$

as the wage bargained between firms and workers is indeed reduced to its reservation level b only if the surplus shared in stage 2 is zero. Financier and entrepreneur can achieve this reduction by raising the payment the entrepreneur receives from the financiers above the search cost γ, so that output net of repayment to the financier, $y - \rho$, equals b.

Notice, however, the value of the firm in stage 1 is strictly positive as, by equation (10),

$$E_1 = \frac{c}{p(\phi_\alpha^*)} > 0. \tag{32}$$

We therefore conclude that $E_2 - E_1 < 0$ if the financier and the entrepreneur use debt strategically to bring down the wage to zero: the firm suffers a capital loss when moving from stage 1 to stage 2.

While we have assumed so far full commitment of all agents, we should however not forget that debt usually has disincentive effects that must be taken into consideration as soon as one starts analyzing strategic behavior. In that respect, a situation in which $E_2 - E_1 < 0$ provides no incentive to the entrepreneur to ever actually hire a worker. In other words, if debt is so high that it reduces E_2 to zero, the entrepreneur prefers to remain in stage 1, and to forever pocket the positive difference between what the entrepreneur lends her, call it z, and the labor search cost γ.

To foreclose this temptation, we should impose the incentive compatibility constraint

$$E_2 - E_1 \geq 0.$$

Combining this constraint with the stage 1 Bellman equation[37]

$$rE_1 = z - \gamma + q(\theta)(E_2 - E_1),$$

and using equation (32), we conclude, not surprisingly, that banks ration the credit they extend to firms:

$$z \leq \gamma + rcp(\phi^*).$$

What do we learn from all this? First, that the strategic use of debt by bankers and entrepreneurs to expropriate workers is a real possibility: banks might indeed lend to firms more than what is required to finance a job search. In that respect, it is both remarkable and reassuring that our stylized model of credit and labor market imperfections, once extended to include an endogenous wage, replicates the results of Perotti and Spier (1993) on the strategic use of corporate debt. Second, that the possibility to expropriate workers never reduces them to their reservation wage. We have indeed established this would require so much debt that the firm would lose any incentive to actually hire a worker, start producing, and repay its bank. Finally, that the strategic use of corporate debt, while theoretically plausible, probably does not amount to much in practice, as the difference

[36] This reasoning of course presupposes either that the entrepreneur has consumed right away the resources lent to him by the financier above and beyond what was needed to search for a worker, or, if she has not, that he has protected them to exclude them from the negotiation with the workers.

[37] This Bellman equation is the generalization of equation (5) when the amount z lent by the financiers differs from the labor search cost γ.

$z - \gamma = rcp(\phi^*)$ is very small relative to γ for any sensible values of the parameters.[38]

B. *Endogenous Destruction*

We have assumed until now rather rudimentary production and destruction processes: output y is constant, and destruction occurs exogenously at rate s. Fortunately, our results readily generalize to a richer stochastic environment that yields interesting insights into the endogenous destruction of firms and their financial fragility.

Maintain, for simplicity, the assumption that wages ω are exogenous, but imagine that the output of a firm is governed by the following random process:[39]

- When a firm starts producing in stage 2, its initial output is y^0. All firms start with the same y^0.
- With Poisson arrival rate $\lambda > 0$, the output of a firm then idiosyncratically jumps to another level y, with y drawn randomly from a distribution with cumulative distribution $G(\cdot)$.[40]

Destruction or Refinancing?—If a firm were operating in *all* states of nature until it gets destroyed exogenously at rate s, computing the present discount value of its output, net of wages, would be as simple a matter as it was in Section II. However, the firm does *not* operate, when output is random, in all states of nature: the financier and the entrepreneur optimally agree to dissolve their match, and close down the firm, if, and as soon as, the total surplus of the match between the bank and the firm becomes negative. Thus, there are two sources of destruction of the firm. An exogenous source, at rate s, that represents outside forces impinging on the firm's viability. Plus an endogenous source, which we must still characterize formally, that captures the optimal dissolution of firms in "bad" states of nature.[41]

The novelty introduced by stochastic changes in productivity is that there are now states of nature in which the firm operates in spite of negative output net of wages ($y - \omega < 0$). These are states in which the financier has committed to inject new liquidity in the firm—to help it ride out of a temporary negative cash flow period—because the value of the match between bank and firm is still positive. However, as we shall see below, some of these states with positive total surplus are *financially fragile,* in the sense that the banker would nevertheless like *ex post* to close down the firm, but is restrained by his prior commitment to keep it in operation. We must therefore determine for which values of y the firm is closed down, when it is refinanced, and when it is financially fragile.

Viability Cutoff Rule and Equilibrium.—The value functions of banks and entrepreneurs add up to the total surplus S_i of their relationship in stage i, with $i = 1, 2, 3$. In stage 2 (which is crucial for destruction), the total surplus $S_2(y)$ depends on the state of nature y, and satisfies

$$(33) \quad rS_2(y) = y - \omega + s[S_3 - S_2(y)] + \lambda \int \left\{ \max[S_2(y'), S_3] - S_2(y) \right\} dG(y').$$

The relationship generates total flow profits $y - \omega$. The match is exogenously destroyed with intensity s, generating a capital gain (or loss, if negative) equal to $S_3 - S_2(y)$. In addition, with intensity λ, output reaches a new level y', and the match generates a capital gain which equals $\max[S_2(y'), S_3] - S_2(y)$ since the match is endogenously destroyed in states of nature in which $S_2(y') < S_3$.

Assume, as in Section I, that the termination of the relationship leads to the loss of the specificity of the entrepreneur-banker relationship, so that $B_3 = B_0$ and $E_3 = E_0$. Together with the

[38] With $p_0 = 1$, $\alpha = 0.5$ and for the calibration parameters of footnote 30, $rcp(\phi^*)$ is only equal to 0.8 percent of the search cost γ—a negligible quantity. Assuming, as we have done earlier, that z equals γ, is thus not a drastic oversimplification.

[39] See Dale T. Mortensen and Pissarides (1994).

[40] We can allow output to be negative if we think of y as output *net* of operating costs other than wages or financial costs.

[41] Destruction, whether exogenous or endogenous, is thus always efficient in our scenario.

free-entry conditions $B_0 = E_0 = 0$, this implies that $S_3 = B_3 + E_3 = 0$. As a result, inspection of equation (33) reveals that $S_2(y)$ is linear in y, and can be written as

$$S_2(y) = \frac{y - y^d}{r + s + \lambda},$$

with the cutoff point y^d solving the equation $S_2(y) = 0$ or, from equation (33),

$$(34) \quad y^d = \omega - \lambda \int_{y^d}^{\infty} S_2(y')\, dG(y') < \omega.$$

This defines a *viability rule:* banker and entrepreneur agree to keep the firm in operation for values of y above y^d for which output is sufficient to generate a positive total surplus.[42] In states where $y \in [y^d, \omega)$, the bank injects additional liquidity $\omega - y > 0$ in the firm to keep it alive.[43] As a result, the value of the firm in stage 2, $E_2(y)$, is always positive, since the entrepreneur receives (as long as the firm operates) additional liquidity in bad states of nature, and makes positive flow profits in good states.

In their financial negotiation in stage 1, financiers and entrepreneurs agree on how to share the total surplus of their relationship, given the total surplus $S_2(y^0)$ that their relationship will generate at the very beginning of stage 2. Hence, the equations of the BB and EE curves of the economy with endogenous destruction are the same as in the economy with exogenous destruction [equations (15) and (16)], but with $S_2(y^0)$ replacing the term $(y - \omega)/(r + s)$. The intersection of these modified BB and EE curves determines equilibrium credit market tightness—which remains, as before, equal to $\phi^* = [(1 - \beta)/\beta](k/c)$—and equilibrium labor market tightness θ^*. The latter depends on the initial profitability y^0 of firms, and on the restrictiveness of the viability cutoff rule y^d. The larger y^0 or the smaller y^d, the larger θ^* and the lower equilibrium unemployment.

[42] If $y^0 < y^d$, the economy is not viable *ex ante:* firms do not get the funds required to proceed to the recruiting stage, and no output is ever produced. We henceforth rule out that case.

[43] This feature is already present in Mortensen and Pissarides (1994), but it is irrelevant in their perfect capital market setup.

Financial Fragility.—We now show that a salient feature of the equilibrium with endogenous destruction we have just described is that the financier would like *ex post* to renege on his commitment to refinance the firm in states of nature $y \in [y^d, \omega)$ if y ends up at the bottom of that range.

Consider the stage 2 Bellman equation of the bank in states of nature where $y < \omega$:

$$(35) \quad rB_2(y) = y - \omega + s[B_3 - B_2(y)] + \lambda \int_{-\infty}^{y^d} \{B_3 - B_2(y)\}\, dG(y') + \lambda \int_{y^d}^{\infty} \{B_2(y') - B_2(y)\}\, dG(y').$$

The bank injects $\omega - y$ in the firm. The firm is destroyed with exogenous intensity s. With intensity λ, output changes to a new level y'. If y' is below y^d, the firm is closed down and the bank is left with B_3. Otherwise, it makes a capital gain $B_2(y') - B_2(y)$.

With our assumption that $B_3 = B_0$ and free entry, equation (35) implies that $B_2 < 0$ when $y < \omega$ if, in addition,

$$(36) \quad y < \omega - \lambda \int_{y^d}^{\infty} B_2(y')\, dG(y') \equiv y^B.$$

Now, comparing this expression with equation (34), we conclude that

$$y^B - y^d = \lambda \int_{y^d}^{\infty} [S_2(y') - B_2(y')]\, dG(y') = \lambda \int_{y^d}^{\infty} E_2(y')\, dG(y') > 0.$$

The inequality follows from the remark above that the value of the firm in stage 2, $E_2(y)$, is positive in *all* states of nature, even when $y < \omega$.[44]

This means that some of the states of nature

[44] Note that this result does not depend on the shape of the financial contract.

in which the bank has contracted to refinance the firm because the total surplus is *positive* ($y > y^d$) can also be states in which the value of the bank is *negative* ($y < y^B$). Were it not for its prior commitment not to do so when $y > y^d$, the bank would therefore prefer *ex post* to sever its relationship with the firm when $y < y^B$.[45]

In these states, firms are *financially fragile,* as their survival hangs solely on the strength of the bank's prior commitments (or on its reputation).[46] Any weakening of these commitments would entail the destruction of some, or all, of these financially fragile firms.

V. Conclusion

This paper has built a simple macroeconomic model of credit and labor market imperfections based on matching frictions. Its main feature is the derivation of a *financial accelerator* that results from the general-equilibrium feedback between credit and labor markets.

Our paper leaves open a number of questions, both theoretical and empirical. First, what would happen if liquidity not only meant *willingness* to lend, but also existence of sufficient financial resources to finance economic activity? Second, can we build upon our model to generate a theory of growth and business cycles? Finally, what empirical evidence could be adduced to back up our claim that the combination of moderate credit frictions and moderate labor frictions is enough to explain high unemployment?

Answering the first question would require us to close our model differently (liquidity would need to assume a more traditional meaning of financial "water" flowing in and out of the economy). Doing so, although no simple matter, would enable us to study whether the economy generates enough liquidity in the face of shocks to finance itself without outside intervention,[47] and would generate a mechanism for the propagation and transmission of shocks over time.

Second, endogenous growth could be introduced in our model by assuming that new entrepreneurs, instead of using an existing technology, are the engine of technological innovation. Accordingly, finance would become an essential input into long-run growth.

Finally, the search for additional cross-sectional empirical evidence on credit frictions figures prominently on our research agenda.[48] Most importantly, we would like to understand further the contribution of differences in the fluidity of regional credit markets to the sometimes persistently divergent unemployment experiences of areas that share, within the same country, identical labor market institutions. This might ultimately help to understand why deregulation of labor markets at the margin has not produced in Europe its expected effects on employment.

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[45] To ensure that the bank *initially* signs a contract with the firm, we must thus reinforce our previous condition $y^0 > y^d$ (which ensures a positive surplus) to require that, in addition, $y^0 > y^B$.

[46] For an alternative view of financial fragility, see den Haan et al. (2003).

[47] This is one of the main question asked by Holmstrom and Tirole (1998).

[48] A cross-country extension of the data set compiled for the United States by Dell'Ariccia and Garibaldi (2003) on gross credit flows would help us provide additional corroboration of our results.

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