Financial and labor market interactions
Specific investments and market liquidity

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Abstract

A double-sided matching process is considered where firms have to search for both financial investors and workers. The value of the match is endogenous as all three actors can proceed on investments specific to the match. Financial investors will screen possible debtors to the quality of their investment project, firms will select their technology and workers will decide upon their effort level. In equilibrium, when wages and debt levels are negotiated, this may lead to multiple equilibria whose characteristics are influenced by various policy variables. Moreover, for highly sclerotic markets, these equilibria may disappear altogether.

Keywords: Market liquidity, matching on financial and labor markets, market interaction, institutional complementarity

JEL-Classification: G24, J64, O14
1 Introduction

European economies have fared relatively well, on average, over the last two decades, despite much talking about "Eurosclerosis" and structural rigidities. While this assessment has to be qualified for some economies, the euro area as a whole had a similar per capita performance as the USA, even over the more wobbling 1990, where common wisdom usually sees the latter far ahead of the former. Nevertheless, GDP per capita increased at 1.7% between 1991 and 2001 in the euro area and has been only slightly higher in the USA with 1.9% (Vijseelaar and Albers, 2002). More importantly, labor productivity per hour worked experienced a stronger increase in Europe (2.0%) than in the USA (1.6%). Similarly, innovative activity of European enterprises have been everything else than disappointing, even though large differences persist across Europe (Bassanini and Ernst, 2002). This barely squares with the common perception of these two regions, giving a bright picture of flexible markets in the USA while painting darker colors for Europe’s rigid and aging economies.

The puzzle becomes even more apparent when concentrating solely on the analysis of imperfections of either labor or financial markets alone. Usually, studies that aim at disentangling the contribution of particular forms of characteristics of these markets across different economies only produce very fragile results, leading some researchers to conclude that more fundamental factors should be retained such as the overall financial development and the legal framework to protect property rights. Nevertheless, while this seems to be an interesting road to take, persistent differences in some performance variables, such as sectoral specialization and structural change or firm demographics and firm size distribution suggest that substantial variation at a more disaggregate level continues to characterize economies, with potentially important macroeconomic effects such as the reaction to supply, demand and policy shocks. These differences, however, cannot be explained by referring to one-dimensional global policy indicators anymore.

Recent contributions in this field, therefore, turned to a more encompassing analysis of the different transmission mechanisms that various policy-induced or institutional market imperfections may have on economic performance. In particular, explicitly considering market interactions where imperfections on two different markets could simultaneously affect macroeconomic performance turned out to be a very fruitful approach (Acemoglu, 2000; Amable and Gatti, 2002; Amable, Ernst, Palombarini, 2002; Wasmer and Weil, 2002). In these models, informational asymmetries, coordination problems and contracting problems are considered to generate economy-wide spillovers beyond the frictions on the market on which they are originating. Even though their own-market effect may still be ambiguous - following results of the earlier research - the spillover onto other markets (the market interaction effect) as well as the combined effect with other characteristics of the macroeconomy (the complementary effect) have the potential to explain structural differences between economies (see Nicoletti et al., 2001, for a recent study).

Against this background, the following paper tries to develop a more general framework through which market interaction and complementary effects can be studied and their impact
on the macroeconomy be analyzed. The aim of the paper is twofold: On the one hand, we are going to demonstrate the potential importance of market interaction for the functioning of the macroeconomy, possibly affecting the characteristics and the number of arising equilibria. On the other hand, in establishing these different equilibria, we are able to show that it may not necessarily be possible to establish a Pareto-ranking between them but that they nevertheless show persistent differences on a more disaggregate level, potentially affecting their reaction to supply, demand and policy shocks.

In the following paper, market interactions arise as a consequence of contractual imperfections on one market that affect outcomes on others. Given that economic activity implies the exchange of goods and services on different markets if not at the same time then at least in a specific order, the individual decision making process will create interrelations between the contractual shortcomings on one market and the decision to engage in economic relations on others. In particular, when firms are financially constraint to seek for outside funding, the extent to which they have access to finance will affect their possibility to put vacancies on the labor market. Moreover, in general equilibrium, labor market developments will feed back into the financial markets, determining the expected returns of financial funds. However, going beyond the current stance of the literature we argue that the effect of market imperfections may be ambiguous due to a particular combination of search and contractual frictions that interact across different markets.

In particular, in the presence of match-specific assets that have to be built up to improve the firm’s performance, quasi-rents generated through the search process allow to remunerate this specific investment. These specific assets may arise for various reasons and may interact with each other, determining the global value of the match. For instance, firms and workers may have to invest in match-related capital such as firm-specific skills, technological effort and innovation that are only valuable inside the relation. Financial investors, on the other hand, may proceed at market screening ex-ante in order to select good entrepreneurs or monitor the firm ex-post monitoring in order to control for good managerial effort. All three types of specific investment may be important to generate high returns to the match and may enter in a complementary way - directly or indirectly - into the firm’s production function. For instance, high levels of innovative effort raises the returns to finance and hence increase incentives for financial investors to enter the market. On the other hand, a decrease of screening effort allows for more bad entrepreneurs to enter the market, increasing the risk of early destruction and consequently reducing innovative and workers’ effort.

For optimal investment in specific assets to occur, the necessary incentives have to be provided through sustained returns to investment. Incentives to invest in specific assets are, however, usually negatively correlated with the outside option of both the investor and the bargaining partner. Consequently, high market liquidity - i.e. low market frictions - may negatively influence the specific investment provided by either firms, workers or financial investors, as the specific match-value decreases. Given the interaction that exists between markets, the reduced incentives for one investment type will spill over to the other market, decreasing overall investment into the firm’s assets, ultimately lowering its productivity. It
seems therefore, that there may exist a trade-off between efficiency gains that can be achieved in very liquid markets - and that usually lead search models to show increasing returns to market liquidity - and specific investment that would allow for a higher firm productivity. Consequently, while more flexible, liquid markets allow for a quick reallocation of resources through increased matching, more rigid markets may provide the necessary incentives for specific investments that are related to the success of existing firms.

The paper relies on an extension of a matching model developed by Wasmer and Weil (2000) as it provides a parsimonious way to analyze labor and financial market imperfections, taking into account informational and search frictions. Conversely to their paper - where search friction arise only exogenously through fixed search and set-up costs - ours is based on an endogenous match value, following the specific investments firms, workers and financial investors are able to make. This increases the complexity of the economic mechanisms, such that only numerical simulations provide an insight in their functioning. Nevertheless, making the match value endogenous yields non-trivial and non-monotonous relations between either credit market or labor market liquidity on the one hand and unemployment and GDP growth on the other.

The paper is organized as follows. In the following section, a review of the literature motivates the incentive structure of this paper’s model which is introduced thereafter in section 2: agents and their decision variables are presented and match values depending on the stage of the firm discussed. In section 3, the outcome of the wage and debt bargaining are derived and the resulting levels of specific investments analyzed. Section 4 derives the reactions of the specific investments to labor and credit market frictions in the partial equilibrium framework. Section 5 discusses the equilibrium schedules describing the general equilibrium and derives conditions for multiplicity of equilibrium; moreover, it presents some numerical results regarding the impact of structural reforms. A final section concludes.

2 Agents and Match Values

2.1 Entrepreneurs, workers and financial investors

Following Wasmer and Weil (2000), three types of agents are considered: entrepreneurs, workers and financiers. Entrepreneurs have ideas but cannot work in production and possess no capital. Worker transform entrepreneurs’ ideas into output but have neither entrepreneurial skills nor capital; financiers (or bankers) have access to the financial resources required to implement production but cannot be entrepreneurs nor workers. A productive firm is thus a relationship between an entrepreneur, a financier and a worker. Each agent may invest in a specific asset, improving his ability and lost when the relationship is dissolved.

Producing output in a firm requires a team of one entrepreneur and one worker. Labor market frictions are present under the form of a matching process à la Pissarides (2000),
with a constant returns matching function $h(U, V)$. Matches between workers and firms depend on job vacancies $V$ and unemployed workers $U$. From the point of view of the firms, labor market tightness is measured by $\theta \equiv V/U$. Labor market liquidity will be $1/\theta$. The instantaneous probability of finding a worker is thus $h(U, V)/V = h(1/\theta, 1) \equiv q(\theta)$, $q'(\theta) < 0$.

An entrepreneur incurs search costs before production starts. These costs must be financed by external funding. Wasmer and Weil (2000) consider credit market frictions modelled in the same way as labor market frictions: a matching function formalizes at the aggregate level the relationship between a banker and a firm. Den Haan, Ramey and Watson (1999) also modelled credit market imperfections with the help of a matching function between borrowers and lenders. In addition to search costs, financial investors can decide to monitor projects closely to increase the realised outcome; in order to do so, they have to invest in a monitoring technology, spending $\eta$.

If $B$ is the number of bankers looking for borrowers and $F$ the number of entrepreneurs looking for financing, the flow of loan contracts successfully signed is given by $m(B, F)$, with $m$ a constant returns functions with positive and decreasing marginal returns to each input. From the point of view of firms, credit market tightness is measured by $\phi \equiv F/B$ and $1/\phi$ is an index of credit market liquidity, i.e. the ease with which entrepreneurs can find financing. The instantaneous probability than an entrepreneur will find a banker is $m(B, F)/F = m(1/\phi, 1) \equiv p(\phi)$. This probability is increasing in credit market liquidity, i.e. decreasing in credit market tightness. The probability that a banker will find a borrower is $m(B, F)/B = m(1, \phi) = \phi \cdot p(\phi)$. This probability is increasing in credit market tightness, thus decreasing in credit market liquidity.

Workers, firms and banks have the possibility to choose the level of match-specific investment they want to expose. In particular, we assume that workers choose the effort level, $e \in \{0, 1\}$, firms the technology, $\alpha \in \mathbb{R}^+$, and banks the level of firm monitoring, $\eta \in \mathbb{R}^+$.

### 2.2 The life cycle of a firm

During the course of its life, the firm passes through four stages: fund raising, recruitment, production and destruction. In each stage a particular interaction between different market participants is taken place, while the market interaction process runs through the intertemporal linkages that exists between the different stages given the presence of the entrepreneur on different markets over the firm’s life cycle.

1. **Fund raising:** In stage 0, entrepreneurs of both types are looking (at a flow search cost $c$) for a financial investor willing to finance the posting of a job vacancy, while financiers are searching for clients at a flow search cost $k$; in addition, they have to pay $\eta$ in order to commit to monitoring the firm during the production stage. The probability that
a entrepreneur meets a financier (equivalently, the probability of transition to the recruitment stage) is \( p(\phi) \).

2. Recruitment: In stage 1, entrepreneurs invest in productive technology and start looking for the worker that will enable them to take up production. The investment consist of two parts: first, entrepreneurs will invest \( \alpha \) in dedicated capital which is not contractible; second, they have to invest \( m \) in organizational capital to make sure to obtain the optimal amount of effort from their worker. The probability that an entrepreneur will meet a worker, and that the recruitment stage will end, is \( q(\theta) \).

3. Production: In stage 2, the firm starts production and is generating flow profits \( \psi(e) \cdot y(\alpha, \eta) \), depending on the installed technology as well as on the worker’s effort\(^2\) and the bank’s monitoring committment. It uses these profits to pay its workers a wage \( w \) and by paying back to its financiers a flow amount \( \rho \) for the entire duration of the match. Both factor payments are negotiated before production starts and contingent on the production technology and the specific investments the three actors have undertaken.

4. Destruction: In the final stage 3, the match between firm and worker is destroyed. We assume that destruction depends partly on the organizational technology that allows to extract effort but also exogenous factors such as the degree of product market competition; transition from stage 2 to 3 occurs with probability \( \sigma(m, e) \).

The above flow diagram describes the different stages of the matching and production process. Using the notation introduced here, we can then formalize the different stages of

\(^2\)The variable \( e \) actually denotes any kind of specific investment by the worker, i.e. effort, specific human capital investments, specific side payments necessary for taking up the job such as moving expenses, etc.
the firm’s life cycle referring to the value of the firm’s and the financial investor’s assets as well as the job value.

### 2.2.1 The value of a firm

Let \( F_i, i \in \{0, 1, 2, 3\} \) denote the different stages of the firm’s life cycle and \( r \) the given risk-less interest rate. Then the Bellman equations for the firm values can be written as follows:

\[
\begin{align*}
  r \cdot F_0 &= -c + p(\phi) \cdot (F_1 - F_0) + \dot{F}_0 \quad (1) \\
  r \cdot F_1 &= -\alpha - m + q(\theta) \cdot (F_2 - F_1) + \dot{F}_1 \quad (2) \\
  r \cdot F_2 &= \psi(e) \cdot y(\alpha, \eta) - w - \rho + \sigma(m, e) \cdot (F_3 - F_2) + \dot{F}_2 \quad (3) \\
  F_3 &= 0 \quad (4)
\end{align*}
\]

where \( \sigma(m, e = 1) = \sigma \) and \( y_\alpha > 0, y_\theta > 0, y_{\alpha\alpha} < 0, y_{\theta\eta} < 0 \). Moreover, for convenience, we want to assume that \( \psi(e = 0) = 0 \); nothing substantially is changed using this assumption. Finally, as the value of a firm is destroyed with the end of the match, we have \( F_3 = 0 \).

In the fund raising stage, firms spend \( c \) to match with an appropriate financial investor which will happen with probability \( p(\phi) \). After installing the productive technology, \( \alpha \), and organizing the production process, \( m \), the firm finds a suitable worker and will switch to the production stage with probability \( q(\theta) \). There, it receives a stream of gross profits of \( y(\alpha, \eta) \)- depending on the monitoring commitment by financial investors - that have to be used to pay wages, \( w \), and make debt reimbursements, \( \rho \).

### 2.2.2 Financial intermediaries

Let \( B_i, i \in \{0, 1, 2, 3\} \) denote the values of the financial investor over the four different stages of the its life cycle. Then the Bellman equations for the financial investor values can be written as follows:

\[
\begin{align*}
  r \cdot B_0 &= -k - \eta + \phi \cdot p(\phi) \cdot (B_1 - B_0) + \dot{B}_0 \quad (5) \\
  r \cdot B_1 &= -\gamma + q(\theta) \cdot (B_2 - B_1) + \dot{B}_1 \quad (6) \\
  r \cdot B_2 &= \rho + \sigma(m, e) \cdot (B_3 - B_2) + \dot{B}_2 \quad (7) \\
  B_3 &= 0 \quad (8)
\end{align*}
\]

During the fund raising stage, the financial investor spends \( k \) as general search costs and commits \( \eta \) to monitor the firm’s realisation of the investment. Having match with probability \( \phi \cdot p(\phi) \), the financial investor finance the recruitment period before the firm finds its labor force, spending \( \gamma \). After this period, he expects to recover his negotiated debt \( \rho \) before the firm quits the market with exit probability \( \sigma(m, e) \).
2.2.3 Workers

Workers expect wages $w$ in exchange for their work effort $e \in \{0, 1\}$. When the firm quits the market, the work relation terminates as well, which happens with probability $\sigma(m, e)$. The effort of the worker, $e$, improves the firm’s productivity but constitutes a specific investment as it is linked to the relationship between the worker and the firm. The higher the investment, the more specific it is and the more costly the loss of the job.

More generally, $e$ can be interpreted as any kind of match-specific investment that is valuable for the firm, such as specific human capital investment or social capital that strengthen any implicit components in the labor contract. Once unemployed, workers benefit from a revenue $b$ waiting to get a chance for a new match, leading to a value of $U$ for unemployed workers.

$$r \cdot W = w - e + \sigma(m, e) \cdot (U - W) + \dot{W}$$  \hspace{1cm} (9)
$$r \cdot U = b + \theta \cdot q(\theta) \cdot (W - U) + \dot{U}$$  \hspace{1cm} (10)

In equilibrium - when $\dot{W} = \dot{U} = 0$ - the value of the job is then determined by the expected net return a worker gets:

$$W - U = \frac{w - e - b}{r + \theta \cdot q(\theta) + \sigma(m, e)}.$$

3 Bargaining and specific investments

3.1 Wage and Debt negotiations

As a first step, the two factor payments - wages and debt repayments - have to be determined. Given the search framework on both the financial and the labor market - wages and debt repayments can be expected to be negotiated to split the match rent.

3.1.1 Splitting profits between workers and employers

Wage bargaining takes place at the second stage. The firm and the union share the surplus of their relationship according to a generalized Nash bargaining rule:

$$w^*_u = \arg \max (F_2 - F_0)^{1-\chi} \cdot (W - U)^\chi$$

where $\chi \in (0, 1)$ measures the bargaining power of the union in the relationship and $w^*_u$ denotes the bargained level of wages. This bargaining leads to the following wage:
Proposition 1  The wage schedule in any firm is the following:

\[ w_u^* = \chi (\psi(e^*) \cdot y(\alpha^*, \eta^*) - m^* - \rho^*) + (1 - \chi) (b + e^*) \]  

\[ \text{(11)} \]

Proof. The first order condition of the surplus sharing rule yields:

\[ \chi \cdot (F_2 - F_0) = (1 - \chi) \cdot (W - U) \]

or

\[ \chi \cdot F_2 = (1 - \chi) \cdot (W - U) \]

since free entry requires that \( F_0 = 0 \). (3) and (4) together with \( e^* = 1 \) give:

\[ F_2 = \frac{\psi(e^*) \cdot y(\alpha^*, \eta^*) - m - w - \rho}{r + \sigma(m, e)} \]  

\[ \text{(12)} \]

(9) implies that \( W - U = \frac{w^* e^* - U}{r + \sigma(m, e)} \), which results in the wage schedule given in the proposition. \[ \blacksquare \]

The bargained wage is a weighted sum of the firm’s output net of the repayment to the bank and a term expressing the annuity value of the utility of an unemployed plus the specific investment cost. The larger the worker’s bargaining power, the larger the share of the firm’s net surplus that he can extract. If workers have no bargaining power, they are paid their opportunity cost of working, i.e. \( e^* + r \cdot U \).

3.1.2 Determining the optimal debt level

The contract between the bank and the entrepreneur stipulates that the bank will finance the recruitment costs (\( \gamma \)) for as long as it takes to find a worker and that the firm will pay a constant amount \( \rho \) for as long as the firm exists. Although we refer to the financial intermediary as a 'bank', it can be noted that the financial contract is more similar to an equity contract than to a debt contract. This specification is kept for simplicity’s sake. Financier and entrepreneur share the surplus of the relationship according to a generalized Nash bargaining rule:

\[ \rho^* = \arg \max (F_1 - F_0)^{1-\lambda} \cdot (B_1 - B_0)^\lambda \]

where \( \lambda \in (0, 1) \) measures the bank’s bargaining power. This program leads to the following repayment schedule:

Proposition 2  When the bank screens to accept only good entrepreneurs, the repayment made by the firm to the bank is given by:

\[ \rho^* = \lambda (\psi(e^*) \cdot y(\alpha^*, \eta^*) - m^* - w^*) + \frac{(\gamma (1 - \lambda) - \alpha^* \lambda)(r + \sigma)}{q(\theta)}. \]  

\[ \text{(13)} \]

Proof. The following proof assumes that the bank has undertaken the necessary screening to single out good entrepreneurs, i.e. \( \delta(\eta^*) = 0 \). Then, the negotiated debt \( \rho^* \) must satisfy the first-order condition:

\[ (1 - \lambda) \cdot \frac{\partial (F_1 - F_0)}{(F_1 - F_0)} \frac{\partial \rho}{\partial \rho} + \lambda \cdot \frac{\partial (B_1 - B_0)}{(B_1 - B_0)} \frac{\partial \rho}{\partial \rho} = 0 \]  

\[ \text{(14)} \]
Firm values at stage 0 and 1 - taken from (1) and (2) - give
\[ r + p(\phi) \cdot (F_1 - F_0) = -\alpha - m + q(\theta) \cdot (F_2 - F_1) + c. \]
Moreover, (12) and (2) lead to \[ r + q(\theta) \cdot (F_2 - F_1) = r \cdot \frac{\psi(\epsilon)(m, e) - \omega - \rho}{r + \sigma(m, e)} + \alpha + m. \] Therefore:
\[
[r + p(\phi)] \cdot (F_1 - F_0) = -\alpha - m + q(\theta) \cdot \left[ r \cdot \frac{\psi(\epsilon)(m, e) - \omega - \rho}{r + q(\theta)} + \alpha + m \right] + c \tag{15}
\]
Furthermore, (7) and (8) imply \( B_2 = \frac{\rho}{r + \sigma(m, e)} \), which - plugged into (6) - gives
\[
B_1 = \frac{\rho \cdot q(\theta) - \gamma \cdot [r + \sigma(m, e)]}{[r + q(\theta)] \cdot [r + \sigma(m, e)]} \tag{16}
\]
while (6) and (5) yield
\[
[r + \phi \cdot p(\phi)] \cdot (B_1 - B_0) = k - \gamma + q(\theta) \cdot (B_2 - B_1). \tag{17}
\]
Taking account of these results, this can be re-expressed as:
\[
[r + \phi \cdot p(\phi)] \cdot (B_1 - B_0) = k - \gamma + q(\theta) \cdot \frac{\rho \cdot r + \gamma \cdot [r + \sigma(m, e)]}{[r + q(\theta)] \cdot [r + \sigma(m, e)]} \tag{18}
\]
Finally, (14), (15), (18) together with the optimal wage (11) and the free entry conditions \( F_0 = B_0 = 0 \) lead to:
\[
(1 - \lambda) \cdot (1 - \chi) \cdot B_1 = \lambda \cdot F_1.
\]
(16), (12) and (2) give, after rearranging terms, the expression for \( \rho \) given in the proposition.

### 3.2 Specific investments

Given these two factor payments, the size of the three different types of specific investments can be determined. Workers will fix their effort level as a function of wages, triggering firms to select an appropriate level of monitoring; financial investors will invest a certain amount (of time and money) to screen possible applicants for funds; and firms will select the technology.

#### 3.2.1 Effort decision by workers

As wages and debt repayments are fixed through negotiations, firms have to fix the firing probability endogenously and at a sufficiently high level such as to make workers indifferent between the high and low effort choices. In our set-up this boils down to saying that firms will choose the lowest value of the organizational technology \( m \) such as to make the two job values equal. In order to keep the model tractable we make a couple of simplifying assumption in the following set-up. In particular, we consider monitoring and effort as additive separate inputs in the destruction probability: \( \sigma(m, e) \equiv \sigma_1(m) + \sigma_2(e) \). Then the amount of monitoring can be determined by:
\[
m^* = \min \{ m \mid W(e = 1, m) = W(e = 0, m) \} \tag{19}
\]
which makes workers effectively choosing the high effort level, i.e. \( e^* = 1 \). Using (9) and (11) we can derive the optimal monitoring decision as:

\[
m^* = \sigma_1^{-1} \left[ \frac{r + \sigma_2(e^*) + \theta q(\theta)}{\chi(\psi(e^*)y(\alpha^*) - e^* - \rho^* - b)} \right].
\]

(20)

### 3.2.2 Selecting good entrepreneurs

Financial investors will select \( \eta \) such as to maximise its return, \( \rho \). Hence in equilibrium, financial investors determine \( \eta^* \) by maximising their entry value \( B_0 \):

\[
\eta^* = \arg \max B_0(\eta)
\]

which results in the following FOC:

\[
E\eta = \lambda \phi p(\phi) (1 - \chi) \psi(e^*) \frac{\partial y(\alpha^*, \eta)}{\partial \eta} - (1 - \lambda \chi) (r + q(\theta)) (r + \sigma) \equiv 0.
\]

(21)

### 3.2.3 Technology choice by firms

Firms select the appropriate technology in the second period such as to maximize the firm’s value:

\[
\alpha^* = \arg \max (F_1 - F_0)
\]

which - taking into account (11) - results in the following FOC:

\[
E\alpha = -r - \sigma + q(\theta) (1 - \chi) \frac{\partial y}{\partial \alpha} \equiv 0 \iff \frac{\partial y(\alpha, \eta^*)}{\partial \alpha} = \frac{r + \sigma}{q(\theta)}
\]

where, using the implicit function theorem, we can show that \( E\alpha = 0 \) implies \( \frac{d\alpha^*}{d\theta} < 0 \).

### 4 Partial Equilibrium

Having determined all the expressions for the determination of specific investments and agents’ income, we can now proceed to the model’s equilibrium. It is however useful to consider first the partial equilibrium effects of markets’ liquidity on the agents’ specific investment levels. Using the above optimality conditions, the following propositions indicate how specific investments on labor and financial markets react to either liquidity changes on both markets.
4.1 Reaction to labor market liquidity

As we have shown above, increasing difficulties for firms to fill a vacancy reduces their incentive to invest in match-specific assets. Similarly, increasing labor market tightness, $\theta$, makes it easier for workers to find an alternative job, hence lowering their effort, which triggers an increased monitoring by firms to keep the worker’s incentive constraint (19) in balance.

**Proposition 3 (Optimal Monitoring)** Optimal monitoring increases with labor market liquidity, i.e. $\frac{d\eta^*}{d\theta} > 0$; consequently the destruction rate raises with labor market liquidity: $\frac{d\sigma}{d\theta} > 0$.

**Proof.** Using (20) and noticing that in partial equilibrium financial market variables are fixed before transaction on the labor market occur, the proposition follows straightforwardly from the above equation. □

Similarly, given the reduced incentives for firms to invest in the match when labor market tightness raises, financial investors - under certain conditions - will screen more closely to single out good entrepreneurs. However, the optimal screening condition (21) does not yield unambiguous results without further specifications. Nevertheless, under mild specific conditions the following relation between $\eta$ and $\theta$ can be established.

**Proposition 4 (Optimal FI monitoring)** Suppose the specification\(^3\) $y(\alpha, \eta) = y_1(\alpha) + y_2(\eta)$ with $y_2$ monotonously increasing in $\eta$ and twice continuously differentiable. Then, the reaction of the optimal monitoring of financial investors depends on the curvature of $y_2$. With $y''_2 < 0$, the reaction decreases with labour market tightness, i.e. $\frac{d\eta^*}{d\theta} < 0$, while with $y''_2 > 0$, it increases, i.e. $\frac{d\eta^*}{d\theta} > 0$.

**Proof.** Using the suggested specification, $\eta^*$ writes as:

$$\eta^* = (y'_2)^{-1} \left( \frac{(1 - \lambda \chi) (r + q(\theta)) (r + \sigma)}{\lambda \phi \psi (\phi) (1 - \chi) \psi (e^*) q(\theta)} \right).$$

As $\frac{(1 - \lambda \chi) (r + q(\theta)) (r + \sigma)}{\lambda \phi \psi (\phi) (1 - \chi) \psi (e^*) q(\theta)}$ is unambiguously increasing with $\theta$, the reaction of $\eta^*$ wrt. $\theta$ depends on the shape of $(y'_2)^{-1}$. As $y_2$ is monotonously and continuously differentiable, $y'_2$ and $(y'_2)^{-1}$ will be monotonous. However, for $y''_2 < 0$, $(y'_2)^{-1}$ will decrease with $\theta$, while for for $y''_2 > 0$, it will increase with $\theta$. □

4.2 Reaction to financial market liquidity

Given the sequencing of the different types of investment, financial market tightness does not play a role in determining technological choice or effort in partial equilibrium. This has simply to do with the fact that at the time, firms and workers meet, the financial structure has already been decided. Nevertheless, financial market tightness will affect incentives for financial investors to screen the market.

\(^3\)Notice that this specification is more restrictive than any specification with positive cross-derivatives.
Proposition 5 (Reaction to financial market liquidity) An increase in financial market liquidity (increase in $\phi$) leads to an increase only of the screening activity by financial intermediaries:

$$\frac{\partial \alpha^*}{\partial \phi} = 0, \frac{\partial m^*}{\partial \phi} = 0, \frac{\partial \eta^*}{\partial \phi} > 0.$$ 

Proof. By inspection we can easily see that neither $m^*$ nor $\alpha^*$ depend on $\phi$. Regarding $\eta^*$, applying the implicit function theorem upon (21) the result easily obtains. $\blacksquare$

Again, notice that all these relations are valid only in partial equilibrium; in general equilibrium, financial market liquidity will affect $\alpha$ and $m$ through the interaction with labor market tightness as we will see in the next section.

5 Equilibrium Relations in general equilibrium

In general equilibrium, the procedure of firm creation, production and destruction is not only run once but multiple times. Hence, new entrepreneurs will be able to react with their investment decisions on changing market conditions on both the financial and the labor market. Given the strategic complementarities between the different investment variables and the reaction in partial equilibrium of all types of investment to either or both types of liquidity we are expecting to see interesting interlinkages between the two markets.

5.1 Multiplicity of equilibria

Proposition 6 The simultaneous equilibrium on the financial and the labor market is determined by the following two relations:

$$\frac{c}{p(\phi)} = \frac{1 - \lambda}{(r + \sigma)(1 - \lambda \chi)} \frac{q(\theta)}{r + q(\theta)} Y(\theta) \quad (FF)$$

$$\frac{k + \eta^*}{\phi \cdot p(\phi)} = \frac{\lambda}{(r + \sigma)(1 - \lambda \chi)} \frac{q(\theta)}{r + q(\theta)} Y(\theta) \quad (BB)$$

where $Y(\theta) = (1 - \chi) \left( \psi(e^*) \psi(\alpha^*, \eta^*) - m^* - e^* - b - \gamma (r + \sigma) \right) - (r + \sigma) \frac{\alpha^*}{q(\theta)} > 0$ in equilibrium.

Proof. In equilibrium, no entry opportunities will be missed, hence $B_0 = 0$ and $F_0 = 0$. Together with $B_3 = F_3 = 0$ this yields:

$$B_0 = 0 \iff B_1^b = \frac{k + \eta^*}{\phi \cdot p(\phi)}$$

$$F_0 = 0 \iff F_1^b = \frac{c}{p(\phi)}$$
which defines the backward-looking relations of firm and bank values. Moreover, the forward-looking values for \(B_1\) and \(F_1\) can be obtained by plugging \(B_2\) and \(F_2\) into (6) and (2). This yields:

\[
B_1^f = \frac{\left(1 - \lambda \right) \phi^* Y(\theta) (\psi (e^*) y(\alpha^*) - m^* - c^* - b) - (\alpha^* + \gamma (1 - \chi))}{(1 - \lambda \chi) (r + q(\theta))}
\]

\[
F_1^f = (1 - \lambda) \frac{\left(1 - \lambda \right) \phi^* Y(\theta) (\psi (e^*) y(\alpha^*) - m^* - c^* - b) - (\alpha^* + \gamma (1 - \chi))}{(1 - \lambda \chi) (r + q(\theta))}
\]

Noting that in equilibrium \(B_1^f = B_1^r\) and \(F_1^f = F_1^r\) and using (21) to substitute \(\eta^*\) with \(\delta (\eta^*)\) the two equilibrium relations can be obtained by dividing one over the other.

Moreover, given these two equilibrium relations, the following proposition can been shown to hold concerning the existence of equilibria

**Proposition 7** Let the equilibrium relations be given by proposition (6). Then, there exists at most two equilibria. In addition, there exists a degree of product market competition, \(\bar{c}\), such that

\[
|\{(\phi^*, \theta^*)\}| = \begin{cases} 2 & \text{for } c \geq \bar{c} \\ 1 & \text{for } c = \bar{c} \\ 0 & \text{for } c < \bar{c} \end{cases}
\]

where the couple \((\phi^*, \theta^*)\) describes a steady state in the \(\phi - \theta\)-quadrant.

**Proof.** Given proposition (3) and the concavity condition regarding \(y, Y(\theta)\) will react negatively to changes in labor market liquidity, and hence the \(\mathcal{FF}\) describes a downward sloping graph in the \(\phi - \theta\)-quadrant.

Regarding the \(\mathcal{BB}\) schedule, the right-hand side unambiguously decreases with increasing labor market liquidity, \(\theta\); the overall sign therefore depends on its reaction to \(\phi\). Here, the right-hand side of the equation increases with \(\phi\) while the left-hand side of the equation has an ambiguous reaction with respect to \(\phi\), leaving the overall sign ambiguous as well. However, as both the numerator and the denominator of the left-hand side increase monotonically with financial market liquidity, only one crossing points exists, yielding at most one maximum or minimum. Given that the numerator of the left-hand side unambiguously decreases with \(\theta\), the sign of the partial derivative of \(\mathcal{BB}\) with respect to \(\phi\) will be determined by the denominator of the left-hand side for low \(\theta\) and by the numerator of the left-hand side for high \(\theta\); in total this yields a \(\mathcal{BB}\)-schedule that takes a minimum in the \(\theta - \phi\)-quadrant.

Finally, the \(\mathcal{FF}\)-schedule moves downward with increasing entry barriers, while \(\mathcal{BB}\) rotates to the left. Nevertheless, given that \(\mathcal{BB}\) has a minimum with respect to \(\theta\) there exists an entry barrier value such that for \(c \geq \bar{c}\), only one equilibrium exists.

**Corollary 8** There exist a degree of competition \(\bar{c}\) for which the equilibrium \(A\) does no longer exist.

Figure 2 illustrates the shape of the equilibrium relations as well as the possibility for multiple equilibria to arise. As the figure shows, with varying degrees of competitive pressure on product markets (represented by different \(\mathcal{FF}\)-schedules) these equilibria may disappear.
For sufficiently high entry barriers, $c > \gamma$, the model identifies two quite distinct regimes on both the labor market and the financial market. In equilibrium $A$ both financial market liquidity - as measured by the ratio $1/\phi = B/F$ - and labor market liquidity - $\theta = V/U$ - are relatively tight from the point of view of financial intermediaries and workers respectively. Financial investors are getting more picky with strong firm competition for funds. At the same time, low labor market liquidity pushes firms to adopt more specific technologies while at the same time they can reduce their spending for more sophisticated monitoring technologies\(^4\). The specific capital invested in a particular match is therefore particularly high in this equilibrium and can be protected through a relatively low liquidity on both financial and labor markets that reduces the value of the outside option for financial investors and workers.

On the other hand, in equilibrium $B$ financial and labor markets are relatively liquid, allowing for a rapid turnover of firms and their workforce. Consequently, invested specific capital is low but the higher matching ratio on labor markets compensates for the loss in productivity in each single match. Without further specification of the production and matching process it is therefore impossible to Pareto-rank the two equilibrium that are qualitatively distinct.

While the $FF$-schedule moves rightwards with decreasing entry barriers, the $BB$-schedules is displaced to the left when financial intermediation cost, $k$, is rising (not presented in figure 2). Rising funding costs reduce the available financial market liquidity and make firm entry more difficult while increasing $\phi$ in equilibrium. Together, this decreases the optimal labor market liquidity, $\theta^*$.\(^4\)

\(^4\)Notice that in our set-up, much in line with earlier literature (see e.g. Bolwes, 1985), expenditures for monitoring technologies are social waste as they do not contribute to the productive output.
Notice, finally, that the BB-schedule allows a maximum labour market liquidity to be sustainable. For too high a degree of competition, i.e. \( c < \bar{c} \), any equilibrium will disappear as firm turnover is too high to generate sufficient incentives for workers and firms to make any upfront investment to guarantee the firm’s profitability. This in turn proves unprofitable for financial intermediaries to enter the market, generating low financial market liquidity. When competition is too strong, no financial investor will be ready to enter the market to provide funds for fear of too low firm profitability that could allow to recover the monitoring costs. Consequently, financial investors prefer to quit the market altogether at that point.

Multiplicity of equilibria arises in this context due to a particular strategic complementarity between the incentive structures shaping specific investment undertaken by the three actors in the model. This may be called institutional complementarities (Aoki, 1995; Amable, Ernst, Palombarini, 2002). Institutional complementarity refers to the fact that the incentive structures on different markets affect each other in providing a global incentive landscape in which the different agents locate their actions: In our case, the decisions to invest in particular technologies, \( \alpha \), to provide effort, \( e \), and to monitor firms, \( \eta \), are all interrelated in general equilibrium. Interestingly, only the monitoring of entering firms has non-trivial partial derivatives with respect to both \( \theta \) and \( \phi \) in partial equilibrium; nevertheless, the number of firms being endogenous in general equilibrium, both the technology choice as well as the effort decision will be affected by the monitoring effort and hence the financial market liquidity in general equilibrium.

5.2 Numerical simulation

For further comparison of the two equilibria, we proceed at some numerical simulations to evaluate the impact of structural policy changes on the equilibrium outcomes in the two cases. Starting from a baseline simulation three different policy changes are analysed: the deregulation of product markets through a lowering of entry barriers, \( c \); the deregulation of labour markets by reducing the wage bargaining power of trade unions, \( \chi \); and the deregulation of financial markets through reducing entry barriers for banks, \( k \). As will be shown in the following, these simulations shows important differences depending on whether the policy impact on equilibrium A - in the following referred to as the "rigid" economy - or B - the "flexible" economy - is considered.

Further characterization of the equilibria requires the matching functions to be specified and the system to be calibrated. We adopt the following specifications:

\[
q(\theta) = q_0 \cdot \theta^{-q_1} \\
p(\phi) = p_0 \cdot \phi^{-p_1}
\]

with \( q_0, p_0 \) strictly positive, \( q_1 \) and \( p_1 \) positive and lower than 1. Here, we will retain \( q_1 = 0.5 \); \( p_1 = 0.4; q_0 = 1; p_0 = 0.88 \). In addition we fix \( r = 0.05; \lambda = 0.45; \sigma = 0.1; \gamma = 1.5; \xi = 0.7 \). The remaining parameters \( c, k, b, \) and \( \chi \) serve as policy variables that will be subject to
structural policy changes. Moreover, we use the specification of the production function as stated in proposition (3), i.e. \( y(\alpha, \eta) = y_1(\alpha) + y_2(\eta) \), with \( y_1(\alpha) = T\alpha^a \) and \( y_2(\eta) = \eta^n \), where \( a, n < 1 \) and \( T \) the relative contribution of specific investment by firms and workers relative to the contribution by financial investors to the total profitability of the firm.

In the baseline simulation when \( c = 0.7, k = 0.3, b = 0, \chi = 0.66, a = 0.34, n = 0.5, T = 1 \), equilibrium \( A \) yields an unemployment rate of 9.8\% and equilibrium \( B \) an unemployment rate of 9.1\%. This figure compares to the unemployment rate of some European countries, but no attempt is made at obtaining a realistic calibration.

### Product market deregulation

First, a reduction of barriers to firm entry as measured by the parameter \( c \) is considered, in the simulation, \( c \) is lowered from 0.7 to 0.685, i.e. by 2.2\%. As can be seen in the following table, the reaction is somewhat different across the two equilibria.

<table>
<thead>
<tr>
<th>Table 1: The impact of product market deregulation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A reduction of barriers to entry by 2.2% changes</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Unemployment</td>
</tr>
<tr>
<td>Output</td>
</tr>
<tr>
<td>Financial market liquidity</td>
</tr>
<tr>
<td><strong>Memoandum item</strong></td>
</tr>
<tr>
<td>Initial unemployment</td>
</tr>
</tbody>
</table>

Parameter values for simulation:
\( \kappa=0, T=1, n=0.5, a=0.34, k=0.3, b=0, \lambda=0.45 \)

In both cases, a more dynamic firm entry reduces the unemployment rate, as standard theory would suggest. However, the unemployment rate is somewhat more elastic in the "rigid" economy \( A \), than in the "flexible" economy \( B \). More interestingly, however, are the results on the financial market. As a more dynamic firm entry yields more opportunity for banks to finance, a reduction in the barriers to entry on the product market produces a more dynamic banking sector ... but only for the "rigid" economy! In the "flexible" economy, the banking sector does not follow the product market dynamics, yielding a higher firm to bank ratio and hence lower liquidity.

This has, on the other hand, important consequences for gross output, as the higher firm-to-bank ratio in the "flexible" economy allows to make up for some of the lost incentives to build up specific investment. Hence, both, the higher matching ratio on the labour market and the higher specific investment by financial investors boost gross output in the "flexible"
economy. Conversely, in the "rigid" economy, the higher financial market liquidity and the lower incentives by firms to invest in specific assets lowers gross output.

Labour market deregulation

Another often discussed structural policy concerns the deregulation of the labor market that could affect both replacement ratios, \( b \), and unions' bargaining power, \( \chi \), impacting directly on the wage to be paid to workers. In the following table, we consider a reduction of the trade unions' bargaining power from 0.66 to 0.6534, i.e. by 1.0%. The results are presented in table 2 and shows - again - differences across equilibria regarding their reaction to such a reduction in bargained wages.

Table 2: The impact of a wage decrease

<table>
<thead>
<tr>
<th>A decrease of wages by 1.0% for equilibrium</th>
<th>( A )</th>
<th>( B )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment</td>
<td>-2.6%</td>
<td>-1.3%</td>
</tr>
<tr>
<td>Output</td>
<td>-8.2%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Financial market liquidity</td>
<td>27.3%</td>
<td>-16.9%</td>
</tr>
<tr>
<td>Memorandum item</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial unemployment</td>
<td>7.6%</td>
<td>7.4%</td>
</tr>
</tbody>
</table>

Parameter values for simulation:
\( k=0, T=1.1, n=0.5, a=0.4, c=0.7, b=0.1, \lambda =0.45, k=0.7 \)

Similarly to a product market deregulation, in both cases, the deregulation of the labor market reduces the unemployment rate, as standard theory would suggest. Again, the unemployment rate is somewhat more elastic in the "rigid" economy \( A \), than in the "flexible" economy \( B \). On the other hand, the increased liquidity on the labor market leads to increased output only in the case of the "flexible" economy \( B \). In the "rigid" economy \( A \), the increased labor market flexibility produces a negative incentive effect on specific investments by both workers and financial investors - as witnessed by the increased financial market flexibility - that yields a strong negative impact on the firm productivity. At least as regards economy \( A \), the negative impact is not being compensated by the higher liquidity on the labor market, contrarily to what is happening in equilibrium \( B \).

Financial market deregulation

Finally, we want to consider the impact of the deregulation of the financial market. In particular, we want to consider a reduction of entry barriers, \( k \), for financial investors from 0.3 to 0.272, i.e. by a considerable 10.3%. Results are presented in table 3.
Table 3: The impact of a financial market deregulation

<table>
<thead>
<tr>
<th>A increase of financial market deregulation by 10.3% changes</th>
<th>for equilibrium A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment</td>
<td>0.1%</td>
<td>-0.6%</td>
</tr>
<tr>
<td>Output</td>
<td>2.4%</td>
<td>-4.0%</td>
</tr>
<tr>
<td>Financial market liquidity</td>
<td>-7.9%</td>
<td>19.8%</td>
</tr>
</tbody>
</table>

Memorandum item

| Initial unemployment                                      | 8.4%            | 8.2%       |

Parameter values for simulation:

\( \kappa=0, \ T=1, \ n=0.5, \ a=0.34, \ c=0.7, \ b=0, \ \lambda=0.45, \ \chi=0.66 \)

Similar to the two preceding examples but even more striking are the differences across the two equilibria regarding the impact such a policy change may have. The increased financial market liquidity as would have been predicted by standard economic theory only settles in for the "flexible" economy B, while for the "rigid" economy A financial market liquidity falls even further. This has to do with the fact that - for high values of \( \phi \), i.e. for low financial market liquidity - the equilibrium curve \( BB \) is backward bent, the incentive effect being stronger than the liquidity effect on the market. In this case, a reduction in the costs of entry for banks can only be matched by an increased investment for firm surveillance which is to say that financial market liquidity has to decrease.

Consequently, to different scenarios arise depending on whether the economy is "flexible" or "rigid". In the latter case, the strong incentive effect raises specific investments by financiers which leads to an increased firm productivity and hence an increase gross production. This will, however, by matched partly by an increase of the unemployment rate that follows from the reduced financial market liquidity which will also affect the dynamics of firm entry. For the "flexible" economy B, however, an ENRON-like phenomena is arising: while unemployment is falling following stronger financial market liquidity, the decrease in specific investments for firm surveillance by financial investors decreases the firm productivity substantially, reducing gross production by 4%.

6 Conclusion

When markets are characterized by transactional imperfections, market interaction may arise where imperfections on one market spill over to another, mutually influencing the macroeconomic outcome. However, as we have shown by way of numerical examples in this paper, no unambiguous, monotonic relationship may exist once specific investment as another form of transaction problem is taken into account. In particular, we have shown that in this case, markets may interact in a way such that the economy with higher friction react
differently to structural policy changes as those expected from standard economic theory. Especially any attempt to increase product or financial market flexibility may not yield the expected result. Hence both partial and general equilibrium effects of market frictions have to be considered simultaneously in order to determine the likely impact of any change in structural policies.

The outcome of such an analysis - where lowering 'imperfections' or the level of 'frictions' does not necessarily yield the expected results - is similar to those results found in the literature (Amable and Gatti, 2002), where higher competition on product markets may increase unemployment because of the presence of an effort incentive mechanism on the labor market. More generally, more 'liquidity' or 'flexibility' may act as a disincentive to specific investment, be it work effort, entrepreneurial screening or innovative outlays.

This analysis can be extended to account for a different industrial specialization a country may follow. Indeed, different industries are identified by different technological characteristics that may determine the extent to which specific investment are necessary for its successful evolution. When only low levels of specific investments are required - or similarly when the marginal productivity of these kinds of investment is high - then lower market frictions may in fact lead to both higher employment and higher industrial growth. Conversely, where industries are characterized by high levels of specific investments, stronger frictions provide the necessary incentives for strong industrial performance. As in this situation, one size does not fit all, one might expect different industrial portfolios to be selected by countries characterized by different degrees of frictions on their credit and labor markets.

7 References


7. Ernst, Ekkehard, "Financial systems, industrial relations and industry specialization", CEPREMAP, 2001


