Financial Fragility, Business Creation and Job Destruction

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After many years of theoretical and empirical research devoted to explaining unemployment by labor market imperfections, the focus has shifted to credit markets. Recent developments in the US economy have played an important role in this change of emphasis, as there is a widespread feeling that financial intermediaries have been a crucial ingredient of the "new economy", during both the initial phase of sustained growth and the second stage of emblematic bankruptcies (e.g., Boo.com) and of sharp decline in stock prices. Few macroeconomic models allow to deal with such complex interactions between labor, credit and good markets. The Modigliani-Miller paradigm, where the financial structure of the firm is irrelevant, is usually adopted as a benchmark from which it is analytically difficult to deviate. In an earlier paper (Wasmer-Weil 2001), we have introduced a simple (tractable) double search model with stochastic frictions in labor and credit markets, and argued that it might serve as a useful tool to understand the impact of credit market imperfections on employment.[1]

This paper illustrates theoretically, through calibration and empirically how the aggregate labor market depends crucially on the financial intermediaries notably in phases of negative cash-flows. For that, we extend the endogenous destruction version of our model (Wasmer and Weil, 2001, Section 6) to technological growth and finite variance of technological shocks. We investigate the life-cycle of firms facing an initial period of deficit, optimistic anticipations of future profits, and the need of being refinanced in case of transitory fall in demand of productivity. Business creation, credit opening and job destruction represent three active margins of the model. We find that financial imperfections lead to financial fragility stemming from

* This paper was prepared for the conference "New Economy, Viability and Implications", Université de Metz, on April 27-28, 2001. We thank the participants for their comments. We also thank Asa Rosen for her careful reading of the paper.

1 See also the subsequent paper of Acemoglu (2000).

negative initial cash-flows and the need for the firm to be refinanced by its investors in bad times. This acts as a forth, latent margin : by latent, we mean that it is not active and has no impact on the equilibrium. However, it may strike if the agents decided to repudiate financial contracts. In some New Economy sectors, this would be the case if everyone realized, after hearing "the King is naked", that price-earnings ratios were abnormally high, leading to immediate repudiation of old financial contracts.

Furthermore, we establish that monetary policy matters more for fragile firms since they are more dependent on the rates at which banks are refinanced. Finally, we attempt to test the model, by deriving a testable link between venture capital and the aggregate labor market. We use a subset of venture capital data compiled by Jeng and Wells (1998) for 17 OECD countries between 1986 and 1997 to investigate the dynamic correlations between venture capital flows and the unemployment rate in panel. As we will see, the results are encouraging : unemployment depends negatively and significantly on venture capital flows the year before, suggesting the presence of lags, which justifies ex-post our modelling approach. These results are obtained regardless of the choice of the variable controls for the aggregate cycle.

The paper is organized as follows : in Section 1, we introduce the concepts of the model and derive the equilibrium along the three active margins. In Section 2 we discuss further some aspects of the relation between financiers and entrepreneurs and establish the existence of the latent margin described above. In Section 3 and 4, we propose a few quantitative illustrations of macroeconomics of the model applied to the paradigm of the New Economy, including the impact of monetary policy and the importance of venture capital flows.

1 The model

1.1 Setup

To analyze the role of credit market imperfections on unemployment, we use the symmetric search framework introduced in Wasmer-Weil (2001). In our earlier paper, we had shown that describing labor *and* credit market imperfections by means of matching functions yields a parsimonious, yet rich, macroeconomic model of unemployment. We briefly present that model, which serves as our starting point here, and refer the reader to our earlier work for further detail.

There are three types of agents : entrepreneurs, workers and financiers. Entrepreneurs have ideas, but need workers to transform them into output. However, labor market frictions make it difficult and costly for entrepreneurs and workers to meet. Following Pissarides (1990), we summarize these difficulties by a constant returns to scale matching function $h(\mathcal{U}, \mathcal{V})$ 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 $\mathcal{U}$.[2] Measuring *labor market tightness* (from the point of view of firms) by the ratio $\theta = \mathcal{V}/\mathcal{U}$, the instantaneous (Poisson) probability that an entrepreneur finds a worker, $\frac{h(\mathcal{U},\mathcal{V})}{\mathcal{V}} = h(\theta^{-1}, 1) \equiv q(\theta)$ is, quite naturally, decreasing the tighter the labor market, i.e., the higher θ. The converse probability[3] of a worker finding an entrepreneur, $\theta q(\theta)$, is increasing in θ.

We assume that entrepreneurs do not have *any* financial resources of their own,[4] so that they must find, before they start searching for a worker, a financier willing to pay a) for the cost of posting a job vacancy; b) for the negative profits of the first initial period of the firm. Financial frictions comes from a *credit market matching function* $m(\mathcal{B}, \mathcal{E})$ that produces matches between available bankers $\mathcal{B}$ and available entrepreneurs $\mathcal{E}$.[5] Measuring *credit market tightness* (again from the point of view of entrepreneurs) by $\phi = \mathcal{E}/\mathcal{B}$, the probability that an entrepreneur finds a financier is $\frac{m(\mathcal{B},\mathcal{E})}{\mathcal{E}} = m(\phi^{-1}, 1) \equiv p(\phi)$, which is decreasing in credit market tightness ϕ. The converse probability that a financier finds a worker, $\phi p(\phi)$, is of course increasing in ϕ.

1.1.1 Technology

A firm can start producing only after its owner has found a worker. The output of a firm has three components : an exogenous deterministic trend e^{gt} (we assume it to be common to output and to all costs in the economy), a random component ε, and finally a "variance" element captured by the shift parameter $\sigma > 0 : y = \sigma \varepsilon e^{gt}$. With $\sigma = 1$ and $g = 0$, one is back to Wasmer and Weil (2001), Section 6. When a firm starts producing, ε is set at an initial level ε^0 that we assume, for simplicity, to be fixed and common to all firms.[6] The productivity level ε thereafter changes randomly. At random dates with Poisson arrival rate λ, a new ε is drawn from a distribution with support $]-\infty, \varepsilon^u]$ and cdf $G(.)$. The arrival rate λ and the distribution $G(.)$ are common to all firms, but both the Poisson dates and realizations of ε are idiosyncratic to the firm. We will show below that the viability of the entrepreneur's ideas requires, of course, that ε^0 be high enough. We will assume for the moment being that it ishe case.

2 Marginal products in matching are positive but decreasing : $h_1 > 0$, $h_2 > 0$, $h_{11} < 0$, $h_{22} < 0$.

3 Herafter we simplify the exposition by using the word probability for "instantaneous Poisson probability" since there is no possible ambiguity.

4 This is an obvious simplification.

5 We impose $m_1 > 0$, $m_2 > 0$, $m_{11} < 0$, $m_{22} < 0$.

6 We could easily allow for the possibility that the initial ε is random. This would not yield additional insights.

Life-cycle of the firm

The life-cycle has four successive phases of stochastic length : In stage 0 (*fund raising*), prospective entrepreneurs are looking (at a flow sweat cost[7] ce^{gt}) for a bank willing, in exchange for a future repayment, to finance the posting of a job vacancy, while financiers are searching for firms (at a flow search cost ke^{gt}). In stage 1 (*recruitment*), entrepreneurs have found a financier. Financier and entrepreneur bargain over a contingent financial contract. This contract stipulates : a repayment rule from the firm to the banker when cash-flows are positive; a shutdown rule determining in which states of nature the firm will be dissolved and the match destroyed; a refinancing rule committing the bank to reinject liquidity into the firms in some negative cash-flow states. In stage 2 (*creation*), the firm has found a worker and is at first generating exogenous flow output $\sigma\varepsilon^0 e^{gt}$. The firm pays its workers an exogenous wage ωe^{gt}.[8] If initially output is not high enough to cover wage costs (i.e., if $\sigma\varepsilon^0 - \omega < 0$), the banker continues financing the firm and covers the shortfall $(-\sigma\varepsilon^0 + \omega)e^{gt}$. If $\sigma\varepsilon^0 - \omega > 0$, the firm starts repaying the firm an agreed upon amount $\rho(\varepsilon^0)e^{gt}$. With Poisson arrival rate $\lambda > 0$, the output of the firm y jumps to another level $\sigma\varepsilon e^{gt}$. Depending on the new value of ε, this brings about either the destruction of the firm in very bad states (ε below some cutoff value ε^d determined later on), or the refinancing of the firm by the bank in bad states (intermediate values, $\sigma\varepsilon^d < \sigma\varepsilon < \omega$), or a new value of repayment by the firm $\rho(\varepsilon)e^{gt} > 0$ in states with $\sigma\varepsilon > \omega$. In the final stage 3 (*destruction*), banker and entrepreneur choose to close down the firm and to dissolve the match between firm and worker because the realization of ε is too unfavorable. In addition to this endogenous destruction, we add the possibility of exogenous destruction by natural turnover, with an exogenous probability s.[9] Throughout, we assume that there are no commitment problems for financiers or firms but discuss at length the relaxation of this assumption later on. All agents are risk neutral.

We will show below that under these assumptions, there exists, as in Mortensen–Pissarides (1994), a balanced growth path with a time-invariant equilibrium unemployment rate.

1.1.2 Optimality conditions

Call B_0 (resp. E_0) and B_1 (resp. E_1) the value of a bank (resp. a firm) in the fund raising and recruitment stages, $B_2(\varepsilon^0)$ and $B_2(\varepsilon)$ (resp. $E_2(\varepsilon^0)$

[7] We have assumed that entrepreneurs have no financial resources. For consistency, we therefore hypothesize that the cost c of searching for a financier is a time, or sweat, cost. This represents the opportunity cost of time, which in a growing economy is also naturally growing at rate g. For instance, it can be linked to the marginal utility from consumption.

[8] We have solved the more complex case of endogenous wages in Wasmer-Weil (2001) and shown notably that giving all the barganing power to firms leads to the same results as when wages are assumed exogenous. The latter result is not as trivial as it may seem, because a strictly positive bargaining power to workers leads firms and banks to negociate a rise in repayment $\rho(\varepsilon)$ so that workers receive lower wages.

[9] Further, the special case λ = 0, g = 0 and $\sigma\varepsilon^0 = y > \omega$ corresponds to Wasmer-Weil (2001), Section 3.

and $E_2(\varepsilon)$) its value in the creation and idiosyncratic changes phases, and finally B_3 (resp. E_3) its value in the destruction stage. Let r denote the (given) riskless rate. The Bellman equations describing the evolution of the value of the bank and the firm over the first four stages are written down in the Appendix. We assume that value of a bank destroyed after the financier has met the entrepreneur is $B_3 = B_0$ – i.e., that *the termination of the relationship leads to the loss of the specificity of the entrepreneur-banker relationship.* The same hods for firms, i.e. $E_3 = E_0$.

1.1.3 Bargaining between financier and entrepreneur

The contract between a financier and an entrepreneur is written after they meet. The terms of the contract are 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; when $\sigma\varepsilon < \omega$, the bank will finance the deficit as long as the total surplus $F_2(\varepsilon) + B_2(\varepsilon) > 0$. The bank thus pays an amount $-(\sigma\varepsilon - \omega)\rho e^{gt}$ in these times; financier and entrepreneur share the surplus of their relationship according to the following rule : $\rho = \alpha(\sigma\varepsilon - \omega)$ when the profits are positive. The parameter α is determined through bargaining in period 1,

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

where $\beta \in (0,1)$ measures the bargaining power of financiers in the credit relationship. This formulation is equivalent to a generalized Nash bargaining rule; at each productivity change, the contracting parts check that the total surplus is still positive. If this is not the case, the match is destroyed : workers become unemployed, firms and bank go back to stage 0.

1.2 Aggregate equilibrium

The aggregate equilibrium is determined by three active margins. There are two entry rules, one for banks (credit creation) and one for entrepreneurs (business creation) and there is a joint destruction rule determining the point at which the firm and the financier agree on business destruction. In addition, there is also a forth, latent margin, not active in steady state but that could potentially be active if the financial commitment described in the previous section did not hold : as we show below, the margin is given by the potential (but neither exerted nor anticipated) repudiation of the contract by the financier when $B_2 < 0$ and $B_2 + F_2 > 0$.

1.2.1 Entry rules and equilibrium credit market tightness

We 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 :

$$B_0 \equiv 0 \qquad \text{and} \qquad E_0 \equiv 0 \tag{2}$$

This implies that $\dot{B}_0 \equiv \dot{E}_0 \equiv 0$. From the free entry conditions (2) and from the fund-raising stage value functions (8) and (11), it immediately follows by reading period 0 Bellman equations backwards that $B_1 = \frac{ke^{gt}}{\phi p(\phi)}$, while $E_1 = \frac{ce^{gt}}{p(\phi)}$. Moreover, given the Nash-bargaining equation (1), it is easy to check that both E_1 and B_1 need to grow at the same rate. Taking the ratio of the two latter equations, this will imply that, on a balance-growth path, tightness of the credit market will be constant : $\phi^* = \frac{1-\beta}{\beta}\frac{k}{c}$. Since ϕ^* is constant, and because we will establish below that equilibrium labor market tightness θ^* is also constant in equilibrium, asset values in all four stages grow at rate g.

1.2.2 Destruction rule

Let us denote $S(\varepsilon) = B_2(\varepsilon) + E_2(\varepsilon)$ the surplus of the match bank-firm in stage 2. Adding up equations (10) and (13) and rearranging, we find that $S(\varepsilon) = \frac{(\sigma\varepsilon-\omega)e^{gt}+\lambda\int \max(S(\varepsilon'),0)dG(\varepsilon')}{r+\lambda+s-g}$. The surplus is linear and increasing in ε. Let ε^d be the solution of $S(\varepsilon^d) = 0$. Note that $S'(\varepsilon) = \frac{\sigma e^{gt}}{r+s+\lambda-g}$, so that we can rewrite the surplus as $S(\varepsilon) = \frac{\sigma(\varepsilon-\varepsilon^d)}{r+s+\lambda-g}e^{gt}$. The viability constraint $S(\varepsilon) \geqslant 0$ therefore imposes the following destruction rule. The match between firm and bank is dissolved, and the job destroyed, for all productivity levels below the cutoff level ε^d. The relationship between the firm and the bank continues otherwise.

To go further, note that $S'(\varepsilon) = \sigma e^{gt}/(r+s+\lambda-g)$ which leads to an alternative characterization of ε^d :

$$\varepsilon^d = \frac{\omega}{\sigma} - \frac{\lambda}{r+s+\lambda-g}\int_{\varepsilon^d}^{\varepsilon^u}(\varepsilon'-\varepsilon^d)dG(\varepsilon') < \frac{\omega}{\sigma} \tag{3}$$

This implies that banker and entrepreneur agree to keep the firm in operation for values of ε in the range $[\varepsilon^d, \omega/\sigma]$, i.e., in states of nature in which productivity is not high enough to generate positive output net of wages but in which it is nevertheless sufficient to generate a positive total surplus. In these states, the bank injects additional liquidity $(\omega - \sigma\varepsilon^d)e^{gt} > 0$ in the firm to keep it alive, and we denote this negative repayment by $\rho(\varepsilon) = (\sigma\varepsilon^d - \omega)e^{gt}$ from the firm to the bank.[10]

How is the destruction cutoff level affected by the parameters of the model ? By differentiating equation (3), one can show that $\partial\varepsilon^d/\partial r > 0$, $\partial\varepsilon^d/\partial\lambda < 0$, $\partial\varepsilon^d/\partial g < 0$, $\partial\varepsilon^d/\partial s > 0$, while $\partial\varepsilon^d/\partial\sigma$ has the same sign as ε^d. The total job destruction rate $\xi = s + \lambda G(\varepsilon^d)$ responds to these parameters in the same way, except for λ for which there is an ambiguity.

[10] Negative cash-flows to the firm is a feature already present in Mortensen-Pissarides (1994), but it is irrelevant in their perfect capital market setup.

1.2.3 Equilibrium labor market tightness

To determine the equilibrium number of job creations, we follow Wasmer-Weil (2001) : it is given by the intersection of two curves, (BB) and (EE), representing respectively the entry of banks and the entry of entrepreneurs, in the space (θ, ϕ). The two curves of course intersect in $\phi^* = \frac{k}{c}\frac{1-\beta}{\beta}$. Their analytical expression is derived from (9) and (12) in replacing B_2^0 and F_2^0 by their expression. In the present context, if $\sigma\varepsilon^0 < \omega$, and using (1), (2) and (8)-(13) in Appendix, one obtains after simplification the equations characterizing each curve, in using the notation $\Pi^0 = \frac{\sigma(\varepsilon^0 - \varepsilon^d)}{r-g+s+\lambda}$:

$$\frac{c}{p(\phi)} = (1-\beta)\frac{q(\theta)}{r-g+q(\theta)}\left[\Pi - \frac{\gamma}{q(\theta)}\right], \tag{4}$$

$$\frac{k}{\phi p(\phi)} = \beta\frac{q(\theta)}{r-g+q(\theta)}\left[\Pi - \frac{\gamma}{q(\theta)}\right] \tag{5}$$

One can easily prove that the same expression holds when $\sigma\varepsilon^0 > \omega$. Equilibrium tension in the labor market in the absence of credit frictions is then $\bar{\theta}$, defined, from equations (5) or (4), by $\Pi^0 = \frac{\gamma}{q(\theta)}$. This means that 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 Mortensen-Pissarides free-entry condition for firms when there are no credit search frictions. As a consequence, we find here that this model nests i) the Mortensen-Pissarides (1994) equilibrium, ii) Wasmer-Weil (2001) and iii) Pissarides (1990). See Wasmer-Weil (2001) for the proofs and for the fact that $\theta^* < \bar{\theta}$, i.e. there are fewer job creations. This arises because financial frictions act as an additional, endogenous entry cost to entrepreneurs.

Finally, note that the equilibrium is calculated without expliciting the bargained value of α, the derivation of which is postponed to next section.

1.3 Monetary policy

On April 18, 2001, when the Federal Reserve bank reduced unexpectedly the interest rate by half a percentage point, the Dow Jones rose 3.91%. The Nasdaq went up by 8.12%. Can we explain this difference by financial fragility of New Economy firms ?

To answer that question, and in the spirit of the "monetary section" in Wasmer and Weil (2001), let us have firms and banks facing a different discount rate, and let's denote by $r^* < r$ the discount factor of banks. Any change in r^* might be thought as resulting from the intervention of the monetary authorities. We can thus describe a new channel for monetary policy : the impact on the valuation of profit perspectives of new firms and new projects, and at the same time, the impact on the job destruction margin through changes in the reservation value ε^d. Solving for this new set of equations, one can show that tightness of the credit market is unchanged, and that operating firms have asset values that depends on r^*, and denoted by $E(\varepsilon, r^*)$. We are interested in comparing $\chi_{old} = \frac{\partial \ln E_2(\varepsilon,r^*)}{\partial r^*}$ for profitable firms, and $\chi_{new} = \frac{\partial \ln E_2(\varepsilon,r^*)}{\partial r^*}$ for non-profitable firms. Using the modified equations (8)-(10), and verifying that $\frac{\partial \varepsilon^d(r^*)}{\partial r^*} > 0$, one can check (see the Appendix for a sketch of the computations) that

$$\chi = |\chi_{new}| - |\chi_{old}| = \frac{\partial \varepsilon^d}{\partial r^*}\left(\frac{1}{\varepsilon^0 - \varepsilon^d} - \frac{1}{\varepsilon - \varepsilon^d}\right) > 0 \text{ for all } \varepsilon > \omega/\sigma$$

This derivative is calculated at $r = r^*$ but the inequality holds in a neighborhood of $r^* < r$. In other words, firms making losses respond more than firms making positive profits to changes in r^*. Interestingly, the differential χ is also larger, ceteris paribus, the larger the sensibility of job destruction to the interest rate, i.e. $\frac{\partial \varepsilon^d}{\partial r^*}$.

2 Some microeconomics of the relation between financiers and entrepreneurs

After having established the aggregate equilibrium of the model, and before deriving some further aggregate results on the links between macroeconomic variables and the financial intermediaries and testing those links, we now investigate further some of its microeconomics aspects, and compute the value of α (the share of cash flows going to the bank in good times) arising from bargaining in stage 1. We will notably introduce a new notion of financial fragility.

2.1 A definition of fragility

Let us first go back to the Bellman equations in stage 2. We will define financial fragility for a given firm as a state in which the total surplus is positive, i.e. $S(\varepsilon) = B_2(\varepsilon) + E_2(\varepsilon) \geqslant 0$ but in which the asset value of banks is negative, $B_2 < 0$. These are states of nature in which the financing of firms with low productivity hangs only on the thread of commitments (or, alternatively, on reputation considerations). Any weakening of these commitments would entail the destruction of some or all of these firms.[11]

To see why such states exists, we need to compute the value functions of firms and banks (see the Appendix). These asset values are represented graphically in Figure 1 as (linear) functions of ε. This graph indeed shows

[11] Note however that the possibility of repudiation of financial contracts is not anticipated, given the assumption made.

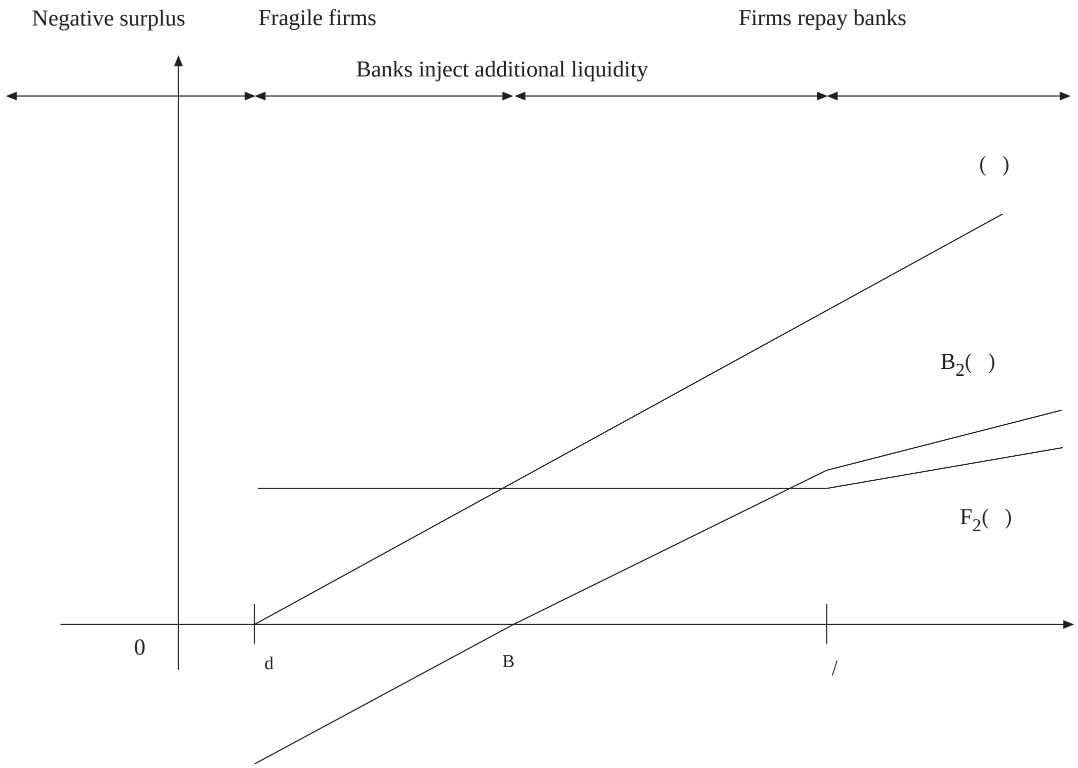

Figure 1 : *Asset values of firms, banks and total surplus as a function of the level of technology ε.*

why there are values of productivity $\varepsilon > \varepsilon^d$ such that, in spite of a positive surplus, the value for the bank of continuing the relation with the firm is negative. This occurs for values of ε between ε^d and $\varepsilon^B < \omega$, where ε^B is the cutoff point such that $B_2(\varepsilon^B) = 0$. These are states of nature in which, were it not for the contract that it has signed with the firm (which we assumed to be irrevocable), the bank would like ex post to get out of the financial relationship that commits it to refinance the firm and close down the firm. One possible measure financial fragility as the distance $\xi = \varepsilon^B - \varepsilon^d$.

2.2 Optimal financial contract

The equilibrium repayment of the entrepreneur to her financier can now be calculated. Banker and entrepreneur must share the expected present discounted value of the profits, net of wages, that the firm will generate once it starts operating. We have :

Proposition 1 : *a) If $\varepsilon^0 < \varepsilon^B$, the firm and the bank never contract : the economy is not viable. b) If $\varepsilon^0 > \varepsilon^B$, a fraction*

$$\alpha = \begin{cases} \beta + (1-\beta)\left[\dfrac{\gamma}{q(\theta)}\dfrac{\omega - \sigma\varepsilon^d}{r+s+\lambda-g} + \dfrac{\omega - \sigma\varepsilon^0}{\omega - \sigma\varepsilon^d}\right] & \text{if } \varepsilon^0 \leqslant \omega/\sigma, \\ \beta + (1-\beta)\dfrac{\gamma}{q(\theta)}\dfrac{\sigma(\varepsilon^0 - \varepsilon^d)}{r+s+\lambda-g} & \text{if } \varepsilon^0 \geqslant \omega/\sigma \end{cases} \tag{6}$$

of output net of wages goes to the banker.

Proof : See the Appendix. □

The equilibrium Nash-bargaining loan contract described by proposition 1 and equation (6) thus stipulates that the higher labor market tightness and accordingly, the higher total search costs for firms, then the higher the share of output net of wages received by bankers in good times. In addition, the transfer from the entrepreneur to the financier positively depends on the expected present discounted value of the firm's profits net of wages $\frac{\sigma\varepsilon^0 - \omega}{r-g+s+\lambda}e^{gt}$.

3 A numerical illustration applied to the New Economy

We can now illustrate some recent features of the New Economy (say, the development of IT sector, of biotechnologies, etc...) using our framework. The New Economy can be well described by a few stylized facts. First, the return of successful businesses is high or very high, and growth prospects in these sectors are high too. Second, the volatility of these firms is also very high, implying a large variance of profitability shocks and frequent job destruction. Thirdly, the credit market may be extremely frictional for those firms, in the sense that the cost of screening projects by financiers may be higher than in traditional sectors. Fourthly, the initial period of the firm is associated with more persistence or more incidence of negative cash-flows, leading to frequent help by financiers. Fifth, in the presence of commitments due to ex-ante negotiations between financiers and entrepreneurs, the incentives of financiers to renege their commitments may be higher than in traditional sectors if repudiation costs due to the need to preserve reputation are lower in emerging sectors. Further, and perhaps less known, there is evidence that transaction costs in the control and monitoring of businesses by creditors has recently been drastically reduced due to the use of new technologies. In a recent paper, Petersen and Rajan (2000) find an increase in the average distance between lenders and borrowers, that we interpret in the context of our model as an reduction in search costs in the matching process of the credit market.[12] As a whole, one could summarize these aspects by si-

[12] Other recent papers have recently studied the importance of distance on borrowing and monitoring costs (for Belgium see e.g. Degryse and Ongena, 2001, notably their table 5).

mulating the behavior of two sectors, with the following alternative set of parameters[13] :

Table 1 : *Simulation of the model*

		Old	New I	New II	New III	New IV
Initial technology	$\sigma\varepsilon^0$	1.8	1.35	1.35	1.35	1.35
Wage	ω	1.5	1.5	1.5	1.5	1.5
Growth rate	g	0.025	0.05	0.05	0.05	0.05
Transition rate	λ	0	0.3	0.3	0.3	0.3
Lower bound of $\sigma\varepsilon$	$\sigma\varepsilon^l$	–	0	0	0	0
Upper bound of $\sigma\varepsilon$	$\sigma\varepsilon^u$	–	3.6	3.6	3.9	3.9
Screening cost for banks	k	0.35	0.35	3.5	3.5	1.75
Bargaining power of banks	β	0.5	0.5	0.5	0.5	0.5
Share of profits of banks	α	0.85	0.86	*n.v.**	0.70	0.77
Credit market tightness	ϕ	1	1	*n.v.*	10	5
Labor market tightness	θ	1.26	0.91	*n.v.*	0.29	0.94
Unemployment rate	u	0.082	0.129	*n.v.*	0.171	0.102
Share of inefficient firms	$F(\varepsilon^d)$	–	0.138	*n.v.*	0.036	0.036
Share of fragile firms	$\frac{\varepsilon^B-\varepsilon^d}{\varepsilon^u-\varepsilon^d}$	–	0.045	*n.v.*	0.117	0.083

* : not viable, i.e. profits are insufficient for firms to enter the market.

The first column represents a sector of the traditional (Old) economy, with a 2.5% growth rate and immediate profits $\varepsilon^0 > \omega/\sigma$. There is little variability in profits, which at the extreme is summarized by $\lambda = 0$. Despite equal bargaining power $\beta = 1/2$, banks bargain a repayment α corresponding to 85% of the flow net profits $\sigma\varepsilon^0 - \omega$ in order to reimburse the flow recruiting costs and take account of the discount rate. We showed in Wasmer-Weil (2001) that this corresponds roughly to an internal rate of returns for the financiers of 22%, i.e. an excess rate of return over the 5% discount rate of banks of 17%. Equilibrium unemployment is 8.2%.

The second column, a sector of the new economy (New I)[14], has a higher growth rate of profits and transaction costs (5%), but the initial level of profits is such that the cash-flow is negative in absence of help by the financiers. In addition, there is some variability in productivity, which takes values in the interval $[0, 3.6]$. This occurs with intensity $\lambda = 0.3$. Given the computed reservation value ε^d, $F(\varepsilon^d) = 13.8\%$ of the distribution of shocks leads to job destruction. Accordingly, the total job destruction rate is $s+\lambda F(\varepsilon^d)$ is 40% higher than in absence of endogenous destruction, i.e. with

[13] exogenous destruction s = 0.1; recruiting costs γ = 1.5; scale parameter in labor matching x_0 = 1.0; scale parameter in credit matching p_0 = 1; bargaining power of banks β = 0.5; discount rate r = 0.05; elasticities of matching function $\eta = \kappa$ = 0.5; variance of technologies σ = 1.

[14] All the sectors are simulated independently of each other.

$\lambda = 0$. This partly explains higher unemployment (12.9%); the other part is due to lower job creation (lower equilibrium labor market tightness). Lower job creation is in fact due to lower present discounted profits, due to more frequent destruction of the firm, and to lower initial profits experienced by both firms and banks : the entrepreneur, initially, obtains nothing, while the bank further refinance the entrepreneur, as compared to column 1. Finally, the share of surviving firms where the financiers have an incentive to default ($B_2 < 0$), computed by $\frac{\varepsilon^B - \varepsilon^d}{\varepsilon^u - \varepsilon^d}$, is about 4.5%.

To have a more realistic picture of the sectors of the New Economy, one can now simulate the impact of larger screening costs supported by financiers looking for entrepreneurs for businesses with high volatility. In fact, it seems natural to consider that higher screening costs apply, the larger the variance of the quality of projects, the higher the uncertainty about future streams of profits, or, in the case of the New vs. the Old Economy, the less known the entrepreneurs. Indeed, in the New Economy, entrepreneurs have no business record, while in the Old Economy, there are much fewer entrepreneurs looking for a financier to finance a "crazy idea" : entrepreneurs in old sectors are in small number and usually well established in the market place. As stated in Petersen and Rajan (2000) : "Small business lending has historically been very costly, because of the paucity of information about small firms and the high costs of the personnel required to obtain even that information". Thinking of start-ups in the New Economy along these lines, we are lead to set k to a higher value, consistent with a high tightness of the credit market. Indeed, with a value $k = 3.5$, one expects an equilibrium value of ϕ ten times higher.

In column 3 (New II), the upper bound of the distribution is now $\sigma\varepsilon^u = 3.9$. Tightness of the credit market is very high ($\phi = 10$). The financial contracts are more balanced, since banks get about 70% of the net profits in good times. But, the mean profits being low compared to initial entry costs for banks, tightness of the labor market is low, and unemployment in the sector is high. The main distinctive feature of this economy is the high degree of financial fragility : in the cross-section of the firms having experienced their first technological shock, a share of 11.7% is fragile, in the sense that only the commitment of banks prevent them from letting the firm go bankrupt ($\sigma\varepsilon^d < \sigma\varepsilon < \omega$ and $\varepsilon < \varepsilon^B$). In our mind, any aggregate shock or news announcement about the profitability of the New Economy, such as the bankruptcy of a symbolic firms (Boo.com) would serve as a pretext for these financiers to either renege or default from the financial contract. If this happened in such an economy, *this would lead to the immediate destruction of these 12% of firms, i.e. a sudden inflow of 4 to 6% of the workforce into unemployment.*

One of the features of the new economy is also the arrival of strong productivity gains in the banking sector, in the spirit of Petersen and Rajan (2000), leading in the column 5 (New III) to a 50% decrease in screening costs k, leads to an equiproportional decline in credit market tightness, an increase in labor market tightness, a better share of profits α for the banks (due to lower labor market tightness), and a 40% decrease in financial fragility which reaches a share of 8.3% of the surviving firms having experienced their first technological shock.

4 Empirical illustration

4.1 A testable prediction

We now proceed to a test of the model. One of its major prediction lies in the link between equilibrium labor market tightness, and the financial frictions as reflected by costs c and k. To obtain a more precise view of this relation, we transform tightness θ in terms of equilibrium unemployment $u = (s + \lambda G(\varepsilon^d))/(s + \lambda G(\varepsilon^d) + \theta q(\theta))$. Doing so, we obtain, linearizing around $\overline{\theta}$ and $\overline{u} = (s + \lambda G(\varepsilon^d))/(s + \lambda G(\varepsilon^d) + \theta q(\overline{\theta}))$, neglecting quadratic terms in unemployment and using a Cobb-Douglas formulation for the matching function in the credit market (without any qualitative implication), one gets :

$$\frac{u - \overline{u}}{\overline{u}} = \frac{1-\eta}{\eta} \frac{\frac{1}{p_0} \frac{k^\varepsilon c^{1-\varepsilon}}{\beta^\varepsilon (1-\beta)^{1-\varepsilon}}}{\Pi} \tag{7}$$

The quantity $\frac{1}{p_0} \frac{k^\varepsilon c^{1-\varepsilon}}{\beta^\varepsilon (1-\beta)^{1-\varepsilon}}$ stands for equilibrium financial costs. After linearization, this relation states that deviations of unemployment with respect to frictional specific country unemployment rate $\overline{u}$ (due to frictions on the labor market without credit imperfections) increase with financial frictions, and decrease with aggregate profits, reflecting cyclical factors. We will thus estimate a linear dynamic version of the latter equation :

$$u_{it} = D_i + b_u.u_{i,t-1} + b_c.cycle_{it} + b_{vc}.vc_{it}$$

where D_i will reflect country-specific frictional factors on the labor market, b_u will characterize the short-run dynamic of unemployment, cyclical factors are reflected by b_c.

4.2 Results

The extensive description of data is in the Appendix. We essentially use a panel of 17 OECD countries using Jeng and Wells' (1998) venture capital data and OECD indicators notably on unemployment, growth and aggregate investment. We obtain 156 observations. Each lag in the specification removes 16 observations, and accordingly, our baseline regression will have 140 observations.

We try several cyclical controls and several specifications. All specifications include lagged unemployment in the regressors. We only report here the specification where the cyclical control is real GDP growth.[15] Columns 1 to 7 of each table include country specific effects. Columns 1, 2 and 3 try different specifications (with possibly a lag on the cyclical control, and with the lagged venture capital variable, or including both the contemporaneous and the lagged venture capital variable). Our preferred specification include contemporaneous and lagged variables, and is reported in column 4. Columns 5 to 9 test the robustness of this specification : notably, columns 5 to 7 add common time effect, country specific trends or both. Columns 8 and 9 impose a common constant instead of the country fixed effects, with or without time effect.

As it can be seen from all columns between 1 and 7 in table 2, our lagged venture capital variable is always negative, and remarkably significant, at the 1% level, whereas current venture capital variable is never significant. This suggests the presence of a time-to-build period, or consistently with our search theory, a time-to-recruit period between investment and the decrease in unemployment. Durbin-Watson are generally very close to 2. In columns 8 and 9, the coefficient on lagged venture capital is significant at the 10% level (7 and 9%), whereas Durbin-Watson is less satisfactory, around 1.5.

There thus seems to be a quite robust negative correlation between lagged venture capital investment and unemployment, the order of magnitude of which is the following : a one standard deviation increase in venture capital flows relative to GDP (i.e. 0.075) has a short-run effect of -0.25 percentage point on unemployment, and -2.4 percentage points in the long-run.

5 Conclusion

The New Economy has recently been associated with large flows of job destructions, bankruptcies and high volatility of the stock exchange, with large responses of the Nasdaq firms to the interest rate policy of the Federal Reserve Bank. Our model incorporates all these aspects. It defines the notion of financial fragility, where destruction of jobs may be inefficient, and underline that the monetary policy is all the more important than there are firms making current losses in expectation of better times. We see the empirical results of Section 4, not as a formal test of the model, but as an encouragement for macroeconomists to more systematically take into account the financial problems linked to business creation and refinancing.

[15] Other specifications can be found in a earlier (IZA DP 179, Aug. 2000) version of Wasmer-Weil (2001) and do not add much given that the results obtained are identical, except when calculating the magnitude of the long-run impact of a 1 standard deviation shock on venture capital. This is found to be around -1% of unemployment, instead of -2.4 with another specification. The short-run impact is however very similar (-0.20% of unemployment) as with the specification reported in the text.

Appendix

Asset values

$$rB_0 = -ke^{gt} + \phi p(\phi)(B_1 - B_0) + \dot{B}_0, \tag{8}$$

$$rB_1 = -\gamma e^{gt} + q(\theta)\left[B_2(\varepsilon^0) - B_1\right] + \dot{B}_1, \tag{9}$$

$$\begin{aligned} rB_2(\varepsilon) &= \rho(\varepsilon)e^{gt} + s[B_3 - B_2(\varepsilon)] \\ &\quad + \lambda \int \{\max[B_2(\varepsilon'), B_3] - B_2(\varepsilon)\} dG(\varepsilon') + \dot{B}_2(\varepsilon) \end{aligned} \tag{10}$$

$$rE_0 = -c + p(\phi)(E_1 - E_0) + \dot{E}_0, \tag{11}$$

$$rE_1 = q(\theta)\left[E_2(\varepsilon^0) - E_1)\right] + \dot{E}_1, \tag{12}$$

$$\begin{aligned} rE_2(\varepsilon) &= e^{gt}[\sigma\varepsilon - \omega - \rho(\varepsilon)] + s[E_3 - E_2(\varepsilon)] \\ &\quad + \lambda \int \{\max[F_2(\varepsilon'), F_3] - E_2(\varepsilon)\} dG(\varepsilon') + \dot{E}_2 \end{aligned} \tag{13}$$

Using a superscript + or − to distinguish between asset values in states with positive and negative net output $\sigma\varepsilon - \omega$, we can rewrite the Bellman equations as :

$$(r + s + \lambda - g)B_2^- = (\sigma\varepsilon - \omega)e^{gt} + \lambda \int_{\varepsilon^d}^{\omega} B_2^-(\varepsilon')dG(\varepsilon') + \int_{\omega}^{\varepsilon^u} B_2^+(\varepsilon')dG(\varepsilon'), \tag{14}$$

$$(r + s + \lambda - g)B_2^+ = \alpha(\sigma\varepsilon - \omega)e^{gt} + \lambda \int_{\varepsilon^d}^{\omega} B_2^-(\varepsilon')dG(\varepsilon') + \int_{\omega}^{\varepsilon^u} B_2^+(\varepsilon')dG(\varepsilon'), \tag{15}$$

and

$$(r + s + \lambda - g)E_2^- = 0 + \lambda \int_{\varepsilon^d}^{\omega} E_2^-(\varepsilon')dG(\varepsilon') + \int_{\omega}^{\varepsilon^u} E_2^+(\varepsilon')dG(\varepsilon'), \tag{16}$$

$$(r + s + \lambda - g)E_2^+ = (1 - \alpha)(\sigma\varepsilon - \omega)e^{gt} + \lambda \int_{\varepsilon^d}^{\omega} E_2^-(\varepsilon')dG(\varepsilon') + \int_{\omega}^{\varepsilon^u} E_2^+(\varepsilon')dG(\varepsilon') \tag{17}$$

The asset values are linear, given t, in ε with slopes

$$\partial B_2^-/\partial\varepsilon = \frac{\sigma}{r + s + \lambda - g}e^{gt}, \qquad \partial B_2^+/\partial\varepsilon = \frac{\alpha\sigma}{r + s + \lambda - g}e^{gt}$$

$$\partial E_2^-/\partial\varepsilon = 0, \qquad \partial E_2^+/\partial\varepsilon = \frac{(1 - \alpha)\sigma}{r + s + \lambda - g}e^{gt}$$

Using the bargaining condition to simplify the expressions of the intercepts, we get piecewise linear expressions as displayed in Figure 1.

Proof of Proposition 1

The proof is by forward substitution of the Bellman equations. The Bellman equations in the recruitment stage, (9) and (12), imply that, in equilibrium,

$$B_1 = \frac{-\gamma + q(\theta)B_2(\varepsilon^0)}{r - g + q(\theta)} \tag{18}$$

and

$$E_1 = \frac{q(\theta)E_2(\varepsilon^0)}{r - g + q(\theta)} \tag{19}$$

a) If $\varepsilon^0 < \varepsilon^B$ then from equation (14) the value $B_2(\varepsilon^0)$ of the bank is negative, which would implies given equation (18) that $B_1 < 0$ and accordingly, the bank and the firm don't contract. In fact, the bank would not even enter in stage 0.

b) If $\varepsilon^B < \varepsilon^0 < \omega/\sigma$, then combining (18), (19), (14) and (16) together with (1) :

$$1 - \alpha = (1 - \beta)\left[\frac{-\gamma}{q(\theta)}\frac{\omega - \sigma\varepsilon^d}{r + s + \lambda - g} + \frac{\sigma(\varepsilon^0 - \varepsilon^d)}{\omega - \sigma\varepsilon^d}\right] \tag{20}$$

or

$$\alpha = \beta + (1 - \beta)\left[\frac{-\gamma}{q(\theta)}\frac{\omega - \sigma\varepsilon^d}{r + s + \lambda - g} + \frac{\omega - \sigma\varepsilon^0}{\omega - \sigma\varepsilon^d}\right] \tag{21}$$

c) If $\varepsilon^0 > \omega/\sigma$, then combining (18), (19), (14) and (16) together with (1)

$$\alpha = \beta + (1 - \beta)\frac{\gamma}{q(\theta)}\frac{\sigma(\varepsilon^0 - \varepsilon^d)}{r + s + \lambda - g} \tag{22}$$

The repayment share is higher, the higher the search cost relative to the initial total surplus, and of course, higher, the higher β.

Proof of Equation (7)

From either equation (5) or (4), and using the equilibrium value for ϕ, equilibrium labor market tightness satisfies

$$\gamma/q(\theta^*) = \gamma/q(\bar{\theta}) - \frac{c}{1 - \beta}[p(\frac{1 - \beta}{\beta}\frac{k}{c})]^{-1} < \gamma/q(\bar{\theta}) \tag{23}$$

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

Monetary Policy

First, rewrite all the Bellman equations with a different discount rate for firms (r) and banks (r^*). Then, use the surplus sharing rule to determine the new value of $(1 - \alpha)$ which will be used to calculate the new value of $E_2(\varepsilon, r^*)$. One obtains $E_2(\varepsilon, r^*) = \frac{\varepsilon^0 - \varepsilon^d}{r^* + \lambda + s - g}\frac{1-\beta}{\beta}\frac{1}{\frac{r^*+q}{r+q} + \frac{1-\beta}{\beta}\frac{r+\lambda+s-g}{r^*+\lambda+s-g}}$ for unprofitable firms and

$E_2(\varepsilon, r^*) = \frac{\varepsilon-\varepsilon^d}{r^*+\lambda+s-g}\frac{1-\beta}{\beta}\frac{1}{1+\frac{1-\beta}{\beta}\frac{r+\lambda+s-g}{r^*+\lambda+s-g}}$ for profitable firms. It is then easy to calculate the logarithm, make a first-order approximation of the last fraction in each equation, calculate the derivative of each of them and finally apply them at $r = r^*$.

Data description

We build a panel of OECD countries using two sources of data. First, some usual macroeconomic indicators on unemployment, aggregate investment, real and nominal GDP were compiled from the OECD national accounts and labor force statistics. These data cover the period 1960-1999. Second, we used data on venture capital published in Jeng and Wells (1998, pp. 64-65, tables 11-12). As they very carefully report it, venture capital investment is the sum of start-up, seed and expansion investment. Early stage investment, which we find to be the most significant variable, is defined as the sum of start-up and seed. These data are used to construct an unbalanced panel covering the period 1986-1995 for 20 OECD countries. New Zealand, Australia, Germany and Japan were removed from our sample given the lack of observations or consistency of the data. We thus build a panel with the 16 following countries : the US, Canada, the UK, Ireland, France, Spain, Italy, Portugal, the Netherlands, Belgium, Austria, Switzerland, Finland, Norway, Sweden and Denmark. All countries thus have 10 venture capital observations, except Norway and Finland (8 observations).

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Table 2 : *Unemployment impact of venture capital (controlling by GDP growth); dependent variable : unemployment**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Unemployment rate (−1)	1.02	1.01	0.89	0.89	0.89	0.73	0.73	1.01	1.02
	(29.80)	(28.83)	(26.42)	(25.84)	(21.07)	(14.79)	(10.28)	(62.33)	(60.68)
GDP growth rate	−44.95	−44.85	−29.80	−29.78	−28.44	−22.55	−21.17	−31.80	−26.30
	(−17.21)	(−16.90)	(−10.03)	(−10.09)	(−6.19)	(−7.12)	(−4.25)	(−10.10)	(−5.92)
GDP growth rate (−1)	–	–	−20.69	−20.82	−21.15	−24.63	−27.29	−15.98	−17.53
			(−7.32)	(−7.37)	(−5.25)	(−8.73)	(−6.79)	(−5.06)	(−4.01)
Venture capital rate	**–**	**0.03**	**–**	**0.57**	**0.27**	**0.13**	**−0.08**	**−0.23**	**0.36**
		(0.03)		**(0.71)**	**(0.28)**	**(0.14)**	**(−0.07)**	**(−0.24)**	**(0.32)**
Venture capital rate (−1)	**−4.15**	**−4.15**	**−3.38**	**−3.79**	**−3.78**	**−3.65**	**−3.70**	**−2.29**	**−2.54**
	(−4.41)	**(−3.90)**	**(−3.25)**	**(−3.12)**	**(−2.98)**	**(−2.54)**	**(−2.45)**	**(−1.73)**	**(−1.84)**
Fixed country effects / constant	–	–	–	–	–	–	–	1.29	0.80
								(9.95)	(3.66)
USA	1.06	1.08	1.91	1.92	1.63	2.76	−2.82	–	–
CAN	1.35	1.38	2.52	2.53	2.24	−3.56	−9.26	–	–
GBR	1.04	1.07	2.15	2.19	1.90	2.20	−2.30	–	–
IRE	2.47	2.52	4.38	4.46	4.08	9.23	3.68	–	–
FRA	1.18	1.21	2.49	2.54	2.22	7.54	2.61	–	–
SPA	1.51	1.57	3.95	4.05	3.68	−5.63	−10.24	–	–
ITA	0.89	0.93	2.35	2.41	2.07	18.37	13.17	–	–
POR	1.77	1.79	2.59	2.60	2.30	4.24	−0.85	–	–
HOL	1.00	1.02	2.08	2.10	1.80	−10.03	−16.20	–	–
BEL	1.90	1.93	3.13	3.19	2.88	−8.87	−13.67	–	–
DEN	0.99	1.02	2.00	2.04	1.73	0.61	−4.57	–	–
NOR	1.75	1.76	3.38	2.39	2.04	−11.50	−19.54	–	–
SWE	1.15	1.16	1.61	1.63	1.34	−19.08	−23.41	–	–
FIN	2.09	2.12	3.23	3.26	2.92	−69.01	−72.36	–	–
AUT	1.26	1.27	1.83	1.85	1.54	7.30	1.88	–	–
SWI	1.07	1.07	1.35	1.36	1.08	−2.10	−6.96	–	–
Common time effects	No	No	No	No	Yes	No	Yes	No	Yes
Country specific trends	No	No	No	No	No	Yes	Yes	No	No
Weighted Statistics									
R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.96	0.97
F-statistics	6077.55	3864.46	4175.26	3328.53	674.54	932.82	444.65	1338.54	330.51
Durbin-Watson	2.05	2.04	1.90	1.90	1.84	2.19	2.13	1.46	1.49
Number of observations	140	140	140	140	140	140	140	140	140

* : Estimation method : Generalized Least Square Dummy Variables (with cross-section weights); t-statistics are in parentheses.