THE MACROECONOMICS
OF LABOR AND CREDIT MARKET IMPERFECTIONS

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Abstract. Labor market frictions are not the only possible source of high unemployment. Credit market imperfections, driven by microeconomic frictions and influenced by macroeconomic factors, could also be to blame. To develop this idea in a simple and tractable macroeconomic model, we treat credit and labor market imperfections in a symmetrical way. Accordingly, we introduce specificity in credit relationships, and assume that credit to potential entrepreneurs is rationed due to endogenous search frictions, in the spirit of Diamond (1990). These imperfections mirror job search frictions in the labor market. We study the determination of equilibrium unemployment in the presence of credit market frictions both with exogenous and endogenous wages. We explore a number of possible extensions or extensions: endogenous destruction, monetary policy and the short run effects of financial liberalization.

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Contrary to what some of the public and academic debates on the causes of unemployment might lead one to believe, 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. Moral hazard, adverse selection and search externalities in credit markets are relevant not only for corporate finance—an area in which they have extensively been studied— but also for labor economics.[1]

Consider, for instance, how the gradual state-by-state deregulation of the US banking industry from the late 1970s to the late 1990s has affected the labor market in US states during that period.[2] To do so we have constructed, from the state-by-state bank deregulation data set assembled by McAndrews and Strahan (2001),[3] a bank deregulation variable d that, on a scale from 0 to 1, measures cumulative banking deregulation in a particular state in a specific year.[4] Using CPS/BLS state data, we have regressed the unemployment rate u on this deregulation variable.

Table 1 reports several dynamic specifications with two lags of the dependent variable,[5] with or without fixed effects. A striking pattern emerges. First, the long run effect of banking deregulation on unemployment is always negative: a state going from full regulation to full deregulation experienced an absolute fall in its unemployment rate of between 1.5 and 3.4% depending on the chosen specification. Second, the contemporaneous effect of deregulation on unemployment seems to be positive: banking deregulation raises the unemployment rate in the short run. Third, the data suggest that it takes a year for the beneficial effects of deregulation on unemployment to start materializing. Finally, regressions of the dependent variable on the square root of the deregulation variable perform better and yield highly significant coefficients. Since the deregulation variable d is between 0 and 1, this shows that there are decreasing marginal benefits (in terms of

[1]For an excellent survey on the importance for macroeconomics of credit market imperfections, see Easterly, Islam and Stiglitz (1999).

[2]Black and Strahan (2001) have studied, as a test of the theory of discrimination, how banking deregulation has affected during that period wages in the banking sector.

[3]We thank Philip Strahan for providing us with the data. See Black and Strahan (2001) for a detailed description.

[4]More precisely, we have cumulated and averaged out the four banking deregulation variables reported in Table 1 of McAndrews and Strahan (2001): intrastate branching by merger and acquisition, unrestricted intrastate branching permitted, state multi-banking holding companies permitted, and interstate multi-bank holding companies permitted.

[5]Non-dynamic specifications lead to large serial residual correlation, so that we have incorporated a dynamic structure in all our specifications.

TABLE 1. Banking deregulation and unemployment in US states (1978-2000)

	I	II	III	IV	V	VI	VII	VIII
constant	0.50	0.69	0.52	0.75				
	(3.74)	(4.85)	(3.93)	(5.35)				
u_{-1}	0.98	0.97	0.98	0.97	0.87	0.86	0.87	0.86
	(32.2)	(32.0)	(32.2)	(31.9)	(28.3)	(28.3)	(28.4)	(28.2)
u_{-2}	-0.10	-0.09	-0.10	-0.09	-0.18	-0.17	-0.18	-0.17
	(-3.26)	(-3.11)	(-3.18)	(-3.00)	(-6.00)	(-5.76)	(-6.06)	(-5.64)
d	0.27				0.00			
	(1.12)				(0.01)			
d_{-1}	-0.44		-0.20		-0.77		-0.77	
	(-1.94)		(-2.49)		(-3.33)		(-5.81)	
$\sqrt{d}$		0.48				0.40		
		(1.86)				(1.62)		
$\sqrt{d_{-1}}$		-0.84		-0.42		-1.29		-0.97
		(-3.45)		(-4.56)		(-5.48)		(-7.59)
State effects	n	n	n	n	y	y	y	y
R^2	0.93	0.94	0.93	0.93	0.94	0.95	0.94	0.94
DW	2.03	2.02	2.03	2.02	2.07	2.08	2.08	2.08
Long run	-1.51	-2.91	-1.74	-3.41	-2.49	-2.89	-2.49	-3.13

Notes. Dep. variable: unemployment rate u. Indep. variable: deregulation d.
Long run: long run effect of full deregulation ($d = 1$) on unemployment rate.
All regressions were run with time dummies and cross section weights.
V to VIII: least-squares dummy variables model. R^2 and DW: weighted
t-statistics are in parentheses. 1069 observations.

unemployment) to banking deregulation.[6] In appendix A, we report various robustness checks on these results. One should be concerned, in particular, that our panel estimates do not reflect the fact that labor market regulations

[6]Similar results obtain when the four banking deregulation variables of Andrews and Strahan (2001) are used separately. It is difficult to discount these results as a statistical fluke. Indeed, given the sometimes extreme nature of the banking restrictions that used to prevail, and sometimes still prevail in US states, it would be surprising not to find large effects of deregulation on unemployment. Remember that a deregulation variable equal to 0 represents a banking environment in which no interstate, let alone intrastate, branching of any kind whatsoever is allowed by law.

differ, too, across states. If such labor regulations are correlated with the deregulation in the banking sector, our coefficients might overestimate the true impact of deregulation in the banking sector. The appendix shows this is not the case.

Survey evidence on creation of small firms further corroborates the message of Table 1: credit and finance matter for employment. For instance, Blanchflower and Oswald (1998) report that raising capital is the principal difficulty encountered by potential entrepreneurs: 20% of the respondents of the 1987 UK National Survey of the Self-Employed report that *where* to get finance was the biggest difficulty they encountered when becoming self-employed.[7] On top of that, 51% 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 reason of their failure.[8] Since 40 to 60% of jobs are held in small firms (less than 100 employees),[9] a theory of job creation and unemployment must deal with difficulties in locating credit, and thus with credit market imperfections.

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.[10]

Our objective in this paper is thus twofold. We want to think about the theory of unemployment in a environment in which the Modigliani-Miller theorem does not apply. And we want to build a specifically *macroeconomic* model of the interaction between credit and labor markets. To this end, we develop a model of firm creation in which new entrepreneurs are credit constrained, and must raise funds *before* they enter the labor market to search for workers. Taking as our starting point that a competitive representation of the credit market would be as unrealistic as the assumption of perfect spot labor markets, we choose to model capital market imperfections and labor market imperfections in a perfectly symmetrical way.

To achieve this symmetry (and the simplicity it entails), we depart from standard models of credit imperfections. Economists traditionally focus on loan market imperfections that stem from moral hazard and/or adverse selection.[11] This type of imperfection is not the explicit driving force of our model. Instead, we take a leaf from the macro-labor literature, and use an alternative modelling strategy that has proved more tractable and fruitful in

[7] Blanchflower and Oswald (1998), table 8.

[8] Blanchflower and Oswald (1998), table 6.

[9] These numbers are based on industry and market services. See the OECD Job Study (1994).

[10] See, for instance, Gertler and Gilchrist (1994), Bernanke and Gertler (1989).

[11] See, for instance, Stiglitz and Weiss (1981) for microeconomic foundations, and Shapiro-Stiglitz (1984) or Aghion et al. (1999) for macroeconomic applications.

thinking about the macroeconomic aspects of labor markets: search theory. We focus on credit and labor rationing that arise, in a world where agents are imperfectly aware of their economic opportunities, from the stochastic nature of the matching process between creditors and borrowers, workers and entrepreneurs. We thus follow, in the credit market, the lead taken by Pissarides (2000) in the labor market, and summarize at an abstract level the properties of the credit and labor matching processes by a pair of matching functions.

We describe how parameters linked to credit market conditions impact labor market equilibrium. We analyze the determination of equilibrium unemployment both when wages are exogenous and when they are endogenous. In the latter case, the equilibrium outcome is crucially affected by the institutional arrangements that govern bargaining between financiers, entrepreneurs and workers—the central organizational problem of capitalism. We establish, for instance, that if one assumes sequential pairwise bargaining (first between banks and firms, then between firms and workers), 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. This feature brings back to the fore of the macro-labor literature the well-documented use of corporate debt as a bargaining tool.[12]

Beyond our basic model, we discuss a variety of extensions: endogenous destruction, monetary policy, and the short run vs. long run effects of financial liberalization.

The paper is organized as follows. Section 2 introduces the model. Section 3 derives the equilibrium with exogenous wages. Section 4 presents the comparative statics of the model, both qualitative and quantitative. Section 5 analyzes equilibrium with endogenous wages. Section 6 presents extensions to the model. The conclusion summarizes and outlines directions for future research.

1. The model

1.1. **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 toil on the production line, and transform the entrepreneurs' ideas into output. They have no entrepreneurial skills, and no capital. Finally, financiers have access to the financial resources required for the concretization of the

[12]See Bronars and Deere (1991), and Perotti and Spier (1993).

entrepreneurs' ideas, but they have no ideas and cannot work on the production line.[13] In the real world, there is a bit of the entrepreneur, the worker and the financier in each agent. In our model, however, there is not, and entrepreneurship, working and financing are assigned, for simplicity, to mutually exclusive types of agents.

1.1.1. *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 at a flow cost γ 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 $\mathcal{U}$.[14] 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 will meet an available worker ($q'(\theta) < 0$).

1.1.2. *Financiers and entrepreneurs.* Since an entrepreneur must expand resources to search for a worker *before* production even starts, a prerequisite to this search process is that the entrepreneur be able to finance his recruitment efforts. Traditional models of the labor market focus solely on labor market frictions, and thus assume away credit market frictions. In models without credit frictions, such as Pissarides (2000), entrepreneurs have no problem financing their vacancies: they either finance them on their own, or borrow the cost of posting vacancies on a perfect capital market. Which way they do it is of course irrelevant in a Modigliani-Miller world. But if credit markets are imperfect, an entrepreneur with an idea but without any capital must turn to credit markets to find the funds required to post a vacancy. Doing so, however, is difficult in a world with credit frictions. As we shall see, these difficulties have a macroeconomic cost—increased unemployment—in a non Modigliani-Miller world.

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

[14] We impose, as usual, that marginal products in matching are positive but decreasing: $h_1 > 0, h_2 > 0, h_{11} < 0, h_{22} < 0$.

We could try, as the rest of the literature,[15] to describe in detail the microeconomic nature of 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. As a result, we describe the relationship between financiers and entrepreneurs in the same way we describe labor market frictions—i.e., by using a credit market matching function.[16]

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 at a flow cost c for one the $\mathcal{B}$ available bankers. This cost is assumed to be non-pecuniary, e.g., a private sweat cost reflecting the time it takes an entrepreneur to find and convince a financier.

The flow of loan contracts successfully signed between financiers and entrepreneurs is determined by the constant returns to scale credit market matching function $m(\mathcal{B}, \mathcal{E})$.[17] 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.[18]

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 ($p'(\phi) < 0$).

1.2. **Four stages in the life of a firm.** The life of a firm can be thus decomposed into four successive stages of stochastic length: fund raising, recruitment, creation and destruction.

[15]See, most notably, Caballero and Hammour (1998).

[16]Den Haan, Ramey and Watson (1999) and dell'Ariccia and Garibaldi (2000) also represent credit market frictions using a matching function, but they do not focus on the labor market. Den Haan et al. (1999) 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 (2000) 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.

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

[18]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 available to transfer wealth across periods, see Holmström and Tirole (1998).

- *Fund raising.* In stage 0, prospective entrepreneurs are looking (at a flow non-pecuniary search cost c) for a bank willing, in exchange for future repayments, to finance the posting of a job vacancy. 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 to operate 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,[19] 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.[20]

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

1.2.1. *The value of a bank.* Call B_i, $(i = 0, 1, 2, 3)$, the value of a bank in the fund raising, staffing, creation and destruction phases. The Bellman equations describing the evolution of the value of the bank over these four stages are:

$$rB_0 = -k + \phi p(\phi)(B_1 - B_0) + \dot{B}_0, \tag{1.1}$$
$$rB_1 = -\gamma + q(\theta)(B_2 - B_1) + \dot{B}_1, \tag{1.2}$$
$$rB_2 = \rho + s(B_3 - B_2) + \dot{B}_2. \tag{1.3}$$

The financier suffers a cash outflow $-k$ in the fund-raising stage while it is looking for a client. It pays out a flow $-\gamma$ 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 a

[19]We study in section 4 what happens when the wage is instead negotiated between entrepreneurs and workers.

[20]We introduce endogenous destruction in section 5.1.1.

bank after it is matched with a firm entails a total loss of the specificity of the match, so that $B_3 = B_0$.

1.2.2. *The value of an entrepreneur.* Let E_i $(i = 0, 1, 2, 3)$ denote the value of an entrepreneurial unit in the fund raising, staffing, creation and destruction phases. It evolves as follows:

$$rE_0 = -c + p(\phi)(E_1 - E_0) + \dot{E}_0, \tag{1.4}$$

$$rE_1 = q(\theta)(E_2 - E_1) + \dot{E}_1, \tag{1.5}$$

$$rE_2 = y - \omega - \rho + s(E_3 - E_2) + \dot{E}_2. \tag{1.6}$$

The entrepreneur expands a flow sweat cost c in the first stage, nothing during the staffing 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 of the firm after a match with a banker destroys all specificity, so that $E_3 = E_0$.[21]

1.3. **Bargaining between the financier and the entrepreneur.** The contract between a financier and an entrepreneur is written after they meet. The terms of the contract are i) that the bank will finance the recruitment cost of the entrepreneurs (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 for as long as the firm operates.[22] 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. In point of fact, the contract between financier and entrepreneur is close to a venture capital deal.

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.[23] It follows that the stipulated loan repayment ρ must satisfy

$$\beta(E_1 - E_0) = (1 - \beta)(B_1 - B_0). \tag{1.7}$$

[21]The assumptions $B_3 = B_0$ and $E_3 = E_0$ are convenient but not essential.

[22]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.

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

2. Equilibrium

Assume it is costless to setup a bank or a firm. Free entry of financiers and entrepreneurs on the credit and labor market then ensures that, in equilibrium, there are no unexploited profit opportunities:

$$B_0 = 0 \qquad \text{and} \qquad E_0 = 0. \tag{2.1}$$

2.1. Equilibrium credit market tightness.

From the free entry conditions (2.1), which imply that $\dot{B}_0 = \dot{E}_0 = 0$), and from the fund-raising stage value functions (1.1) and (1.4), it follows from reading period 0 Bellman equations backwards in time that:

$$B_1 = \frac{k}{\phi p(\phi)}, \tag{2.2}$$

while

$$E_1 = \frac{c}{p(\phi)}. \tag{2.3}$$

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 shared between financier and entrepreneur according to (1.7), we immediately have:

Proposition 1. *In equilibrium, the tightness of the credit market is*

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

Proof. Substitute (2.2) and (2.3) into (1.7). □

The lower the flow cost for financiers of looking for a suitable lender, and the higher the flow cost for entrepreneurs of 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, the tighter the credit market (higher ϕ^*). Remarkably, ϕ^* and hence the value of the financier and of the entrepreneur are constant in equilibrium and do not depend on θ—which allows for a convenient recursive solution the model.[24]

[24]This recursivity is not general. Section 5.2 below presents an extension that does not preserve recursivity.

2.2. **Equilibrium financial contract.** Banker and entrepreneur share 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 (2.2), (2.3) and proposition 1, observe that free entry of banks and firms imposes the constancy of the value of the bank and of the firm in the fund-raising stage. Therefore, $\dot{B}_1 = \dot{E}_1 = 0$ in equilibrium. But then the Bellman equations in the recruitment stage, (1.2) and (1.5), imply that, in equilibrium,

$$B_1 = \frac{-\gamma + q(\theta)B_2}{r + q(\theta)}, \tag{2.4}$$

and

$$E_1 = \frac{q(\theta)E_2}{r + q(\theta)}. \tag{2.5}$$

Similarly, the "exit" equations $B_3 = B_0 = 0$ and $E_3 = E_0 = 0$ imply that $\dot{B}_2 = \dot{E}_2 = 0$, so that from equations (1.3) and (1.6),

$$B_2 = \frac{\rho}{r + s}, \tag{2.6}$$

and, from equations (1.5) and (1.6),

$$E_2 = \frac{y - \omega - \rho}{r + s}. \tag{2.7}$$

By forward substitution of (2.6) into (2.4), and of (2.7) into (2.5), 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^*.

2.3. **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 derive from eventually striking out 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*

$$\frac{k}{\phi p(\phi)} = \beta \frac{q(\theta)}{r + q(\theta)} \left\{ \frac{y - \omega}{r + s} - \frac{\gamma}{q(\theta)} \right\}, \tag{2.8}$$

$$\frac{c}{p(\phi)} = (1-\beta) \frac{q(\theta)}{r + q(\theta)} \left\{ \frac{y - \omega}{r + s} - \frac{\gamma}{q(\theta)} \right\}. \tag{2.9}$$

Proof. Equations (2.2) and (2.3) provide us with backward-looking expressions for B_1 and E_1 that depend on solely ϕ: it is these expressions that we read on the left-hand side of equations (2.8) and (2.9). Now, forward substitutions of equation (2.6) into (2.4), and of equation (2.7) into (2.5) give us with two alternative formulas B_1 and E_1 that depend on the endogenous parameters ρ and θ. Substituting out 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 (2.8) and (2.9). Equilibrium requires that the backward and forward expressions for B_1 and E_1 coincide—whence proposition 3. □

Equation (2.8) defines an upward sloping iso-value ($B_0 = 0$) locus in (θ, ϕ) space. 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), this must be compensated, to maintain zero profits, by a looser labor market (i.e., many vacancies relative to unemployment) which shortens the expected duration of the recruiting stage. Similarly, equation (2.9) defines a downward sloping iso-value ($E_0 = 0$) locus 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).

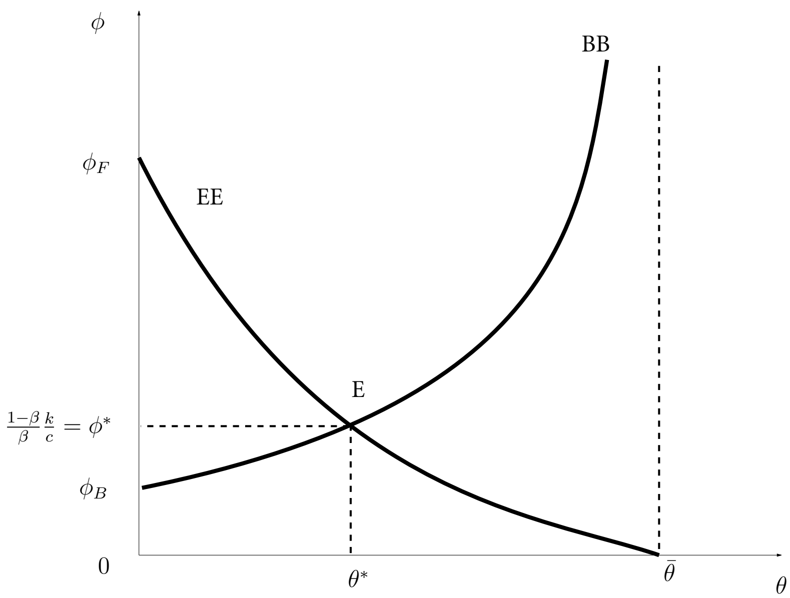

FIGURE 1. Equilibrium with exogenous wage

Equilibrium is depicted graphically in Figure 1.[25] 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.[26]

Our model nests the Pissarides equilibrium. The Pissarides equilibrium without credit market frictions obtains when either $k = 0$, or $c = 0$, or $p(\phi) = +\infty$ for all ϕ. Equilibrium tension in the labor market in the absence of credit frictions is then $\bar{\theta}$, defined, from equation (2.8) or (2.9), by

$$\frac{y-\omega}{r+s} = \frac{\gamma}{q(\bar{\theta})}.$$

In the absence of credit frictions, the value of newly created firm (matched with a banker but not with a worker) is zero—which is indeed the Pissarides free-entry condition for firms when there are no credit search frictions.

[25]Figure 1 is reminiscent of the IS/LM model—although our EE/BB model rests on 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.

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

How does θ^* compare with $\bar{\theta}$? The answer is provided by inspection of Figure 1, or more formally by

Proposition 4. *Credit market imperfections lower equilibrium labor market tightness: $\theta^* < \bar{\theta}$.*

Proof. From either equation (2.8) or (2.9), and using proposition 1, equilibrium labor market tightness satisfies

$$\gamma/q(\theta^*) = \gamma/q(\bar{\theta}) - \frac{c}{1-\beta}[p(\frac{1-\beta}{\beta}\frac{k}{c})]^{-1} < \gamma/q(\bar{\theta}). \tag{2.10}$$

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

Our results about equilibrium labor market tightness translate directly into statements about equilibrium unemployment and gross output, since unemployment rises and gross output declines when θ rises. In particular, credit frictions unambiguously raise equilibrium unemployment relative to the Pissarides model. Accordingly, given labor market frictions and profit conditions, our model predicts the existence of a positive relationship between equilibrium unemployment and credit market frictions.

2.4. **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 (defined below) 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

$$s(1-u) = \theta q(\theta) u. \tag{2.11}$$

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 2 by the intersections W and P of the Beveridge curve with these two rays from the origin.

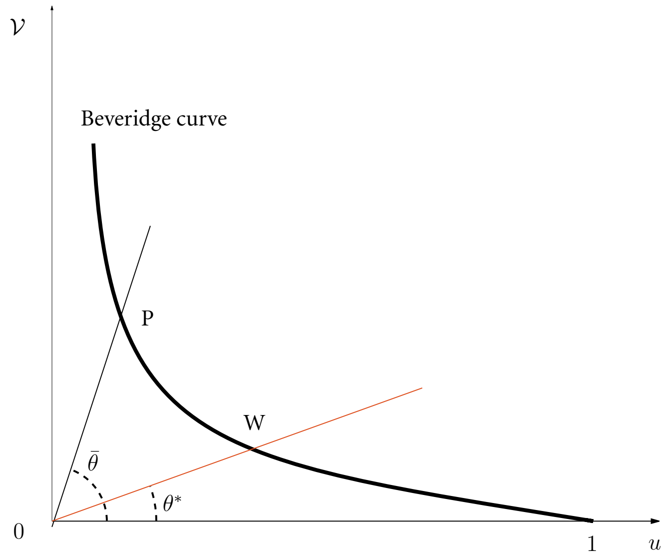

FIGURE 2. Beveridge curve (P: Pissarides equilibrium; W: equilibrium with credit market imperfections)

3. COMPARATIVE STATICS

We now examine how equilibrium credit and labor market tightness react, in our economy, to changes in fundamental parameters. We provide qualitative (graphical) answers, and algebraical measures (based on log-linearization), and numerical measures of the effects at work.

3.1. **Qualitative comparative statics.** Let us look in turn at the effect on equilibrium of higher search costs for banks, of lower search costs for firms, and of improved firms' net output.

3.1.1. *Higher search costs for banks.* What happens if the banks' search cost k rises? Inspection of equations (2.8) and (2.9) 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 curves stays unchanged (firms entry decisions are not directly affected by k). As a result, the credit market tightens and the labor market slackens, as depicted in figure 3. The basic mechanism is simple: higher search costs make some financiers exit the credit market. This induces some firms to exit, which lowers θ and mitigates the tightening of 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

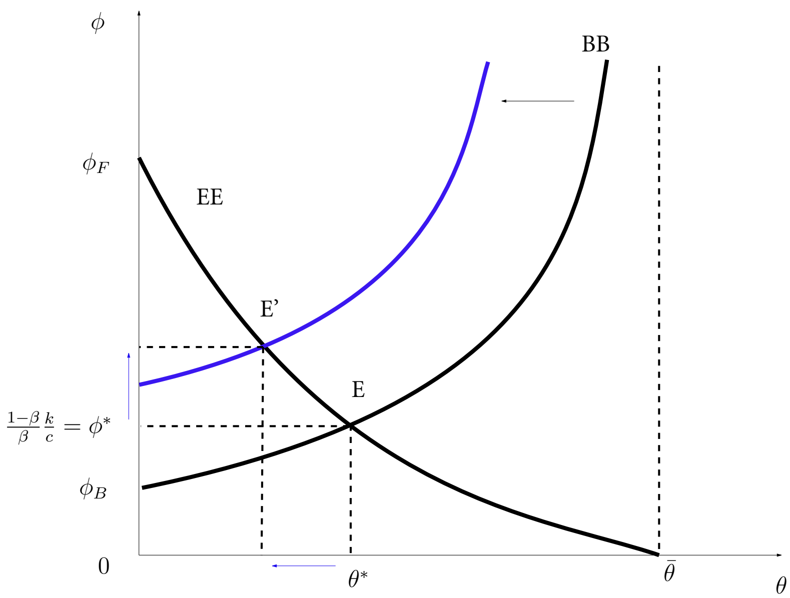

FIGURE 3. Increase in the bank's search cost k

qualitatively to that associated with contractionary monetary policy in the IS/LM model.

3.1.2. *Lower credit search costs for entrepreneurs.* What happens if the firm's fundraising 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. Equilibrium is depicted in figure 4.

3.1.3. *Improvement in the firm's profits.* Imagine output net of wages $y - \omega$ increase. This increased profitability directly affects the entry decisions of *both* firms and financiers by increasing 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 5 depicts

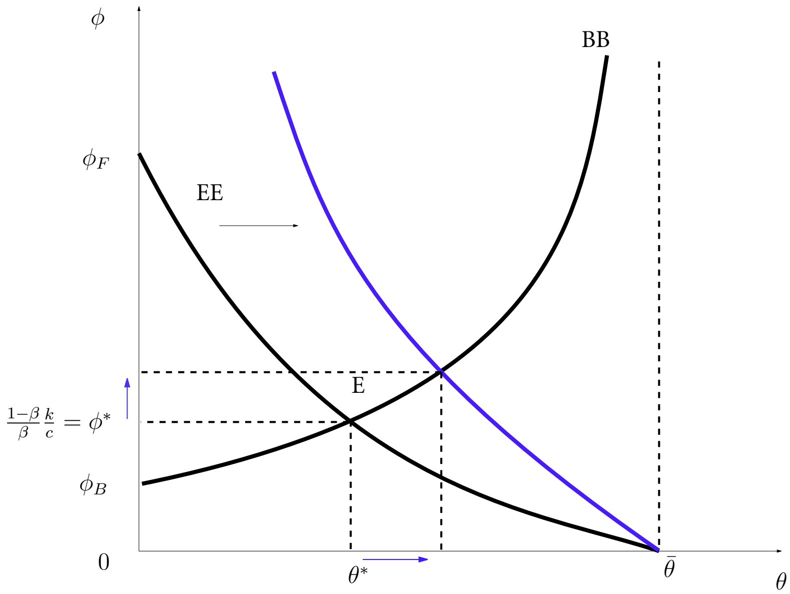

FIGURE 4. Decrease in the firm's search cost c

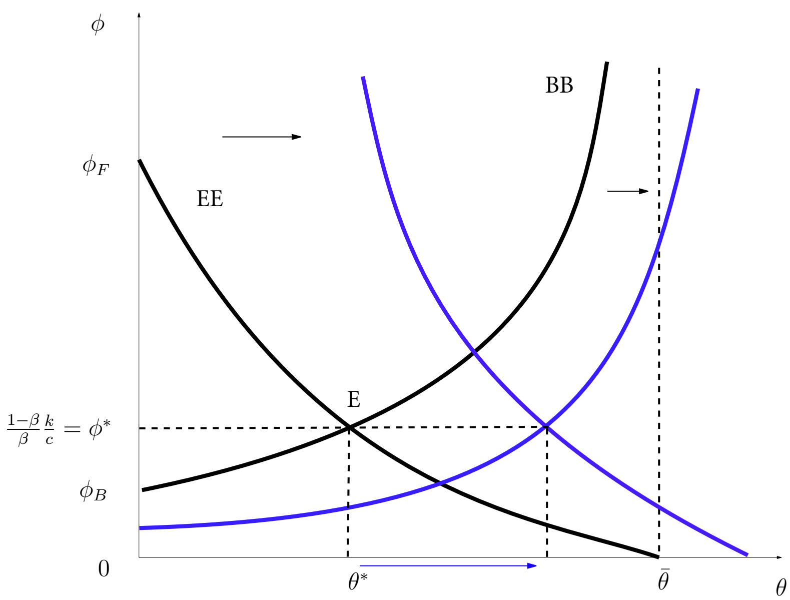

FIGURE 5. Increase in net output $y - \omega$

the equilibrium: credit market tightness is ultimately unchanged[27], but the labor market tightens and unemployment declines.

3.2. **Log-linearization.** The qualitative comparative statics results we have just presented do not tell us much about the quantitative relevance of the labor and credit market frictions. To get a feeling for the size of the effects we have been discussing, we now log-linearize its main equations. We proceed under the simplifying assumption that the discount rate r is zero.[28]

3.2.1. *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 log-differential of a variable x, i.e., $\hat{x} = d\log x$. Call ϵ and η the elasticities of the credit and labor matching functions:

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

Under the assumptions we have made on the matching functions, $\epsilon \in (0,1)$ and $\eta \in (0,1)$. Elementary algebraic manipulations of equation (2.8), using proposition 1,[29] tell us how equilibrium labor market tightness responds to changes in c, k, γ and Π when $r = 0$:

$$\hat{\theta}^* = \frac{1}{\eta}\left\{(1+\mu)\hat{\Pi} - \mu[\epsilon\hat{k} + (1-\epsilon)\hat{c}] - \hat{\gamma}\right\}, \tag{3.1}$$

where

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

is a measure of credit market tightness—i.e., a measure of the departure of equilibrium labor market tension from the Pissarides model. 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 *multiply* by a factor $1+\mu$ the effect of changes in profits on labor market tightness relative to the Pissarides case $(\mu = 0)$.
- The elasticity of θ^* with respect to the *search cost of banks* k is $-\mu\epsilon/\eta$, while its elasticity with respect to the credit search cost of firms is $-\mu(1-\epsilon)/\eta$. Both elasticities are negative: credit frictions slacken the labor market. These elasticities are larger in absolute value the tighter the credit market.

[27]This is a result of proposition 1.

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

[29]Alternatively, we could use both (2.8) and (2.9).

- The elasticity of θ^* with respect to the labor search cost γ is exactly the same, $-1/\eta$, as in the Pissarides model.

3.2.2. *Unemployment.* Using equation (2.11), the equilibrium unemployment rate u^* responds to changes in θ^* according to:

$$\hat{u}^* = -(1-u)(1-\eta)\hat{\theta}^*. \tag{3.2}$$

As in the Pissarides model, the proportional effect of labor market tightness on the unemployment rate depends on the level of employment—a reflection of the convexity of the Beveridge curve.

3.2.3. *Excess return.* Finally, define the internal rate of return of loans to firms, as the interest rate R that equalizes the expected discounted value of the loan $\gamma/[R+q(\theta^*)]$ and the expected discounted repayment on the loan $\{q(\theta^*)/[R+q(\theta^*)]\}\{\rho/(R+s)\}$. Using proposition 2, we find that

$$R - r = \beta(r+s)\mu. \tag{3.3}$$

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.

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

$$\begin{aligned} q(\theta) &= q_0\theta^{-\eta} \\ p(\phi) &= p_0\phi^{-\epsilon}, \end{aligned}$$

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

Table 2 reports equilibrium unemployment rates in four different cases that correspond to all possible combinations of "high" and "low" credit and labor market frictions.[30]

Traditional explanations (based solely on labor market imperfections) 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 first column of our table. In line with the empirical results presented in introduction, the first row of table 2 captures an alternative perspective: high unemployment might result from the combination of g4moderate labor *and* credit frictions.

[30]We assume $\beta = .5$, $\gamma = 1.5$, $y = 1$, $s = .15$, $r = .05$, $c = k = .35$, $\eta = \epsilon = .5$, and $\omega = .66$.

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

TABLE 2. Equilibrium unemployment

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

The multiplier $1 + \mu$ equals 1.74, so that the elasticities of tightness to profits Π, search costs c or k, and γ are respectively, using (3.1), 3.4, -1.74 and -2. The internal rate of return on loans to the firms is 22.4% a year, i.e. an excess return of 17.4% over the riskless rate $r = 5\%$. In other terms, the internal rate of return on loans is 17.4% higher than it would be absent credit market imperfections—which we view again as an improvement over the standard calibrations.

4. Endogenous wage

We have so far assumed 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.

In this paper, we limit ourselves, for the sake of brevity, to an environment in which bankers, entrepreneurs and workers meet and negotiate *pairwise and sequentially*. This gives an incentive to the parties who bargain first (the financier and the entrepreneur) to anticipate in their financial dealings

[31]See Merz (1995) 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% of total discounted output $y/(r + s)$. Equivalently, flow pecuniary costs $\mathcal{B}k$ represent 5.3% of annual GDP.

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.[32]

4.1. **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. We assume that these contracts are negotiated *sequentially*. The loan contract is first 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.

4.1.1. *Wage bargaining.* We 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 Bellman equations:

$$rW = \omega + s(U - W) + \dot{W}, \tag{4.1}$$

$$rU = b + \theta q(\theta)(W - U) + \dot{U}, \tag{4.2}$$

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.[33] Then

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

[32]The use of debt as a device to decrease the share of workers has been studied empirically and formalized theoretically by Bronars and Deers (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). Our assumption of sequential bargaining seems more natural.

[33]The assumption of E_0 as a threat point rather than E_1 is made for simplifying the resolution of the extension to endogenous wages. We could an alternatively assume that the outside option of the firm during bargaining is E_1, which would mean that the relation banker-entrepreneur is preserved in case of a separation. However, in that case, the financier would have to start again paying the recruitment cost γ. Knowing this, he might prefer to credibly commit *ex-ante* to withdraw from the relationship in such a case, which brings us back to our specification. Both assumptions (E_0 or E_1) lead to similar qualitative results, however with fewer terms in the wage equation with our specification.

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

Proposition 5. *The wage schedule in any individual firm is given by*

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

Proof. The first-order condition for an optimal surplus sharing is, using the exit condition $E_2 = 0, \alpha E_2 = (1-\alpha)(W-U)$. Substituting equations (1.6), (4.1), and (4.2) into this first-order condition yields the expression in the proposition. $\square$

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—a crucial effect since it will be taken into account by financier and firm in their negotiation over ρ:

Corollary 1. *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 (4.1) and (4.2) to compute U in proposition 5. This yields:

Corollary 2. *The optimal wage contract is:*

$$\omega = \alpha_\theta(y - \rho) + (1 - \alpha_\theta)b, \tag{4.3}$$

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 ($\alpha_\theta = 1$).

4.1.2. *Loan bargaining.* Since the loan contract between financier and entrepreneur is written before the entrepreneur meets his worker, 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 6. *The financial contract between financier and entrepreneur is*

$$\rho = \beta_\alpha(y - \omega) + (1 - \beta_\alpha)(r + s)\gamma/q(\theta), \tag{4.4}$$

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

Proof. Using corollary 1 to keep track of 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 $B_0 = E_0 = 0$:

$$(1 - \beta_\alpha)B_1 = \beta_\alpha E_1. \tag{4.5}$$

The expression in the proposition follows immediately, using equations (1.2), (1.3), (1.5) and (1.6). □

The equilibrium Nash-bargaining loan contract is formally similar to the one described by proposition 6 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 $\alpha = \beta = .5$, β_α equals $2/3$, which represents a non negligible increase in the effective bargaining power of financiers.

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 7. *When wages are endogenous, equilibrium credit market tightness is*

$$\phi^*_\alpha = \frac{1 - \beta_\alpha}{\beta_\alpha}\frac{k}{c} < \frac{1 - \beta}{\beta}\frac{k}{c} = \phi^*. \tag{4.6}$$

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 6). Proposition 7 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.

4.1.3. *Equilibrium.* We now derive the equilibrium wage ω and equilibrium labor and tightness θ^*_α:

Proposition 8. *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:*

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

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

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

Proof. Similar to the proof of proposition 3. □

4.2. **Incentive compatibility.** 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 ρ. In point of fact, the cash flow from financier to entrepreneur should rise beyond γ up to the point where wages have been reduced to their reservation level b![34] We should however not forget that, in more general settings, debt has disincentive effects on the recruiting efforts of the entrepreneurs. We must check that the introduction of these disincentive effects into our model would not overturn its results.

Imagine therefore, to simplify, that the entrepreneur searches for a worker only if finding a worker does not lower the firm's expected value:

$$\frac{q(\theta)}{r+q(\theta)}E_2 - E_1 \geq 0.$$

[34]This reasoning of course presupposes either that the entrepreneur has consumed right away the resources lent to his 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.

Call z the flow amount lent by the financier to the entrepreneur. The Bellman equation (1.5) for the firm becomes

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

By combining this optimality condition with the incentive compatibility constraint, we establish that

$$z \leq \gamma,$$

i.e., that the financier rations credit to the firm. But the firm wishes to borrow at least γ from the entrepreneurs: $z \geq \gamma$. Therefore, in equilibrium, $z = \gamma$: the incentive compatibility constraint is binding, and the wage remains higher than the reservation level b. In other words, the financial contract (γ, ρ) we have described is the incentive compatible equilibrium under endogenous wages.

5. Extensions and applications

We now demonstrate, by exploring possible extensions and applications, that our basic framework is well-suited, in large part because of its simplicity, to study three macroeconomic questions at the interface between labor and financial economics: endogenous firm destruction, monetary policy, and financial liberalization.

5.1. **Endogenous destruction.**

The deterministic production and destruction processes we have assumed so far are rudimentary: output y is constant, and destruction occurs exogenously at rate s. We now show that our results easily generalize to richer stochastic environments, with interesting insights into the endogenous destruction of firms and 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:

- When a firm start operating, 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 $G(.)$.[35]

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

5.1.1. *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 2. However, the firm does *not* operate, when output is random, in all states of nature: the financier and the entrepreneur optimally 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.[36]

By contrast, there are 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.

5.1.2. *Viability cutoff rule and equilibrium.* The value functions of banks and entrepreneurs in the first two stages of their existence are still given, respectively, by equations (1.1) and (1.2), and equations (1.4) and (1.5). However, the value functions in the third, operating, stage now depend on the realization of y:

$$\begin{aligned} rB_2(y) &= \rho(y) + s[B_3 - B_2(y)] \\ &\quad + \lambda \int \{Max[B_2(y'), B_3] - B_2(y)\} dG(y') + \dot{B}_2(y), \quad (5.1) \\ rE_2(y) &= [y - \omega - \rho(y)] + s[E_3 - E_2(y)] \\ &\quad + \lambda \int \{Max[F_2(y'), F_3] - E_2(y)\} dG(y') + \dot{E}_2. \quad (5.2) \end{aligned}$$

At first, when a firm has just found a worker and starts operating, $y = y^0$, so that the initial values of banks and firms in the production stages are $B_2(y^0)$ and $E_2(y^0)$. As in section 1, we assume that $B_3 = B_0$ and $E_3 = E_0$, namely that the termination of the relationship leads to the loss of the specificity of the entrepreneur-banker relationship. In a long-run equilibrium, $\dot{B}_2 =$

[36] All destructions, whether exogenous or endogenous, are thus efficient in our scenario.

$\dot{E}_2 = 0$, so that the total surplus of the bank-firm match in the operating stage, $S(y) = B_2(y) + E_2(y)$, equals, adding up equations (5.1) and (5.2),

$$S(y) = \frac{(y - \omega) + \lambda \int Max(S(y'), 0) dG(y')}{r + \lambda + s}.$$

Banker and firm agree when they meet to keep the firm in operation only as long as $S(y) \geq 0$. Since the surplus $S(y)$ is linear and increasing in y, this defines a *viability rule*: the firm operates if and only if $y \geq y^d$, where the cutoff output level y^d is the solution of the equation $S(y^d) = 0$. Exploiting the linearity of $S(\cdot)$, we find:

$$y^d = \omega - \frac{\lambda}{r + s + \lambda} \int_{y^d}^{\infty} (y' - y^d) dG(y') < \omega. \tag{5.3}$$

Remarkably, this implies that banker and entrepreneur agree to keep the firm in operation for values of y in the range $[y^d, \omega]$ for which output is not high enough to generate positive output net of wages, yet is sufficient to generate a positive total surplus. In these states, the bank injects additional liquidity $\omega - y > 0$ in the firm to keep it alive (we treat this a negative repayment $\rho(y) = y - \omega$ from the firm to the bank).[37] Of course, if $y^0 < y^d$, the economy is not viable ex ante: firms don't get the funds required to proceed to the recruiting stage, and no output is ever produced. We henceforth rule out that case.

Using definition (5.3) of the cutoff output level y^d, we can rewrite the total surplus of the relationship between bank and firm as:

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

In their financial negotiation, financiers and entrepreneurs share the initial value of this total surplus $S(y^0)$, net of the present discounted value of the cost of posting vacancies $\gamma/q(\theta)$. Consequently, 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 2.8 and 2.9), but with $S(y^0)$ replacing the term $(y - \omega)/(r + s)$.

The intersection of the 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.

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

By mimicking the proof of proposition 4, it is straightforward to prove that equilibrium labor market tightness with credit frictions still falls short of equilibrium labor market tightness without credit frictions.

5.1.3. *Financial fragility.* One of the salient features of the equilibrium with endogenous destruction we have just described is that, while the financier commits ex ante to refinance the firm in states of nature $y \in [y^d, \omega)$ that have negative (but not too negative) cash flows, he would like ex post to renege on his commitment if y ends up at the bottom of that range. To see this, it suffices to note, from equation (5.1), that the bank's value, in states in which it refinances the firm to the tune of $\omega - y$, is

$$B_2(y) = \frac{(y-\omega) + \lambda \int Max(B_2(y'), 0)dG(y')}{r + \lambda + s}.$$

By the same argument used to compute y^d, this implies that the bank's value is positive if and only if y is above a cutoff value y^B given by

$$y^B = \omega - \frac{\lambda}{r+s+\lambda} \int_{y^B}^{\infty} (y' - y^d) dG(y') < \omega. \tag{5.4}$$

Simple calculations establish that $y^d < y^B$,[38] so that some of the states of nature in which the bank contracts ex ante to refinance the firm ($y^d < y < y^B$) turn out ex post to be states in which the bank would like to renege on its promise. We view these states as financially fragile, as they correspond to a situation in which the survival of the firm hangs only on the strength of the bank's prior commitments (or on its reputation). Any weakening of these commitments would entail the destruction of some, or all, of these financially fragile firms.

5.1.4. *New vs. old economy.* This model could help us think about the differences between the "new" and the old economy. Presumably, the old economy is characterized with projects, or ideas, that are profitable right away ($y^0 > \omega$) with little subsequent variability (low λ). By contrast, the salient features of the new economy are negative output net of wages upon creation ($y^0 < \omega$) and considerable uncertainty about future output (high λ)—a scenario which amplifies the role of credit frictions during negative cash-flow episodes. Numerical simulations could be used to explore the different employment and output implications of the two economies.

[38]The easiest proof is by contradiction. Alternatively, one can show that y^B is a weighted average between ϵ^d and ω, with the weight on ϵ^d given by the share of net output paid back by firms to banks.

5.2. **Monetary policy.** To think about the effects on monetary policy on liquidity and unemployment, we return to the basic framework of section 1 with deterministic output and exogenous wage. We adopt the theoretical shortcut of describing monetary policy as affecting, in a way that we do not model, the opportunity cost of banks.

Imagine that the discount rate of banks in the first and second stages of their existence, call it r^B differs from that of the other agents, r.[39] Straightforward computations establish that, in the exogenous wage case, equilibrium credit market tightness satisfies:

$$\phi = \frac{1-\beta}{\beta}\frac{r^B + q(\theta)}{r + q(\theta)}\frac{k}{c}. \tag{5.5}$$

Credit market tightness ϕ now depends on labor market tightness, so that the solution of our model loses its recursivity. But the interpretation of equation (5.5) remains straightforward. If banks face a lower opportunity cost of funds than entrepreneurs ($r^B < r$), then they effectively extract, during the bargaining with firms over ρ, a higher effective share of the total surplus of the financial relationship. This share increases with θ, because entrepreneurs must search for workers longer in a tighter labor market. This longer duration hurts bankers less in relative terms if they discount the future at a lower rate.

A few calculations enable us to write the BB and the EE curves as:

$$\frac{k}{\phi p(\phi)} = \beta \frac{q(\theta)}{r^B + q(\theta)}\left\{\frac{y-\omega}{(r+s)} - \frac{\gamma}{q(\theta)}\right\}, \tag{5.6}$$

$$\frac{c}{p(\phi)} = (1-\beta)\frac{q(\theta)}{r + q(\theta)}\left\{\frac{y-\omega}{(r+s)} - \frac{\gamma}{q(\theta)}\right\}. \tag{5.7}$$

The EE curve, which is the indifference curve of entrepreneurs, is independent of the monetary policy parameter r^B, but the location of BB curve does depends on r^B. Looser monetary policy (a decrease in r^B) shifts the BB curve down and to the right, but leaves EE unchanged. In equilibrium, depicted in Figure 6, this lowers ϕ^* and raises θ^*, slackening the credit market and reducing the unemployment rate. These are typical, almost textbook-like, effects of looser monetary policy.

Two remarks are in order. First, monetary policy has a direct impact on credit market tightness, and credit market tightness is transmitted to the labor market through a change in the creation rate of new firms. Second, monetary policy is more effective (given labor market frictions) in stimulating the economy when credit market frictions are high. This is quite intuitive: decreasing the opportunity cost of credit has more impact when

[39]See appendix B for computations, and for more general case in which the discount rate of banks in stage 3 also differs from r.

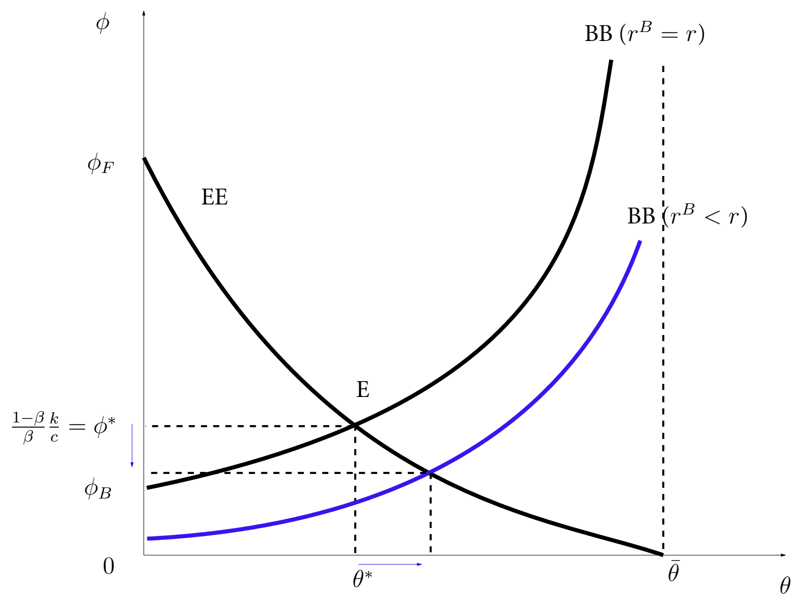

FIGURE 6. Impact of looser monetary policy

the total cost of screening is high. Graphically, the BB curve is flatter, and the EE curve steeper, when the efficiency of credit matching is lower.

5.3. **Financial liberalization: short run vs. long run effects.** 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 such equilibria, which can be viewed as describing long run outcomes, a financial liberalization, which we can capture as a policy that lowers the search cost k of banks, always has, as we saw earlier, unambiguous expansionary effects: lower search costs for banks attract more financiers into credit; this attracts more entrepreneurs, which reduces equilibrium unemployment.

5.3.1. *Unemployment overshooting.* What if, by contrast, we lived in a short run in which the total number of banks were fixed and unresponsive 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 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.

We conclude 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. This rationalizes the widely held suspicion, advanced for instance by Easterly, Islam and Stiglitz (1999), that financial liberalization might well destabilize the economy.[40] The mechanism at play is straightforward, and it is quite general: 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 when there are obstacles to entry raises short run unemployment.

5.3.2. *Formal analysis.* Let N denote the fixed number of banks in the short run. We can think of N as summarizing the state of "credit conditions." Normalize the number of workers to 1, so that $u = \mathcal{U}/1$ denotes both the unemployment rate and the number of unemployed. The total number of banks in stage 0 ($\mathcal{B}$), in stage 1 ($\mathcal{V}$), and in stage 2 (which equals the number of active firms $1-u$) must equal N at every instant:

$$\mathcal{B} + \mathcal{V} + (1-u) = N. \tag{5.8}$$

Neglecting *very* short run dynamics, the short run stock of unemployed workers, firms and banks satisfy following flow balance conditions:

$$s(1-u) = \phi p(\phi)\mathcal{B}, \tag{5.9}$$

$$\phi p(\phi)\mathcal{B} = q(\theta)\mathcal{V}, \tag{5.10}$$

$$s(1-u) = \theta q(\theta)u. \tag{5.11}$$

In a short run equilibrium, the flow of new vacancies created by successful bank/firm matches, $\phi p(\phi)\mathcal{B}$, equals the number of vacancies that get filled in at every instant, $q(\theta)\mathcal{V}$. The flow of banks losing their client because of exogenous separations, $s(1-u)$, equals the flow of banks in the first stage of their life (i.e., of financiers searching for entrepreneurs) that find partner firm, $\phi p(\phi)\mathcal{B}$. Finally, the number of workers losing their job because of exogenous separations, $s(1-u)$, equals the number of workers who find jobs at any instant, $\theta q(\theta)u$.

Substituting the flow balance conditions (5.9), (5.10) and (5.11) into the "credit conditions" equation (5.8), we conclude that short-run credit and

[40]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.

labor market tightness satisfies:

$$\frac{\theta q(\theta)}{s+\theta q(\theta)}\left(1+\frac{s}{\phi p(\phi)}\right)+\theta s=N. \tag{5.12}$$

Given the fixed number of banks N, equation (5.12) expresses mathematically the short run constraint on the number of credit lines that must be satisfied in equilibrium. One can show that equation (5.12) defines an upward sloping locus of points in (θ,ϕ) space, which we call NN.[41] When the labor market is tight (θ high), there are many firms, and consequently many banks, operating in stages 1 and 2. Since the number of banks cannot exceed N, there must accordingly be few banks in stage 0 (ϕ low)—whence the negative slope of the NN locus. As N rises, NN shifts down and to the right (*cf.* figure 7): for given θ, the credit market need not be as tight, nor ϕ as high, if there are more financiers in the economy.

In equilibrium, the value of a "credit line" searching for a firm must be nonnegative:

$$B_0 \geq 0. \tag{5.13}$$

Otherwise, banks would exit the market.[42] This short run equilibrium condition should be contrasted with the long run equilibrium condition $B_0 = 0$. We show in appendix C that short run equilibrium credit market tightness satisfies:

$$\phi=\frac{1-\beta}{\beta}\frac{k+rB_0}{c}\geq\frac{1-\beta}{\beta}\frac{k}{c}. \tag{5.14}$$

The (not yet calculated) incumbency rent B_0 of existing banks strengthens their effective bargaining power against firms, which tightens the credit market relative to what it would be were free on credit markets free (i.e., if B_0 were zero).

Furthermore,[43] the zero-profit condition for entrepreneurs (there is no bank entry, but firms do enter freely) defines a modified EE curve:

$$\frac{c}{p(\phi)}=(1-\beta)\frac{q(\theta)}{r+q(\theta)}\left\{\frac{y-\omega}{r+s}-\frac{\gamma}{q(\theta)}\right\}-(1-\beta)\Delta(\theta)B_0, \tag{5.15}$$

where the function $\Delta(\theta)\equiv 1-\{s/(r+s)\}\{q(\theta)/[r+q(\theta)]\}\geq 0$ captures the effect of restricted bank entry on firms' profits.[44]

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[41]One can also show that curve NN goes through the origin and has a vertical asymptote at $\theta=\theta^a$, where θ^a is the solution of the equation $\theta(s+q(\theta))=N$. Thus, θ^a increases with N.

[42]Although entry of banks is impossible, we assume exit can occur instantaneously.

[43]See appendix C for details.

[44]Restricted entry of banks reinforces their bargaining position by raising their outside option in the financial negotiation. In addition, there is a pure size-of-the-cake effect: when the outside option of the banks rises, the total surplus to be shared goes down, which

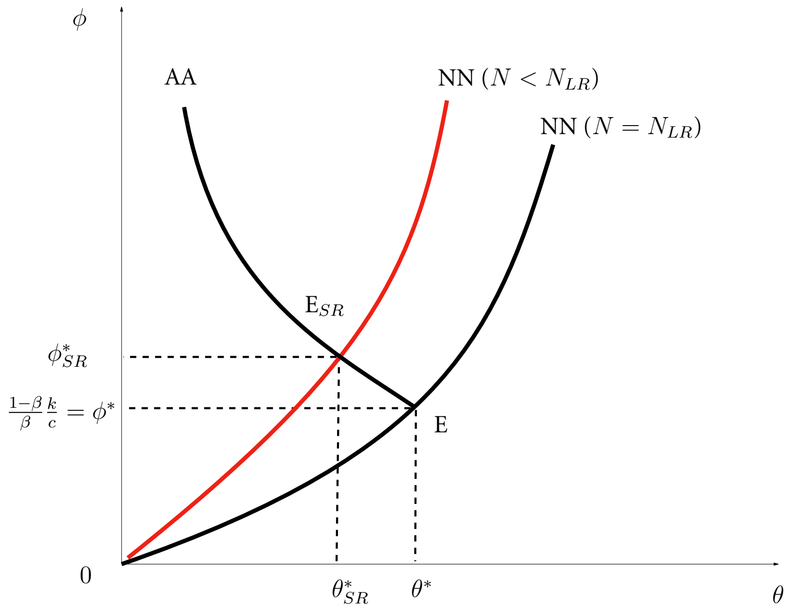

FIGURE 7. Short run and long run equilibria

Eliminating B_0 from equations (5.14) and (5.15), we obtain a second relation between θ and ϕ that subsumes the effects of both financial bargaining and free entry of firms. This latter curve, which we call AA, is downward sloping in (θ, ϕ) space with a vertical asymptote at $\theta = 0$. Each point on the AA curve corresponds to a different value of B_0. The long run equilibrium E=(θ^*, ϕ^*) described earlier in section 2 corresponds to the value $B_0 = 0$ that would prevail were banks entering freely. In the short run, however, the total number of banks is limited at N. Equilibrium is given by the intersection E$_{SR}$ $= (\theta^*_{SR}, \phi^*_{SR})$ of the NN and AA curve, as described in figure 7.

Call N_{LR} the number of banks in the long run (i.e., the number of banks such that the NN curve intersects the AA curve at E). When $N < N_{LR}$, the lack of financiers in the short run amplifies the effect of credit matching frictions by raising equilibrium credit tightness and slackening the labor

reduces the share going to bankers. The latter effect is of course smaller than the former, with the intuitive implication that firms' profit are negatively affected by restricted entry of banks.

market—thus leading to increased unemployment in the short run relative to the long run.[45]

A decrease in the search cost of banks ("financial liberalization") does not affect the position of the NN curve. However, one can show that it shifts the AA curve down and to the left. In the long run, this eventually leads to an increase in the number of banks, with a higher θ^* and lower ϕ^*. In the short-run, with a fixed number of banks, financial liberalization however lowers labor tightness, which confirms our intuition that financial liberalization leads θ to undershoot, and unemployment to overshoot, their long run values.

5.4. **Table 1 revisited.** The data presented in the introduction support the theoretical prediction of unemployment overshooting following banking deregulation. In all specifications of Table 1, the contemporaneous effect of banking deregulation is to increase unemployment. It is only after a year that the negative effect of deregulation unemployment starts to materialize. This negative effect dominates, as predicted by theory, in the long run.

6. Conclusion

This paper has set the foundation of a simple macroeconomic model of credit and labor market imperfections based on matching frictions. This model has enabled us to study many macroeconomic questions at the interface of labor and financial economics.

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, in addition that presented in Tables 1 and 3, 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,[46] and would generate a mechanism for the propagation and transmission of shocks over time.

[45]If, on the other hand, the total number of banks is too high in the short run, i.e., if $N > N_{LR}$, banks instantaneously exit the market to avoid losses ($B_0 < 0$) until the number of remaining banks reaches N_{LR} and the value of a credit line returns to 0.

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

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.[47] Most importantly, we would like to understand further what is 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.

Appendix A. Additional controls, and robustness checks

If the stringencies of labor and banking regulations are positively correlated, the coefficients of Table 1 overestimate the true impact of deregulation in the banking sector. As an additional robustness check, we therefore introduce a new exogenous variable, LABREG, which is defined as the maximum of the minimum wage in each state and of the Federal minimum wage.[48] The counterpart of Table 1 with this additional control is presented in Table 3.

To control for possible regional business cycles correlated with banking deregulation, we reran regressions II and VI of Tables 1 and 3 for nine regional subsamples.[49] The results, which are available upon request, by and large confirm the results of the whole panel. The sign of long-run effects is negative in eight regions, and the short-run effect is positive is six of them. Overall, the coefficients are estimated much less precisely because of the decrease in cross-sectional heterogeneity and the decrease in the sample size. However, they remain significant in all but two regions.

Appendix B. Monetary policy

Denote by r^B the discount rate of banks in the first and second stages of their life. Assume all other agents discount the future at their psychological rate r. The Bellman equations of the banks are:

$$r^B B_0 = -k + \phi p(\phi)(B_1 - B_0) + \dot{B}_0, \tag{B.1}$$

$$r^B B_1 = -\gamma + q(\theta)(B_2 - B_1) + \dot{B}_1, \tag{B.2}$$

$$r B_2 = \rho + s(B_3 - B_2) + \dot{B}_2, \tag{B.3}$$

while those of the firms are still give by equations (1.4), (1.5), and (1.6). Using forward substitutions of the Bellman equations to get expressions for B_1 and E_1, and

[47] A cross country extension of the data set compiled for the US by Dell'Ariccia and Garibaldi (2000) on gross credit flows would help us provide additional corroboration of our results.

[48] These data were kindly provided to us by David Neumark and William L. Wascher, to whom we express our gratitude.

[49] New England, Middle Atlantic, East-North Central, West-North Central, South Atlantic, East-North Central, West-North Central, Moutains, Pacific.

TABLE 3. Banking deregulation and unemployment in US states (1978-2000), controlling for labor market regulation

Specification	I	II	III	IV	V	VI	VII	VIII
Constant	-1.10	-0.96	-1.07	-0.91				
	(-1.79)	(-1.57)	(-1.74)	(-1.49)				
u_{-1}	0.98	0.96	0.97	0.96	0.87	0.86	0.87	0.86
	(32.1)	(31.9)	(32.1)	(31.8)	(28.2)	(28.3)	(28.4)	(28.1)
u_{-2}	-0.10	-0.09	-0.09	-0.09	-0.17	-0.17	-0.18	-0.16
	(-3.22)	(-3.05)	(-3.14)	(-2.93)	(-5.83)	(-5.58)	(-5.88)	(-5.46)
d	0.27				0.01			
	(1.13)				(0.04)			
d_{-1}	-0.47		-0.23		-0.77		-0.76	
	(-2.06)		(-2.82)		(-3.30)		(-5.69)	
$\sqrt{d}$		0.47				0.39		
		(1.82)				(1.59)		
$\sqrt{d_{-1}}$		-0.86		-0.45		-1.27		-0.95
		(-3.53)		(-4.88)		(-5.35)		(-7.41)
LABREG	0.31	0.32	0.31	0.32	0.29	0.26	0.29	0.26
	(2.68)	(2.81)	(2.66)	(2.81)	(2.06)	(1.97)	(2.05)	(1.86)
State effects	n	n	n	n	y	y	y	y
R^2	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.94
DW	2.03	2.02	2.03	2.03	2.08	2.08	2.08	2.08
Long-run	-1.70	-3.08	-1.92	-3.60	-2.47	-2.86	-2.47	-3.11

Notes. Dep. variable: unemployment rate u. Indep. variable: deregulation d.
LABREG: maximum of the state and Federal minimum wages.
Long run: long run effect of full deregulation ($d = 1$) on unemployment rate.
All regressions with time dummies and cross section weights
V to VIII: least-squares dummy variables model. R^2 and DW: weighted
t-statistics in parenthesis. 1069 observations

remembering that the equilibrium surplus $B_1 + E_1$ has to be split in proportions $\beta, 1-\beta$ between bank and firm, we get:

$$\frac{E_1}{B_1} = \frac{1-\beta}{\beta}\frac{r^B + q(\theta)}{r + q(\theta)}.$$

Using the free-entry conditions to compute the backward-looking values of B_1 and E_1, we find that:

$$\phi = \frac{1-\beta}{\beta}\frac{r^B + q(\theta)}{r + q(\theta)}\frac{k}{c},$$

which is equation (5.5) in the text.

If we had assumed that the discount rate of banks in the third phase were r_3^B, then we would have found instead:

$$\phi = \frac{1-\beta}{\beta} \frac{r^B + q(\theta)}{r + q(\theta)} \frac{r_3^B + s}{r+s} \frac{k}{c}.$$

Appendix C. Short run equilibrium

The Bellman equations are the same as in the long-run case (section 1), and so is the free entry condition for entrepreneurs, $E_0 = 0$. However, the free-entry condition for banks, $B_0 = 0$, is replaced by the "credit condition" constraint (5.8).

From the free entry condition for firms, which implies $\dot{F}_0 = 0$, and from the fund-raising stage value functions (1.1) and (1.4), it immediately follows that

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

while

$$E_1 = \frac{c}{p(\phi)}. \tag{C.2}$$

Since the total surplus $(B_1 - B_0) + (E_1 - E_0)$ of the banking relationship is shared between financier and entrepreneur according to (1.7), we immediately get equation (5.14) in the text. By forward substitution of the Bellman equations, we also conclude that the repayment flow from entrepreneur to financier is

$$\rho/(r+s) = \beta \frac{y-\omega}{r+s} + (1-\beta)\left[\frac{\gamma}{q(\theta)} + \frac{r+q(\theta)}{q(\theta)}\Delta(\theta)B_0\right].$$

Substituting this expression into the zero-profit condition for entering entrepreneurs, we get equation (5.15) of the EE curve in the text.

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