Labor Market Flexibility and Growth.

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Abstract

This paper studies whether flexibility on the labor market contributes to output growth. Under the assumption that firms and workers face imperfect capital markets, I show that labor market flexibility has three types of effects. It first contributes to relax firms credit constraints. Second it can prompt firms to make more productive investments but the more likely so if capital market imperfections are low. Finally it positively influences workers precautionary savings and thereby raises the volume of global savings. Based on these three effect, the model brings two results. First the economy can exhibit multiple equilibria when capital market imperfections are large, the high flexibility equilibrium being always Pareto dominated. Second the model predicts that productivity growth should be positively associated with labor market flexibility for relatively low levels of capital market imperfections. We provide macro empirical evidence which supports this last conclusion.

Preliminary and Incomplete.

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1. Introduction.

Since its creation, the Euro Zone has been lagging behind the United States in terms of output growth. From 1992 to 2005, the US business sector has been growing significantly faster pace than its Euro Zone counterpart, year 2001 being the sole significant exception. Moreover while this growth gap seemed to be on a disappearing trend by the end on the 1990's, the first years of the 2000's decade have witnessed a resurgence in this growth gap with a steady expansion from 0.7 in 2002 to about 2.5 percentage points in 2005.

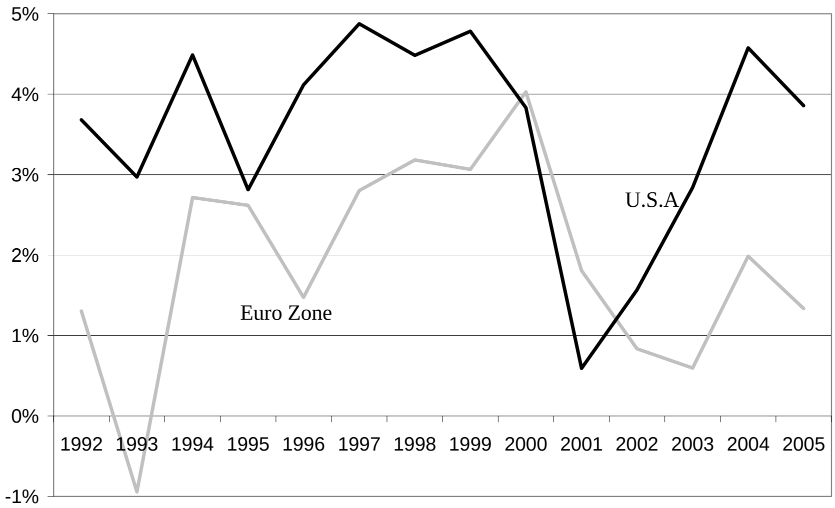

Figure 1: Business Sector GDP Growth. Source: OECD Economic Outlook.

A broader focus on the whole economy (and not only on the business sector) yields a very similar view as to the Euro Zone-USA growth gap: on average, the US has grown each year 1.4 percentage point faster than the Euro Zone on 1992-2005. Not withstanding this worrying picture for the Euro Zone, a similar pattern emerges from a rapid comparison of the respective productivity growth performances. The difference in output per worker growth is still more than one percentage point in the business sector and 0.8% percentage point for the whole economy in favor of the US.

Why is this so? Why has the U.S. grown, over the last years, significantly faster than the Euro Zone? Where does the growth gap between the Euro Zone and the US come from? Providing an answer to this question is not an easy task: looking at figures for long run fundamental sources of growth, namely investment and employment evolutions, it turns out that employment has been increasing somewhat faster in the US than in Euro Zone (1.4% to 0.8% per year on 1992-2005) while the investment to output ratio has been on average pretty larger in the Euro Zone than in the US (16.1% to 12.9% on 1992-2005). Finally considering the fact that catch-up effects should be larger for the Euro Zone given that its productivity is lower, a rapid calibration of a Solow growth model shows that this figures should predict a productivity growth gap in favor of the Euro Zone not in favor of the US[1]. Still business sector labor productivity growth has been growing on average 1 percentage point faster in the US than in the Euro Zone on 1992-2005[2].

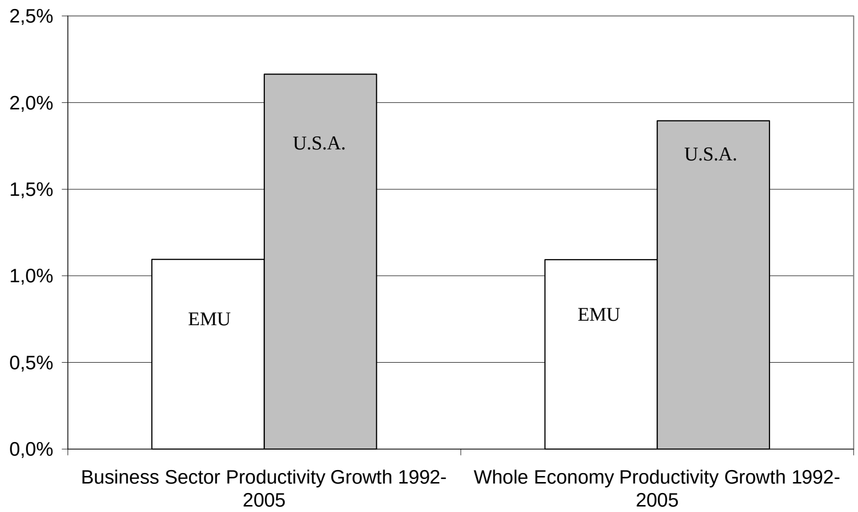

Figure 2: Average Productivity Growth. Source: OECD Economic Outlook.

Therefore if traditional growth determinants cannot account for the output - productivity growth gaps, then this begs the question of where these gaps come from and whether any stark structural difference between these two economies can help understanding this long run growth performance gap? On the list of possible culprits or at least of suspects, the labor market and its regulation have been given very high priority.

[1] Put differently, given the figures for capital accumulation and employment growth in the US and the Euro Zone, the difference in TFP needed to rationalize the difference in growth rates is inconsistent with empirical estimates of TFP growth.

[2] All the figures stated here have been taken out of the OECD economic outlook. The employment variable (ETB) is named "employment of the business sector", the output variable (GDPBV) is named "gross domestic product business sector volume factor cost" and the investment variable (IBV) is named "private non-residential fixed capital formation volume".

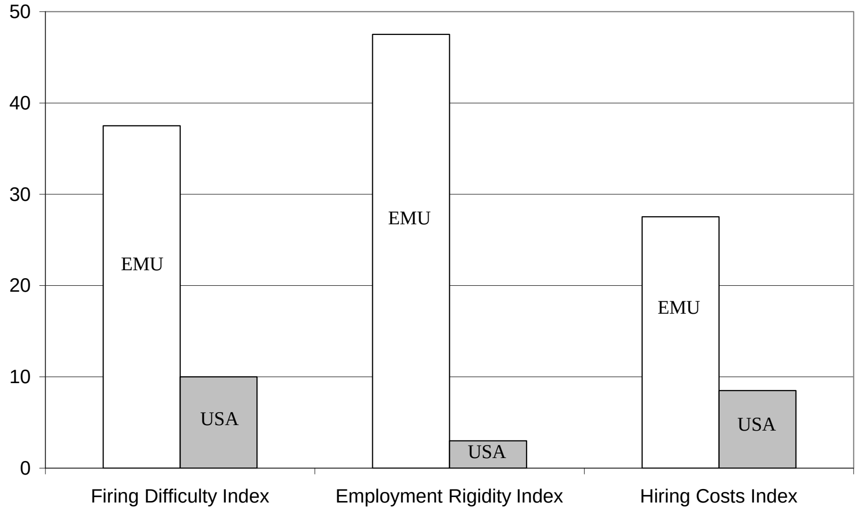

Figure 3: Labor Regulation Indexes. Source: Botero et al. [2004].

Indeed, a large number of commentators have pointed in the direction of the labor market, regarded as the driving element of this growth gap. More precisely, the supposed lack of flexibility in Euro Zone labor markets has been set responsible for the poor growth performance relative to the U.S.[3]. However it is important to note that labor market regulation does not have *a priori* any direct impact on growth, at least according to standard growth models because it does not affect directly fundamental sources for capital accumulation such as savings and investment. Nor does the functioning of the labor market affect education or the capacity to carry out research and development activities, which are the primary sources of endogenous long run growth. It therefore remains a question to understand how such a pattern whose influence is mostly indirect (i.e. second order) can have that huge (i.e. first order) impact so as to be a valid explanation for the Euro Zone - US growth gap. In this paper I ask two questions. First (how) can labor market institutions affect productivity growth ? Put differently, does labor market flexibility enhance growth and how? Second what are the policy implications that come out of the set of answers delivered to the first questions?

[3]Recently (march 2006), the president of the ECB, Jean-Claude Trichet, endorsed this view, in an interview declaring "anything that helps raising flexibility is good to fight joblessness in today's world". Both the IMF and the OECD also share to a similar belief: "To enjoy strong GDP growth, developed economies need, as a priority, policy frameworks that encourage competitive intensity. This means [...] encouraging labor market flexibility". (Finance & Development, march 2006)."[...] institutional structures and policy settings that favour competition and flexibility in capital and labour markets [...] also make a key difference to growth prospects. In particular, many of our countries need more competitive product markets; labour markets that adjust better and more rapidly to shocks". (The Sources of Economic Growth in OECD Countries [2003]) Last but not least, the Kok report on employment policy (2003) underlines the need for more flexibility in labor markets as a means to enforce the Lisbon agenda designed to make Europe the most competitive economic area in the world.

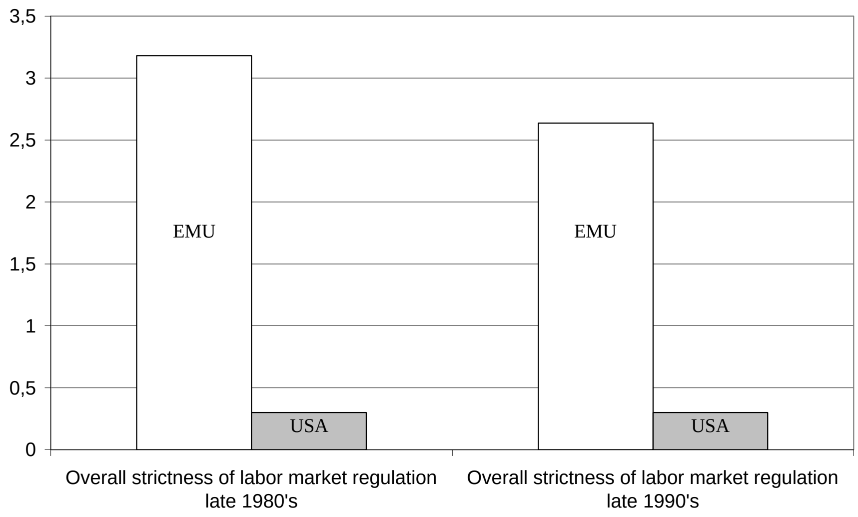

Figure 4: Labor Market Regulation. Source: OECD Employment Outlook.

The idea I will push forward in this paper consists in claiming that labor market institutions can account for sizeable productivity growth gaps in general and the for the US-Euro Zone productivity growth gap in particular when interactions between labor and credit markets are taken into account. The basic claim of the model consists in showing that on the one hand labor market flexibility always helps firms reducing their borrowing constraints. On the other hand however, labor market flexbility can decrease (resp. increase) firms incentives to invest in high total factor productivity projects when firms face tight (resp. wide) borrowing constraints. Labor market flexibility will therefore be positively associated with productivity growth if and only if capital markets are sufficiently well developed. This conclusion will finally prove to be confirmed through empirical evidence.

1.1. Mechanism of the model.

We model labor market flexibility as the possibility for firms to propose wage contracts contingent to the ex post marginal productivity of labor. When the labor market is flexible, then firms do not provide any insurance to workers against ex post fluctuations in labor productivity: labor compensation is then contingent to ex post effective labor productivity. On the contrary, when the labor market is said to be inflexible, then firms provide insurance to workers against ex post fluctuations in labor productivity and labor compensation is then related to the ex ante average and not the ex post effective productivity of labor. Put differently, labor market flexibility is inversely related to the degree of wage insurance provided by firms to workers[4].

In a simple model with risk neutral firms and risk averse workers, firms should optimally provide fixed wage contracts to workers with full insurance against ex post fluctuations in labor productivity. Now let us make two assumptions. First firms face capital market imperfections in the form of ex post imperfect enforceability. Second, firms can choose the project they invest in among different technologies with more productive technologies also embedding more volatile shocks. Then the wage contract they agree upon with workers has an influence on their borrowing capacity. Namely if firms provide contingent wage contracts -(part of) labor productivity risk is transferred to workers- then that can raise firms profits before debt repayments in the bad states of the world and thereby raise firms borrowing capacity[5]. As soon as firms marginal productivity of capital is larger than the risk free interest rate, then the policy consisting for firms to provide contingent wage contracts in order to alleviate borrowing constraints can raise expected profits.

Moreover the wage contract firms provide workers with modifies firm incentives for investment: when a firm decides to propose contingent wage contracts, it benefits on the one hand from an increase in its borrowing capacity while on the other hand, it has to pay a premium on its wage bill. Then when capital markets imperfections are large, if the firm invests in a highly productive technology, it looses the gain in terms of increased borrowing capacity since its productivity in the bad state is very low (because more productive projects are also more volatile). On the contrary, when capital markets imperfections are low, if the firm invests in a highly productive technology, although its productivity in the bad state is very low, it does not loose as much of its gain in terms of increased borrowing capacity because lenders are able somewhat to smooth (imperfectly) bad and good states of nature. As a result at the individual optimum, labor market

[4] One may argue that although wage flexibility is important, it remains a second order issue relative to employment flexibility as long as workers are more concerned with loosing their jobs than undergoing a wage cut. Although this point is well-taken, it is important to note that under the assumption that a Walarasian spot labor market exists at each date, compensation and employment risks are isomorphic at the aggregate level since at any date, the labor market balances supply from (previously sacked) workers and demand from firms, the wage rate being the equilibrium variable. Therefore under the assumption that a set of complete labor markets exists the dichotomy between wage and employment flexibility is irrelevant and one can focus on wage risk as long as it simplifies the analysis. The model focusing on "wage risk" is in particular more tractable insofar as one can rely on a static ex ante ex post model while the "employment risk" model definitely needs some type of time-to-build technology as to define a non degenerate choice for firms between short and long term labor contracts.

[5] Equivalently, when a firm adopts a contingent labor compensation scheme, this reduces the risk premium on its financial liabilities, the volume of capital borrowed being given.

flexibility is more likely to be associated with higher total factor productivity, the lower the capital market imperfections, i.e. the higher the degree of financial development.

To sum up, when capital imperfections are large, labor market flexibility is associated with more rapid capital accumulation but with lower total factor productivity. When capital imperfections are large, labor market flexibility is associated with higher growth through more rapid capital accumulation and through higher total factor productivity.

1.2. Related literature.

To be written.

1.3. Road map of the paper.

The paper is organized as follows. The following section lays down the model and its main assumptions. Section 3 describes the different strategies agents adopt as regards the labor and the capital market. In section 4, we build the general equilibrium of the economy. The individual and social optimality properties for the different possible equilibria are derived in section 5. The main results of the model as regards growth and labor market flexibility can then be found in section 6. Conclusions are eventually drawn in section 7.

2. The framework.

We consider a single good economy with three types of agents, entrepreneurs, lenders and workers. All agents live for two periods t and $t+1$. There is a continuum of unit mass of each of type of agent.

2.1. Entrepreneurs and lenders.

Entrepreneurs and lenders do not have any labor endowment but they have a capital endowment k at time t. Their preference writes as

$$U_e = (b_{t+1})^{\beta} (c_{t+1})^{1-\beta} \tag{2.1}$$

where b_{t+1} represents the time $t+1$ bequest an entrepreneur makes to its off-spring and c_{t+1} represents the time $t+1$ consumption. lenders can lend their capital k on the capital market. Entrepreneurs have access to a set of constant returns to scale technologies. Noting k the capital stock invested (be it entrepreneurs own funds or financial liabilities entrepreneurs have contracted) and l the number of workers hired, entrepreneurs' technologies write as

$$y_s = A_s k^{\alpha} l^{1-\alpha} \tag{2.2}$$

Entrepreneurs' technologies are subject to a macroeconomic shock s, There are two states of nature, a good $s = h$ and a bad one $s = l$ with $A_h > A_l$. Both states of nature are equiprobable. We adopt the following notations: we note m the mean, $m = \frac{A_h + A_l}{2}$ and σ the standard deviation, $\sigma = \frac{A_h - A_l}{2}$. Finally we assume that $\frac{\partial m}{\partial \sigma} > 0$: projects which are more productive on average also embed more volatile shocks.

An entrepreneur is faced with the following budget constraints: At time t, it can invest its own capital and borrow from capital markets to invest in its firm. Similarly, at time t lenders can lend their capital on the loan market. At time $t+1$, entrepreneurs and lenders divide their final income between consumption and bequest to the next generation of entrepreneurs. Noting s the volume of capital invested at time t, and

k_i agent i initial capital endowment, an entrepreneur or a lender faces the following budget constraints:

$$\begin{aligned} s_t &\leq k_i \\ c_{t+1} + b_{t+1} &\leq \left(1 + \rho_{i,s}\right) s_t \end{aligned} \tag{2.3}$$

where $\rho_{i,s} = r$ if the agent i is a lender and $\rho_{i,s}$ is the firm's return on asset in state s if agent i is an entrepreneur. Entrepreneurs and lenders program therefore writes as

$$\begin{aligned} &\underset{b_{t+1};c_{t+1}}{max} \; (b_{t+1})^{\beta} \, (c_{t+1})^{1-\beta} \\ &\text{s.t. } c_{t+1} + b_{t+1} \leq \left(1 + \rho_{i,s}\right) k_i \end{aligned} \tag{2.4}$$

Once production has taken place and liabilities have been paid back, entrepreneurs and lenders problem consists in choosing the volume of goods they want to devote to bequest and consumption given their final income. Given that entrepreneurs and lenders know the return $\rho_{i,s}$ when they choose how much to consume and how much to bequeath, the optimal bequest b^*_{t+1} and the optimal consumption c^*_{t+1} write as

$$\begin{aligned} b^*_{t+1} &= \beta \left(1 + \rho_{i,s}\right) k_i \\ c^*_{t+1} &= (1 - \beta) \left(1 + \rho_{i,s}\right) k_i \end{aligned} \tag{2.5}$$

Assuming as previously that $\beta = \frac{1}{2}$, entrepreneurs and lenders expected indirect utility then writes as

$$V_e = \frac{1}{2} E \left[\left(1 + \rho_{i,s}\right) k_i\right] \tag{2.6}$$

In the case of a lender the optimal decision consists in lending its capital k on the capital market. On the contrary, in the case an entrepreneur, its problem consists in maximizing its expected profit, i.e. $E\left[\left(1 + \rho_{i,s}\right) k_i\right]$. To do so, entrepreneurs take two types of decisions: on the one hand they determine the volume of labor l and the amount of capital d they want to invest. On the other hand, they choose the labor contract $\{w_s\}_s$ they offer to workers and the technology $m(\sigma)$ they want to invest in.

2.2. Workers.

At time t, workers have a labor endowment equal to one but no capital endowment. Their preference writes as

$$U_w = (c_t)^{\beta} (c_{t+1})^{1-\beta} \tag{2.7}$$

Workers borrow capital to finance their time t consumption c_t. They also provide their labor endowment to firms. At time $t+1$, they use their labor income to finance their time $t+1$ consumption c_{t+1} and pay back the loans contracted at time t. Let us note w_s, a worker's time $t+1$ labor income when state s happens at time $t+1$, then the budget constraints each worker faces write as

$$\begin{aligned} c_t &\leq d_t \\ c_{t+1} &\leq w_s - (1+r)\, d_t \end{aligned} \tag{2.8}$$

where d_t is the amount of debt a worker contracts at time t and r is the interest rate on period t loans due at time $t+1$. Workers' program therefore writes as

$$\begin{aligned} &\underset{c_t;c_{s,t+1}}{max}\ (c_t)^{\beta}\, E\,(c_{s,t+1})^{1-\beta} \\ &\text{s.t. } c_{s,t+1} \leq w_s - (1+r)\, c_t \end{aligned} \tag{2.9}$$

2.3. Workers optimal consumption choices.

The problem for workers consists in choosing the optimal consumption path $(c_t; c_{s,t+1})$ given the interest rate on the capital market r, and the wage contract $\{w_s\}_s$ they have agreed on with entrepreneurs. Noting c_t^* the optimal time t consumption, the first order condition of the problem (**??**) then writes as

$$\frac{\beta w_h - (1+r)\, c_t^*}{(1+r)\, c_t^* - \beta w_l} = \left[\frac{w_h - (1+r)\, c_t^*}{w_l - (1+r)\, c_t^*}\right]^{\beta} \tag{2.10}$$

In the case where $\beta = \frac{1}{2}$, the last condition simplifies as

$$(1 + r)\, c_t^* = \frac{w_h}{w_h + w_l} w_l \tag{2.11}$$

This means that consumers optimal first period consumption is such that its second period cost is equal to a given fraction of the lowest second period wage income. Thereby the optimal time $t+1$ consumption $c_{s,t+1}^*$ is always strictly positive:

$$c_{s,t+1}^* = \frac{w_s}{w_h + w_l} w_s \tag{2.12}$$

One can also note that the optimal first period consumption decreases, every thing else equal, with any mean preserving spread in the wage contract $\{w_s\}_s$. This corresponds to a standard precautionary savings motive: when income volatility increases and in the absence of any financial instrument to hedge income fluctuations, workers decide to reduce the amount of capital borrowed from capital market in order not to compromise their future consumption. The expected indirect utility of consumers then writes as

$$V_w = \frac{1}{2} \left(\frac{w_l w_h}{1 + r} \right)^{\frac{1}{2}} \tag{2.13}$$

As expected, consumers' expected indirect utility decreases with the interest rate and increases with the income w_s. Moreover consumers are indifferent between two different wage contracts $\{w_{1,s}\}_s$ and $\{w_{2,s}\}_s$ if and only if for they yield the same level of indirect utility, every thing else equal. This then writes as

$$w_{1,l} w_{1,h} = w_{2,l} w_{2,h}$$

Assuming for instance that $\{w_{1,s}\}_s$ is a fixed wage contract, i.e. $w_{1,l} = w_{1,h} = w$ while $\{w_{2,s}\}_s$ is a strictly contingent contract, i.e. $w_{2,s} = \eta_s w$ with $\eta_l \neq \eta_h$, then the last condition simplifies as

$$\eta_h = \eta_l^{-1} \tag{2.14}$$

2.4. Markets.

At the beginning of each period, there are two different markets which open one after the other. The first market on which transactions take place is the capital market. On this market, entrepreneurs and workers sign one period contracts with lenders. We assume that entrepreneurs face ex post imperfect enforceability. They can default on their financial claims at some cost. The risk free interest rate is noted r. The second market on which transactions take place is the labor market. The labor market is competitive. At the end of the period, firms pay wages to workers and financial contracts are paid back. An entrepreneur profits in state s write as

$$\pi_{1,s} = y_s\left(d,l\right) - w_s l - \left(1+r\right)d$$

where d is the volume of capital the entrepreneur has borrowed from the capital market and l is the number of workers he has hired. Since transactions are imperfectly enforceable, firms can always retain a fraction τ of their output and abstract from paying their debts (the marginal cost to default is in this case equal to $1-\tau$). In this case conditional on state s happening, they earn

$$\pi_{2,s} = \tau\left(y_s\left(d,l\right) - w_s l\right)$$

with $\tau \leq 1$. To be incentive compatible the face value of the entrepreneur financial liabilities $\left(1+r\right)d$ and the wage bill $w_s l$ must be such that the cost to pay back one's liabilities is lower than the cost to default. Then a firm liabilities must be such that

$$\left(1+r\right)d \leq \left(1-\tau\right)\left(y_s\left(d,l\right) - w_s l\right) \tag{2.15}$$

This constraint is valid only as long as firms are not able to issue contingent debt. In the case where firms can issue contingent debt, then the borrowing constraint firms face writes as

$$\left(1+r^*\right)d \leq \left(1-\tau\right)\max_s\left(y_s\left(d,l\right) - w_s l\right) \tag{2.16}$$

where r^* is the interest rate on risky debt.

3. The no contingent debt economy.

3.1. Firms optimal behavior.

Given that firm decisions are sequential, the program of a representative firm can be solved with backward induction. First we determine the strategy of the representative firm as regards the volume of labor it hires, then we turn to the capital demand of the representative firm and finally we determine the optimal wage contract and the optimal technology. Let us consider a firm i which has chosen a given compensation scheme $\{w_l, w_h\}$ when other firms choose to propose an equivalent certain wage rate w. Then assuming that the compensation scheme $\{w_l, w_h\}$ verifies workers participation constraint, i.e. $w_l w_h \geq w^2$, where w is the certain equivalent wage rate proposed on the labor market, firm i program first consists in choosing the number of worker l_i such that it solves

$$\max_{l_i} E\Pi\left(l_i\right) = m\left(\sigma\right)\left(k_i + d_i\right)^{\alpha} l_i^{1-\alpha} - Ew_s l_i - \left(1+r\right) d_i \tag{3.1}$$

The solution to this problem (firm i optimal demand for labor) then writes as

$$\left(1-\alpha\right) m\left(\sigma\right)\left(k_i + d_i\right)^{\alpha} l_i^{-\alpha} = Ew_s \tag{3.2}$$

Now one can solve the problem consisting for firm i in determining its optimal amount of debt finance d_i. This amounts to solve the following problem

$$\begin{gathered} \max_{d_i} E\Pi\left(d_i\right) = m\left(\sigma\right)\left(k_i + d_i\right)^{\alpha} l_i^{1-\alpha} - Ew_s l_i - \left(1+r\right) d_i \\ \text{s.t.} \begin{cases} \left(1-\alpha\right) m\left(\sigma\right)\left(k_i + d_i\right)^{\alpha} l_i^{-\alpha} = Ew_s \\ \forall s,\ \left(1+r\right) d_i \leq \left(1-\tau\right)\left[A_s\left(k_i + d_i\right)^{\alpha} l_i^{1-\alpha} - w_s l_i\right] \end{cases} \end{gathered} \tag{3.3}$$

Introducing firm i optimal labor demand (3.2) in both the objective function (3.1) and the borrowing constraints $(1-\tau)\left[A_s\left(k_i+d_i\right)^\alpha l_i^{1-\alpha}-w_s l_i\right] \geq (1+r)\, d_i$ we can rewrite (3.3) as the following problem

$$\begin{aligned} &\max_{d_i} E\Pi\left(d_i\right)=\alpha m\left(\sigma\right)\left[\tfrac{1-\alpha}{Ew_s} m\left(\sigma\right)\right]^{\frac{1-\alpha}{\alpha}}\left(k_i+d_i\right)-\left(1+r\right) d_i \\ &\text{s.t. } \forall s,\ \left(1+r\right) d_i \leq \left(1-\tau\right)\left[\tfrac{1-\alpha}{Ew_s} m\left(\sigma\right)\right]^{\frac{1-\alpha}{\alpha}}\left[A_s-\left(1-\alpha\right)\tfrac{m(\sigma)}{Ew_s} w_s\right]\left(k_i+d_i\right) \end{aligned} \tag{3.4}$$

The labor contract $\{w_s\}_s$ has two different effects on the borrowing capacity of the firm. An increase in the volatility of labor compensation raises the cost of labor and as a matter of fact reduces the productivity of the firm because the efficiency frontier the firm faces is less favorable. On the contrary however, an increase in the volatility of labor compensation can raise profits before debt repayments and hence raise the cost for the firm to default and thereby increase the borrowing capacity of the firm. Similarly, the choice of the technology σ has two different effects on the borrowing capacity of the firm. On the one hand an increase in the volatility of technological shocks raises by definition the firm average productivity. On the other hand however, an increase in the volatility of technological shocks reduces the productivity of the firm conditional on a bad state of nature. Moreover for a given compensation scheme $\{w_s\}_s$ an increase in the volatility of technological shocks increases the firm demand for labor and hence further reduces profits before debt repayments conditional on a bad state of nature.

There are then two different cases: if $\alpha m\left(\sigma\right)\left[\frac{1-\alpha}{Ew_s} m\left(\sigma\right)\right]^{\frac{1-\alpha}{\alpha}} \leq 1+r$, then firms simply lend their capital on financial markets because lending is more profitable than investing in the firm. Firms expected profits write as $E\Pi^* = (1+r)\,k$. As is clear the expected profits of firm i do not depend upon nor on the type of the labor contract nor on the technology chosen. On the contrary when $\alpha m\left(\sigma\right)\left[\frac{1-\alpha}{Ew_s} m\left(\sigma\right)\right]^{\frac{1-\alpha}{\alpha}} > 1+r$ then firm i optimal expected profits write as

$$E\Pi=\frac{\alpha m\left(\sigma\right)-\left(1-\tau\right)\left[A_j-\left(1-\alpha\right)\frac{w_j}{Ew_s} m\left(\sigma\right)\right]}{\left(1+r\right)\left[\frac{Ew_s}{(1-\alpha)m(\sigma)}\right]^{\frac{1-\alpha}{\alpha}}-\left(1-\tau\right)\left[A_j-\left(1-\alpha\right)\frac{w_j}{Ew_s} m\left(\sigma\right)\right]}\left(1+r\right) k_i$$

where j is the state of nature for which the borrowing constraint is binding:

$$j = \arg\min_{p} \left[A_p - (1-\alpha) \frac{w_p}{Ew_s} m(\sigma) \right]$$

Assuming for now on that $\tau = 1$, noting $w_s = \eta_s w$, and simplifying the last expression, we obtain that the state of nature for which the borrowing constraint is binding is the bad state, i.e. $j = l$, if and only if

$$\eta_l^2 > \frac{(1-\alpha) m - \sigma}{(1-\alpha) m + \sigma}$$

Then firms expected profits write as

$$\frac{E\Pi(\sigma,\eta)}{(1+r) k_i} = \frac{\alpha - (1-\tau)\left[1 - \frac{\sigma}{m} - 2(1-\alpha)\frac{\eta^2}{1+\eta^2}\right]}{\alpha - (1-\tau)\left[1 - \frac{\sigma}{m} - 2(1-\alpha)\frac{\eta^2}{1+\eta^2}\right] - \left[\alpha - \frac{1+r}{m}\left[\frac{w}{(1-\alpha)m}\frac{1+\eta^2}{2\eta}\right]^{\frac{1-\alpha}{\alpha}}\right]}$$

where for now on η stands for η_l. As is clear in this last case, the expected profits of firm i do depend upon on the type of the labor contract and the technology chosen. Firms' expected profits can be positively or negatively related to wage variability since on the one hand wage variability raises labor costs and therefore reduces the firm's productivity while on the other hand, wage variability can ease the firm's borrowing constraints by increasing minimum profits before debt repayments. Similarly, choosing a more productive technology raises expected profits on the one hand because total factor productivity is larger. On the other hand however, choosing a more productive technology means every thing else equal a lower borrowing capacity due to more volatile shocks.

The next propositions then derive the main properties of the optimal wage contract and the optimal technology in this last context.

Proposition 1. *As long as firms credit constraint is binding, the optimal wage contract* $\{w_l^*, w_h^*\}$ *is such that* $w_l^* < w < w_h^*$. *Moreover the difference* $w_h^* - w_l^*$ *decreases with the risk free interest rate* r.

Proposition 2. *When firms cannot issue contingent debt, noting* $\varepsilon(y)$ *the elasticity of* y *wrt to* σ, *the* *optimal technology σ^* is an increasing function of the optimal wage contract η^* if and only if*

$$\varepsilon\left(\frac{\partial m}{\partial \sigma}\right) < \varepsilon(m)\left[\varepsilon(m) - 1\right]$$

Proof. c.f. appendix 7.2 for a proof of proposition 1. As concerns proposition 2, the first order condition determining the optimal wage contract η^* writes as

$$\alpha = \frac{1+r}{m}\left[\frac{Ew_s}{(1-\alpha)m}\right]^{\frac{1-\alpha}{\alpha}}\left[1 + \frac{1-\eta^4}{4\eta^2}\frac{\alpha - (1-\tau)\left[1 - \frac{\sigma}{m} - 2(1-\alpha)\frac{\eta^2}{1+\eta^2}\right]}{\alpha\tau}\right]$$

while the first order condition determining the optimal technology σ^* writes as

$$\alpha = \frac{1+r}{m}\left[\frac{Ew_s}{(1-\alpha)m}\right]^{\frac{1-\alpha}{\alpha}}\left[1 + \frac{m}{\sigma}\frac{\varepsilon(m)}{1-\varepsilon(m)}\frac{\alpha - (1-\tau)\left[1 - \frac{\sigma}{m} - (1-\alpha)\frac{\eta^2}{1+\eta^2}\right]}{\alpha\tau}\right]$$

where $\varepsilon(y) = \frac{\sigma}{y}\frac{\partial y}{\partial \sigma}$. Therefore the individually optimal wage contract and the individually optimal technology verify the following condition that

$$\varepsilon(m) = \frac{1-\eta^4}{4\eta^2}\varepsilon\left(\frac{\sigma}{m}\right)\frac{\sigma}{m}$$

The optimal technology σ is therefore an increasing function of the optimal wage contract η if and only if

$$\frac{\partial}{\partial \sigma}\left[\frac{\varepsilon(m)}{\varepsilon\left(\frac{\sigma}{m}\right)\frac{\sigma}{m}}\right] < 0$$

Applying the following property

$$\frac{\partial \varepsilon(m)}{\partial \sigma} = \frac{\varepsilon(m)}{\sigma}\left[1 - \varepsilon(m) + \varepsilon\left(\frac{\partial m}{\partial \sigma}\right)\right]$$

the last condition $\frac{\partial}{\partial \sigma}\left[\frac{\varepsilon(m)}{\varepsilon\left(\frac{\sigma}{m}\right)\frac{\sigma}{m}}\right] < 0$ ends up being equivalent to

$$\varepsilon\left(\frac{\partial m}{\partial \sigma}\right) < \varepsilon(m)\left[\varepsilon(m) - 1\right]$$

In this case, the condition

$$\varepsilon(m) = \frac{1-\eta^4}{4\eta^2}\varepsilon\left(\frac{\sigma}{m}\right)\frac{\sigma}{m}$$

defines a positive relationship between η and σ while the condition

$$\alpha = \frac{1+r}{m}\left[\frac{Ew_s}{(1-\alpha)m}\right]^{\frac{1-\alpha}{\alpha}}\left[1+\frac{\varepsilon(m)}{1-\varepsilon(m)}\left[\frac{1-\tau}{\alpha\tau}+\frac{m}{\sigma}\frac{\alpha-(1-\tau)\left[1-(1-\alpha)\frac{\eta^2}{1+\eta^2}\right]}{\alpha\tau}\right]\right]$$

defines a negative relationship between η^* and σ^*. These two conditions therefore determine a unique couple (σ^*, η^*) which maximizes firms expected profits. ■

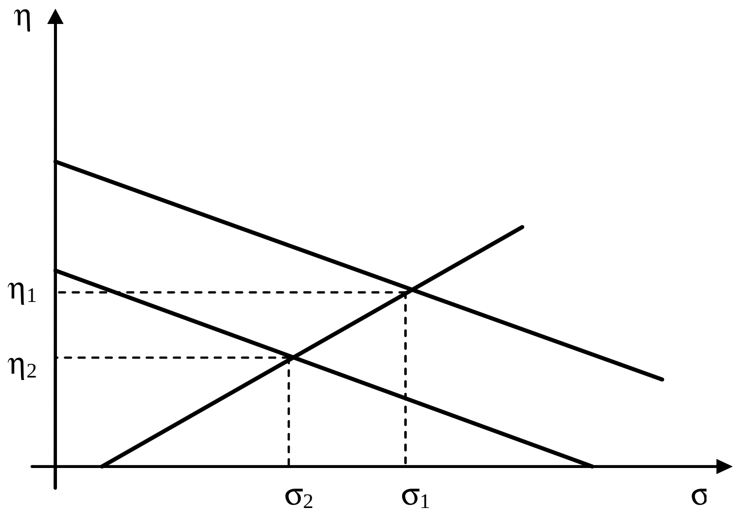

Figure 5: Firm optimal strategies in partial equilibrium when contingent debt is not available.

In this proposition, we have three different properties. The first one states that the situation where firms are not able to borrow capital up to the point where the expected marginal productivity of capital is equal to the risk free interest rate is a necessary and sufficient condition for firms to provide contingent compensation schemes to workers. This property is very natural: consider a firm which provides fixed wage contracts and faces a binding borrowing constraint in the sense that its expected marginal productivity of capital is larger than the interest rate on the capital market when the borrowing capacitty is exhausted. Then on the one hand there is a strictly positive cost to being unable to borrow a larger volume of capital. On the other hand providing contingent wage contracts could help increase the volume of capital it is possible to borrow while the marginal increase in labor cost is zero with fixed wage contracts since

$$\left.\frac{\partial E w_s}{\partial \eta}\right|_{\eta=1} = \left.\frac{\partial}{\partial \eta}\left(\eta + \frac{1}{\eta}\right)\right|_{\eta=1} = \left.\left(1 - \frac{1}{\eta^2}\right)\right|_{\eta=1} = 0$$

Therefore as soon as firms are credit constrained, they have incentives to provide contingent wage contracts basically because a binding credit constraint is always marginally costly while providing flexible labor contracts is always marginally cost free. Secondly proposition 1 states that a large interest rate reduces firms incentives to provide contingent labor compensation schemes. This is natural since a large interest rate reduces firms demand for capital and therefore reduces the need to provide contingent labor contracts. Finally proposition 2 shows that firms which choose to provide workers with more flexible labor contracts also choose to invest in less productive technologies. Once again this is very natural: if a firm decides to provide flexible labor contracts in order to alleviate its credit constraints, it also undergoes an increase in labor costs due to the risk premium it pays to workers. Now investing in a highly productive technology also means accepting large fluctuations in the firm's productivity. Given that lenders compute the borrowing constraint they impose to firms w.r.t. the bad state of nature, investing in a highly productive technology and providing flexible labor contracts would mean that the firm would pay for a risk premium on workers wages without benefiting from an increased borrowing capacity since a highly productive technology is very unproductive when the bad state happens. Therefore firms prefer to invest in low productivity technologies when they provide flexible labor compensation contracts. For instance when $m(\sigma) = m\sigma^{\gamma}$ with $m > 0$ and $0 < \gamma < 1$ then the labor market flexibility is always TFP reducing since $\varepsilon(m) = \gamma$ and $\varepsilon\left(\frac{\partial m}{\partial \sigma}\right) = \gamma - 1 < 0$ which implies that the condition

$$\varepsilon\left(\frac{\partial m}{\partial \sigma}\right) < \varepsilon(m)\left[\varepsilon(m) - 1\right]$$

is always satisfied.

3.2. The general equilibrium of the economy.

3.2.1. The equilibrium of the capital market.

Up to now the risk free interest rate has been taken to be exogenous. To determine the equilibrium interest rate that prevails in the economy, one simply needs to equal the supply for capital provided by lenders and the demand for capital expressed by entrepreneurs and consumers. Put differently the equilibrium interest rate is determined through

$$k_l = d + l\,(c_t^*)_1 + (1-l)\,(c_t^*)_2$$

where k_l represents lenders capital supply, d firms aggregate demand for capital, l firms aggregate demand for labor, $(c_t^*)_1$ is the first period consumption of workers hired by entrepreneurs and $(c_t^*)_2$ is the first period consumption of workers who have not been hired by entrepreneurs. Entrepreneur i labor demand l_i and capital demand d_i respectively write as

$$l_i = \left[\frac{(1-\alpha)\,m}{Ew_s}\right]^{\frac{1}{\alpha}} (k_i + d_i)$$

$$d_i = \frac{A_l - 2\,(1-\alpha)\,m\frac{\eta^2}{1+\eta^2}}{(1+r)\left[\frac{Ew_s}{(1-\alpha)m}\right]^{\frac{1-\alpha}{\alpha}} - \left[A_l - 2\,(1-\alpha)\,m\,(\sigma)\,\frac{\eta^2}{1+\eta^2}\right]} k_i$$

Given that entrepreneurs are identical, that $w_s = \eta_s w$ with $w_l w_h = w^2$, the equilibrium of the capital market simplifies as

$$k_l - \frac{1}{1+r}\frac{w}{2} = \frac{A_l + 2\,(1-\alpha)\,m\,(\sigma)\,\frac{\eta}{1+\eta^2}\left[\frac{\eta}{1+\eta^2} - \frac{1}{2} - \eta\right]}{(1+r)\left[\frac{Ew_s}{(1-\alpha)m}\right]^{\frac{1-\alpha}{\alpha}} - \left[A_l - (1-\alpha)\,m\frac{\eta^2}{1+\eta^2}\right]} k$$

3.2.2. The equilibrium of the labor market.

At the equilibrium of the labor market, labor demand balances labor supply. Given that entrepreneurs are all identical, noting k firms aggregate capital stock and d firms aggregate borrowing, the expected wage rate Ew_s is then equal to the expected marginal productivity of labor

$$Ew_s = (1-\alpha)\,m\,(k+d)^{\alpha}$$

and the uncontingent wage rate writes as

$$w = \frac{2\eta}{1+\eta^2}(1-\alpha)\,m\,(k+d)^\alpha \tag{3.5}$$

3.2.3. General Equilibrium.

The general equilibrium of the economy corresponds to the situation where all markets, the capital and the labor market, balance supply and demand. To determine the properties of this situations, one simply need to plug the two last expressions in the capital market equilibrium condition, we end up with an equilibrium interest rate r being defined through

$$k_l = \left[A_l - (1-\alpha)\,m\frac{2\eta^2}{1+\eta^2}\left[1-\frac{1}{1+\eta^2}\right]\right]\frac{(k+d)^\alpha}{1+r} \tag{3.6}$$

where the aggregate volume of capital d firms borrow at the general equilibrium of the economy is such that

$$(1+r)\,d = \left[A_l - \frac{2\eta^2}{1+\eta^2}(1-\alpha)\,m\right](k+d)^\alpha \tag{3.7}$$

Finally firm optimal technology is such that

$$\frac{m}{\sigma}\frac{\varepsilon(m)}{1-\varepsilon(m)} = \frac{1-\eta^4}{4\eta^2} \tag{3.8}$$

and the optimal labor contract firm propose to workers verifies

$$\frac{1+r}{m}\left[\frac{Ew_s}{(1-\alpha)\,m}\right]^{\frac{1-\alpha}{\alpha}}\left[1+\frac{m}{\sigma}\frac{\varepsilon(m)}{1-\varepsilon(m)}\frac{\alpha-(1-\tau)\left[1-\frac{\sigma}{m}-(1-\alpha)\frac{\eta^2}{1+\eta^2}\right]}{\alpha\tau}\right] = \alpha \tag{3.9}$$

Proposition 3. *The general equilibrium of the economy is represented by the vector (η, σ, r, d, w). Firms choose their optimal labor contract η and their optimal technology σ respectively such that (3.9) and (3.8) are verified. The equilibrium interest rate on the capital market r and the volume of capital d firms are able to borrow are respectively such that (3.6) and (3.7) are verified.*

Proof. Straightforward. ■

A few remarks here are in order. First firms borrowing capacity decreases with the interest rate. This is due first to larger debt repayments second because firms choose optimally to propose less contingent compensation schemes to workers and third because firms optimally choose to invest in more productive, yet more risky technologies on the other hand. As a result of these three effects, firms demand for capital is walrasian: it decreases with the cost of capital. Second, workers demand for capital decreases with the interest rate as a basic trade-off between contemporary and future consumption. This is due a standard substitution effect. However an increase in the interest rate also has an income effect: it modifies workers future labor income and therefore affects workers contemporary consumption and thereby workers demand for capital. On the one hand firms raise fewer capital when the cost of capital increases. Since capital and labor are complements in firms production function workers demand for capital decreases with the interest rate according to this first effect. On the other hand however, firms invest in more productive technologies when the interest rate increases. This second effect raises every thing else equal, the marginal productivity of labor. Hence workers future labor income is raised and workers increase their contemporary consumption. Therefore the income effect is *a priori* ambigious since labor income can increase or decrease following an change in the cost of capital. However workers contemporary consumption (i.e. demand for capital) is affected in a third manner. When the cost of capital increases, firms provide less contingent labor compensation schemes to workers. Therefore the need for workers to reduce their consumption as a hedging device against labor income fluctuations is reduced. Therefore, workers demand for capital increases as the cost of capital increases according to this last effect. To sum up, workers demand for capital can well be increasing in the cost of capital if the last two effects dominate the first one.

Then if the increase in workers demand for capital compensates for the decrease in firms demand for capital, there can exist a range of interest rates for which the global demand for capital increases with the interest rate due to the fact that the reduction in firms demand for capital is more than offset by the increase in workers demand for capital. As a result, there can be multiple equilibria. In the first one the interest rate is low, firms propose relatively flexible labor contracts to workers and invest in relatively unproductive technologies. Workers have a low contemporary consumption and firms borrow the bulk of available capital on the credit market. In the second equilibrium the interest rate is large, firms propose relatively fixed labor contracts to workers and invest in relatively productive technologies. Workers have a large contemporary consumption and firms borrow only a relatively small share of available capital on the credit market, the bulk of available capital being used to finance workers' consumption.

It is therefore unclear which of the low or the large labor market flexibility equilibrium is the Pareto optimal equilibrium. Nor is it clear if the Pareto optimal equilibrium is the also high growth equilibrium or not. However the model clearly shows that different labor market institutions can emerge and remain existent in a general equilibrium framework as long as some market imperfections are being introduced. The view that the supposed lack of flexibility in Continental European labor markets is an out-of-equilibrium phenomenon, or put differently, is a pure political economy equilibrium is therefore not necessarily completely relevant. Structural cross-country differences in labor market institutions can well be an equilibrium phenomenon entirely based on pure economic mechanisms.

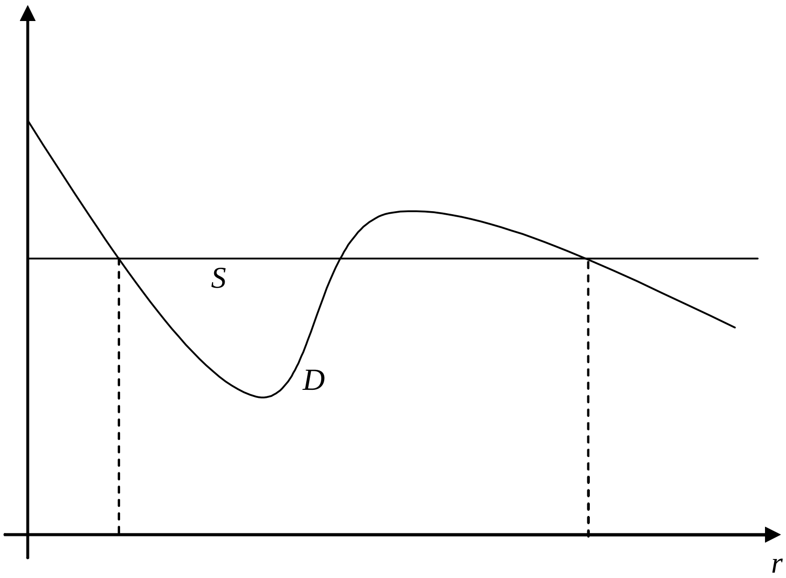

Figure 6: Equilibrium of the capital market.

3.3. The welfare analysis.

Given that the economy is populated by heterogenous agents, the welfare analysis can be carried out using two different welfare criteria: the utilitarian or the egalitarian social welfare. In the case of the utilitarian welfare criterion, social welfare is simply the sum of individual welfare weighted by each type of agents weight in the total population. Since lenders, workers and entrepreneurs have identical weights in the economy, noting W_{util} the utilitarian welfare criterion, we have

$$W_{util} = V_w + V_f + V_l$$

where V_w represents workers welfare, V_f represents firms welfare and V_l represents lenders welfare. At the general equilibrium of the economy, using in particular expressions (3.5) and (3.6) the different individual welfare functions V_i write as

$$\begin{aligned} V_w &= \frac{2\eta}{1+\eta^2} \frac{(1-\alpha)}{(1+r)^{\frac{1}{2}}} \frac{m(\sigma)(k+d)^{\alpha}}{2} \\ V_f &= \left[\sigma + (1-\alpha)\left[\frac{2\eta^2}{1+\eta^2} - 1\right]\right] \frac{m(\sigma)(k+d)^{\alpha}}{2} \\ V_l &= \left[1 - \sigma - (1-\alpha)\frac{2\eta^2}{1+\eta^2}\left[1 - \frac{1}{1+\eta^2}\right]\right] \frac{m(\sigma)(k+d)^{\alpha}}{2} \end{aligned}$$

Therefore the utilitarian social welfare criterion can write as

$$W_{util} = \left[\frac{\alpha}{1-\alpha} + \frac{2\eta}{1+\eta^2}\left(\frac{1}{\sqrt{1+r}} + \frac{\eta}{1+\eta^2}\right)\right] \frac{(1-\alpha)\, m(\sigma)(k+d)^{\alpha}}{2} \tag{3.10}$$

Proposition 4. *When the economy exhibits multiple equilibria, then the socially optimal equilibrium is the low labor market flexibility equilibrium.*

Proof. At at the general equilibrium of the economy, the interest r, the optimal labor contract η, the volume of debt d firms borrow and firms' optimal technology σ verify the capital market equilibrium condition

(3.6)

$$k = \left[\frac{1-\sigma}{1-\alpha} - \frac{2\eta^2}{1+\eta^2}\left[1 - \frac{1}{1+\eta^2}\right]\right] \frac{(1-\alpha)\, m(\sigma)\,(k+d)^{\alpha}}{1+r}$$

Therefore from expression (3.10) the utilitarian social welfare can be simplified as

$$W_{util}(\eta, r) = \frac{\left[\frac{\alpha}{1-\alpha} + 2\left[\frac{\eta}{1+\eta^2}\right]^2\right]\sqrt{1+r} + 2\frac{\eta}{1+\eta^2}}{\frac{1-\sigma}{1-\alpha} - 2\left[\frac{\eta^2}{1+\eta^2}\right]^2} \frac{k\sqrt{1+r}}{2} \tag{3.11}$$

As is clear this expression is useful since it only depends upon the cost of capital r and the labor contract η which are positively correlated across equilibria: the high labor market flexibility equilibrium is also the low interest rate equilibrium. From expression (3.11), it is clear that a larger interest rate r increases every thing else equal, the utilitarian social welfare criterion. As to the effect of the labor contract η, the utilitarian social welfare criterion can be written as $W_{util} \equiv N(\eta)/D(\eta)$ with

$$\begin{aligned} N(\eta) &= \left[\frac{\alpha}{1-\alpha} + 2\left[\frac{\eta}{1+\eta^2}\right]^2\right]\sqrt{1+r} + 2\frac{\eta}{1+\eta^2} \\ D(\eta) &= \frac{1-\sigma}{1-\alpha} - 2\left[\frac{\eta^2}{1+\eta^2}\right]^2 \end{aligned}$$

As is clear, the numerator $N(\eta)$ is strictly increasing in η and r. As to the denominator $D(\eta)$, it is a strictly decreasing function of η. Therefore social welfare under the utilitarian criterion increases with η and r. This implies that the low labor market flexibility equilibrium maximizes social welfare. ■

The intuition for this result is fairly simple: social welfare is maximized at the low flexibility equilibrium for three reasons. First because this equilibrium allocates risk to agents which are the least risk averse in the economy. Second because it allocates capital to those which have no other means to raise their utility. Third because it gives incentives to firms to invest in projects with high productivity which benefits all agents in the economy, workers and lenders in particular. For these three reasons, when the economy faces multiple equilibria, the Pareto optimal equilibrium is always the low labor market flexibility equilibrium.

4. The contingent debt economy.

4.1. Firms optimal behavior.

Up to now, we have restricted firms choices as concerns financial liabilities to uncontingent debt. Now let us assume that firms can issue contingent debt. The borrowing constraint they face now writes as

$$(1-\tau)\min_{s}\left(y_s\left(d,l\right)-w_s l\right) < \left(1+r^*\right)d \leq (1-\tau)\max_{s}\left(y_s\left(d,l\right)-w_s l\right) \tag{4.1}$$

where r^* represents the interest rate on contingent debt. Moreover let us assume without generality that the firm defaults in the bad of nature $s=l$ and pays back its debts in the good state of nature, $s=h$. Then the program of this firm writes as

$$\max_{l_i} E\Pi\left(l_i\right)=\frac{1}{2}\left[A_h\left(k_i+d_i\right)^{\alpha}l_i^{1-\alpha}-w_h l_i-\left(1+r^*\right)d_i\right]+\frac{\tau}{2}\left[A_l\left(k_i+d_i\right)^{\alpha}l_i^{1-\alpha}-w_l l_i\right] \tag{4.2}$$

Noting $m\left(\tau\right)=A_h+\tau A_l,\ m\left(\tau,\phi\right)=\left(1-\tau\right)A_h+\phi A_l,\ w\left(\tau\right)=w_h+\tau w_l,\ w\left(\tau,\phi\right)=\left(1-\tau\right)w_h+\phi w_l$, and solving the problem of the firm similarly to what has been done in the previous section, the firm labor demand first writes as

$$\left[\frac{(1-\alpha)\,m\left(\tau\right)}{w\left(\tau\right)}\right]^{\frac{1}{\alpha}}\left(k_i+d_i\right)=l_i \tag{4.3}$$

Now as concerns lenders, we can derive the risk premium on contingent debt r^*-r (r being the risk free interest rate) from a no arbitrage condition. Since lenders are risk neutral, the risk free interest rate r and the interest rate on contingent debt r^* verify the following condition

$$\left(1+r\right)d=\frac{1}{2}\left(1+r^*\right)d+\frac{\phi}{2}\left[A_l\left(k_i+d_i\right)^{\alpha}l_i^{1-\alpha}-w_l l_i\right] \tag{4.4}$$

where ϕ is the fraction of net output lenders are able to seize in case of default. Assumuing that $\phi < 1 - \tau$ we can rule out the case where the seized output would be larger than the face value of firms debts:

$$\phi \left[A_l \left(k_i + d_i \right)^{\alpha} l_i^{1-\alpha} - w_l l_i \right] < \left(1 + r^* \right) d$$

Therefore introducing the labor demand (4.3) into the expected profit function (4.2), we end up with the following expressions: when firms want to issue contingent debt, there expected profits write as

$$E\Pi \left(d_i \right) = \left[\frac{\left(1 - \alpha \right) m \left(\tau \right)}{w \left(\tau \right)} \right]^{\frac{1-\alpha}{\alpha}} \alpha \frac{m \left(\tau \right)}{2} \left(k_i + d_i \right) - \frac{1}{2} \left(1 + r^* \right) d_i$$

Similarly, introducing the labor demand (4.3) into the no arbitrage condition (4.4) we end up with the following expressions: when firms want to issue contingent debt, the capital supply function linking the volume of capital d they raise to the risk free interest rate r and the risk premium $r^* - r$ writes as

$$\left(1 + r \right) d_i = \frac{1}{2} \left(1 + r^* \right) d_i + \frac{\phi}{2} \left[A_l - \frac{\left(1 - \alpha \right) m \left(\tau \right)}{w \left(\tau \right)} w_l \right] \left[\frac{\left(1 - \alpha \right) m \left(\tau \right)}{w \left(\tau \right)} \right]^{\frac{1-\alpha}{\alpha}} \left(k_i + d_i \right) \tag{4.5}$$

Finally introducing the no arbitrage condition (4.5) into the borrowing constraints (4.1) the program which determines the firm optimal capital demand therefore writes as

$$\begin{aligned} \max_{d_i} E\Pi \left(d_i \right) &= \tfrac{1}{2} \left[\tfrac{(1-\alpha) m(\tau)}{w(\tau)} \right]^{\frac{1-\alpha}{\alpha}} \left[\alpha m \left(\tau \right) + \phi \left[A_l - \left(1 - \alpha \right) m \left(\tau \right) \tfrac{w_l}{w(\tau)} \right] \right] \left(k_i + d_i \right) - \left(1 + r \right) d_i \\ \text{s.t. } \left(1 - \tau + \phi \right) \left[A_l - \tfrac{(1-\alpha) m(\tau)}{w(\tau)} w_l \right] &< 2 \left(1 + r \right) \left[\tfrac{w(\tau)}{(1-\alpha) m(\tau)} \right]^{\frac{1-\alpha}{\alpha}} \tfrac{d_i}{k_i + d_i} < m \left(\tau, \phi \right) - \left(1 - \alpha \right) m \left(\tau \right) \tfrac{w(\tau,\phi)}{w(\tau)} \end{aligned} \tag{4.6}$$

The labor contract $\{w_s\}_s$ has three different effects on the borrowing capacity of the firm. First, as previously an increase in the volatility of labor compensation raises the cost of labor and as a matter of fact reduces the productivity of the firm because the efficiency frontier the firm faces is less favorable. Secondly, however, an increase in the volatility of labor compensation (in the sense of an increase in w_h and a decrease in w_l) can raise the volume of capital lenders can seize in case of default (in the bad state of nature). Finally an increase in the volatility of labor compensation (in the sense of an increase in w_h and a decrease in w_l)

reduces firms profits before debt repayments in the good state of nature, and hence the firm borrowing capacity. Similarly, the choice of the technology σ has two different effects on the borrowing capacity of the firm. On the one hand an increase in the volatility of technological shocks raises by definition the firm average productivity. On the other hand however, an increase in the volatility of technological shocks raises the firm borrowing capacity because the firm borrowing constraint is not computed anymore w.r.t. the sole bad state of nature (in which case the firm borrowing capacity would have otherwise been reduced). Finally for a given compensation scheme $\{w_s\}_s$ an increase in the volatility of technological shocks increases the firm demand for labor and hence reduces profits before debt repayments conditional on a bad state of nature. Then assuming that raising capital is profitable for the firm, i.e.

$$\left[(1-\alpha)\frac{m(\tau)}{w(\tau)}\right]^{\frac{1-\alpha}{\alpha}}\left[\alpha m(\tau)+\phi\left[A_l-(1-\alpha)w_l\frac{m(\tau)}{w(\tau)}\right]\right]>2(1+r)$$

the expected profit of the firm writes as

$$\frac{E\Pi}{2(1+r)k_i}=\frac{\alpha-(1-\tau)\left[\frac{A_h}{m(\tau)}-(1-\alpha)\frac{w_h}{w(\tau)}\right]}{2\frac{1+r}{m(\tau)}\left[\frac{w(\tau)}{(1-\alpha)m(\tau)}\right]^{\frac{1-\alpha}{\alpha}}-\left[\frac{m(\tau,\phi)}{m(\tau)}-(1-\alpha)\frac{w(\tau,\phi)}{w(\tau)}\right]}$$

We can then derive the following proposition.

Proposition 1. *When firms can issue contingent debt, then they optimally choose firms the optimal labor contract η and the optimal technology σ so as to verify*

$$\frac{1+r}{m(\tau)}\left[\frac{w(\tau)}{(1-\alpha)m(\tau)}\right]^{\frac{1-\alpha}{\alpha}}\left[\frac{1-\left(\tau\eta^2\right)^2}{\tau\eta^2}-\frac{\partial m(\tau)}{\partial\sigma}\frac{m(\tau)}{m}\frac{1}{1-\varepsilon(m)}\right]=\alpha\phi\frac{1-\tau^2}{\tau}$$

where $\varepsilon(m)$ is the elasticity of m w.r.t. σ

$$\varepsilon(m)=\frac{\partial m}{\partial\sigma}\frac{\sigma}{m}$$

Proof. Computing the first order condition determining the optimal labor contract we find that η verifies

$$W\left[1-\frac{1}{2\alpha}\frac{1-\left(\tau\eta^{2}\right)^{2}}{\tau\eta^{2}}\frac{V}{1-\tau}\right]=V\left[1-\frac{\phi}{\tau\left(1-\tau\right)}\right]+\left[\phi U+\alpha-V\right]$$

while the optimal technology σ is determined by the following condition

$$W\left[1-\frac{1}{2\alpha}\frac{\partial m\left(\tau\right)}{\partial\sigma}\frac{m\left(\tau\right)}{m}\frac{1}{1-\varepsilon\left(m\right)}\frac{V}{1-\tau}\right]=V\left[1-\frac{\phi\tau}{1-\tau}\right]+\left[\phi U+\alpha-V\right]$$

with the following notations

$$\begin{aligned}
U &= \frac{m\left(\sigma\right)-\sigma}{m\left(\tau\right)}-\frac{\left(1-\alpha\right)\eta^{2}}{1+\tau\eta^{2}}\\
V &= \alpha-\left(1-\tau\right)\left[\frac{m+\sigma}{m\left(\tau\right)}-\frac{1-\alpha}{1+\tau\eta^{2}}\right]\\
W &= 2\frac{1+r}{m\left(\tau\right)}\left[\frac{w}{\eta}\frac{1+\tau\eta^{2}}{\left(1-\alpha\right)m\left(\tau\right)}\right]^{\frac{1-\alpha}{\alpha}}
\end{aligned}$$

Then taking the difference between the two first order conditions, we end up with

$$\frac{1+r}{m\left(\tau\right)}\left[\frac{w\left(\tau\right)}{\left(1-\alpha\right)m\left(\tau\right)}\right]^{\frac{1-\alpha}{\alpha}}\left[\frac{1-\left(\tau\eta^{2}\right)^{2}}{\tau\eta^{2}}-\frac{\partial m\left(\tau\right)}{\partial\sigma}\frac{m\left(\tau\right)}{m}\frac{1}{1-\varepsilon\left(m\right)}\right]=\alpha\phi\frac{1-\tau^{2}}{\tau}$$

■

One can note that the relationship between the optimal technology and the optimal labor contract in the contingent debt case is essentially similar to the uncontingent debt case. Basically, the uncontingent debt case is a special case of the contingent debt case if considered with $\tau=1$.

Corollary 2. *When firms can issue contingent debt, then the optimal technology σ is a decreasing function of the optimal labor contract η if and only if*

$$\varepsilon\left(\frac{\partial m}{\partial\sigma}\right)>\frac{\varepsilon\left(m\left(\tau\right)\right)}{\varepsilon\left(m\right)}\left[\varepsilon\left(m\right)-1\right]\left[\varepsilon\left(m\right)+\left(1-\varepsilon\left(m\right)\right)\left(1-\tau\right)X\left(\sigma,\tau\right)\right]$$

where

$$X(\sigma,\tau)=\frac{\sigma}{m(\tau)}+\sigma m\frac{\phi}{\tau}\frac{1+\tau}{1+r}\left[\frac{(1-\alpha)\,m(\tau)}{w(\tau)}\right]^{\frac{1-\alpha}{\alpha}}$$

Proof. At the individual optimum, firms technology and workers labor contracts are determined through the condition

$$\frac{1+r}{m(\tau)}\left[\frac{w(\tau)}{(1-\alpha)\,m(\tau)}\right]^{\frac{1-\alpha}{\alpha}}\left[\frac{1-\left(\tau\eta^2\right)^2}{\tau\eta^2}-\frac{\partial m(\tau)}{\partial\sigma}\frac{m(\tau)}{m}\frac{1}{1-\varepsilon(m)}\right]=\alpha\phi\frac{1-\tau^2}{\tau}$$

As is clear the left hand side of this expression unambigiously decreases in η while the variations wrt σ are ambigious. Taking the first derivative of this left hand side wrt σ and after some tedious algebra we end up with the following condition: the left hand side expression increases in σ if and only if

$$\varepsilon\left(\frac{\partial m}{\partial\sigma}\right)>\frac{\varepsilon(m(\tau))}{\varepsilon(m)}\left[\varepsilon(m)-1\right]\left[\varepsilon(m)+(1-\varepsilon(m))(1-\tau)\,X(\sigma,\tau)\right]$$

where

$$X(\sigma,\tau)=\frac{\sigma}{m(\tau)}+\sigma m\frac{\phi}{\tau}\frac{1+\tau}{1+r}\left[\frac{(1-\alpha)\,m(\tau)}{w(\tau)}\right]^{\frac{1-\alpha}{\alpha}}$$

■

Corollary 3. *When firms can issue contingent debt then an exogenous increase in labor market flexbility is more likely to be associated with an increase in firms average productivity than in the case where firms cannot issue contingent debt.*

Proof. When firms cannot issue contingent debt, labor market flexibility is associated with less productive investments if and only if

$$\varepsilon\left(\frac{\partial m}{\partial\sigma}\right)<-\varepsilon(m)\left[1-\varepsilon(m)\right]$$

Similarly when firms can issue contingent debt, labor market flexibility is associated with more productive investments if and only if

$$\varepsilon\left(\frac{\partial m}{\partial \sigma}\right) > -\frac{\varepsilon\left(m\left(\tau\right)\right)}{\varepsilon\left(m\right)}\left[1-\varepsilon\left(m\right)\right]\left[\varepsilon\left(m\right)+\left(1-\varepsilon\left(m\right)\right)\left(1-\tau\right)X\left(\sigma,\tau\right)\right]$$

Since $X > 0$, a sufficient condition which ensures that labor market flexibility is more likely to be associated with an increase in firms average productivity in the case where contingent debt is not available writes as $\varepsilon\left(m\left(\tau\right)\right) > \varepsilon\left(m\right)$ which simplifies

$$m > \sigma\frac{\partial m}{\partial \sigma}$$

which is always true since by definition

$$A_l = m - \sigma > 0 \text{ and } \frac{\partial A_l}{\partial \sigma} = \frac{\partial m}{\partial \sigma} - 1 < 0$$

■

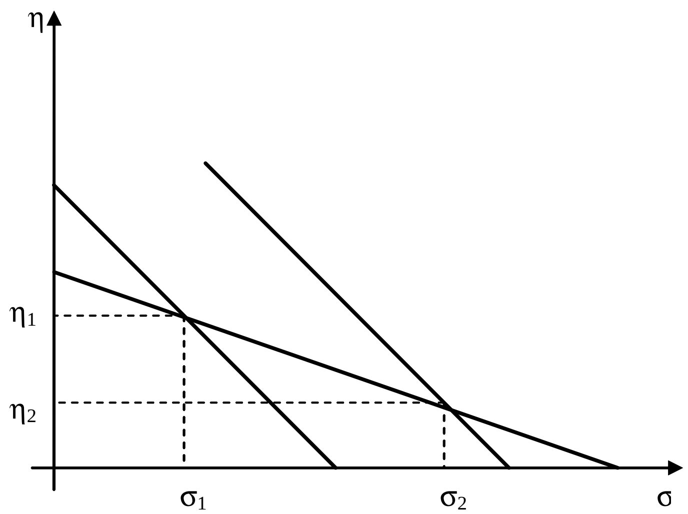

Figure 7: Firm optimal strategies when contingent debt is available.

4.2. The general equilibrium of the economy.

4.2.1. The equilibrium of the capital market.

Up to now the risk free interest rate has been taken to be exogenous. To determine the equilibrium interest rate that prevails in the economy, one simply needs to equal the supply for capital provided by lenders and the demand for capital expressed by entrepreneurs and consumers. Put differently the equilibrium interest rate is determined through

$$k_l = d + l\,(c_t^*)_1 + (1-l)\,(c_t^*)_2$$

where k_l represents lenders capital supply, d firms aggregate demand for capital, l firms aggregate demand for labor, $(c_t^*)_1$ is the first period consumption of workers hired by entrepreneurs and $(c_t^*)_2$ is the first period consumption of workers who have not been hired by entrepreneurs. Entrepreneur i labor demand l_i and capital demand d_i respectively write as

$$l_i = \left[\frac{(1-\alpha)\,m(\tau)}{w(\tau)}\right]^{\frac{1}{\alpha}}(k_i + d_i)$$

$$d_i = \frac{m(\tau,\phi) - (1-\alpha)\,m(\tau)\,\frac{w(\tau,\phi)}{w(\tau)}}{2(1+r)\left[\frac{w(\tau)}{(1-\alpha)m(\tau)}\right]^{\frac{1-\alpha}{\alpha}} - \left[m(\tau,\phi) - (1-\alpha)\,m(\tau)\,\frac{w(\tau,\phi)}{w(\tau)}\right]}k_i$$

Given that entrepreneurs are identical, that $w_s = \eta_s w$ with $w_l w_h = w^2$, the equilibrium of the capital market simplifies as

$$k_l - \frac{1}{1+r}\frac{w}{2} = \frac{m(\tau,\phi) - \frac{(1-\alpha)m(\tau)}{w(\tau)}\left[w(\tau,\phi) - 2\eta^2\left[\frac{\eta}{1+\eta^2} - \frac{1}{2}\right]\right]}{2(1+r)\left[\frac{w(\tau)}{(1-\alpha)m(\tau)}\right]^{\frac{1-\alpha}{\alpha}} - \left[m(\tau,\phi) - (1-\alpha)\,m(\tau)\,\frac{w(\tau,\phi)}{w(\tau)}\right]}k$$

4.2.2. The equilibrium of the labor market.

At the equilibrium of the capital market, labor demand balances labor supply. Given that entrepreneurs are all identical, noting k firms aggregate capital stock and d firms aggregate borrowing, the expected wage rate

Ew_s is then equal to the expected marginal productivity of labor

$$w(\tau) = (1-\alpha)\, m(\tau)\, (k+d)^{\alpha}$$

and the uncontingent wage rate writes as

$$w = \frac{\eta}{1+\tau\eta^2}\,(1-\alpha)\, m(\tau)\,(k+d)^{\alpha} \tag{4.7}$$

4.2.3. General Equilibrium.

The general equilibrium of the economy corresponds to the situation where all markets, the capital and the labor market, balance supply and demand. To determine the properties of this situations, one simply need to plug the two last expressions in the capital market equilibrium condition, we end up with an equilibrium interest rate r being defined through

$$k_l = \left[\frac{m(\tau,\phi)}{2} + \frac{1}{2}(1-\alpha)\frac{m(\tau)}{w_h+\tau w_l}\left[\frac{\eta^2 w}{1+\eta^2} - w(\tau,\phi)\right]\right]\frac{(k+d)^{\alpha}}{1+r} \tag{4.8}$$

where the aggregate volume of capital d firms borrow at the general equilibrium of the economy is such that

$$(1+r)\, d = \frac{1}{2}\left[m(\tau,\phi) - (1-\alpha)\, m(\tau)\,\frac{w(\tau,\phi)}{w(\tau)}\right](k+d)^{\alpha} \tag{4.9}$$

Finally firm optimal technology is such that

$$\frac{1+r}{m(\tau)}\left[\frac{w(\tau)}{(1-\alpha)\, m(\tau)}\right]^{\frac{1-\alpha}{\alpha}}\left[\frac{1-\left(\tau\eta^2\right)^2}{\tau\eta^2} - \frac{\partial m(\tau)}{\partial\sigma}\frac{m(\tau)}{m(\sigma)}\frac{1}{1-\varepsilon(m)}\right] = \alpha\phi\frac{1-\tau^2}{\tau} \tag{4.10}$$

and the optimal labor contract firms propose to workers verifies

$$W\left[1-\frac{1}{2\alpha}\frac{1-\left(\tau\eta^2\right)^2}{\tau\eta^2}\frac{V}{1-\tau}\right] = V\left[1-\frac{\phi}{\tau(1-\tau)}\right] + \alpha\left[\phi U + \alpha - V\right] \tag{4.11}$$

Proposition 4. *The general equilibrium of the economy is represented by the vector* (η, σ, r, d, w). *Firms choose their optimal labor contract* η *and their optimal technology* σ *respectively such that (4.11) and (4.10) are verified. The equilibrium interest rate on the capital market* r *and the volume of capital* d *firms are able to borrow are respectively such that (4.8) and (4.9) are verified.*

Proof. Straightforward. ■

A few remarks here are in order. *To be continued...*

4.3. The welfare analysis.

To be done.

5. Growth effects of labor market flexibility.

We embed the framework considered in the previous sections into a dynamic model. At each point in time there is a continuum of unit mass of workers, a continuum of mass 2 of agents who can be entrepreneurs or lenders with equal probability[6]. At the beginning of each period, entrepreneurs hire workers and agree on labour contracts with them. They borrow capital from lenders to finance investment and they choose a technology and engage in production. Workers supply labour to entrepreneurs and agree on labour contracts with them. They borrow capital from lenders to finance beginning of period consumption. Lenders lend capital to firms to finance investment. They lend capital also to workers to finance consumption.

At the end of each period, entrepreneurs pay workers according to the labour contracts they agreed upon. They pay back lenders for beginning of period loans and they divide their profits between consumption and bequest. Workers are paid according to the wage contract they agreed upon with entrepreneurs. They pay back lenders for beginning of period loans and consume their labour income net of loan repayments. Lenders are paid back on beginning of period loans extended to workers and entrepreneurs and they divide their final capital income between consumption and bequest.

Let us note k_t the capital stock in the economy at the beginning of period t, and k_{t+1}^s the capital stock in the economy at the beginning of period t when state s has happened at time t. If the good state of nature happens at time t, the capital stock at the beginning of period $t+1$, k_{t+1}^h, writes as

$$k_{t+1}^h = \frac{1}{2}\left(\frac{1}{2}k_t + d\right)^{\alpha} \begin{cases} A_h - \frac{2}{1+\eta^2}\left(1-\alpha\right)m\left(\sigma\right)\left[1-\frac{\eta^2}{1+\eta^2}\right] & \text{if no contingent debt} \\ A_h - \frac{1}{1+\tau\eta^2}\left(1-\alpha\right)m\left(\tau\right)\left[1-\frac{\eta^2}{1+\eta^2}\right] & \text{otherwise} \end{cases} \quad (5.1)$$

The first part of the right hand side $A_h\left(\frac{1}{2}k_t+d\right)^{\alpha}$ represents total output in the economy. The second part of the right hand side $\frac{2\eta^2}{1+\eta^2}\left(1-\alpha\right)m\left(\sigma\right)\left(\frac{1}{2}k_t+d\right)^{\alpha}$ or alternatively $\frac{\eta^2}{1+\tau\eta^2}\left(1-\alpha\right)m\left(\tau\right)\left(\frac{1}{2}k_t+d\right)^{\alpha}$ represent the wage bill distributed to workers in the case where firms cannot issue contingent debt and the case where firms can do so. The final part of the right hand side $1-\frac{\eta^2}{1+\eta^2}$ represents the share of the wage bill workers

[6] This assumption helps simplify the exposition of the model since firms beginning of period aggregate capital stock k_f is always equal to lenders beginning of period aggregate capital stock k_l which is half the economy's beginning of period aggregate capital stock k_t.

dedicate to beginning of period loans repayments. Finally entrepreneurs and lenders bequest a share $\beta = \frac{1}{2}$ of their final wealth and consume a share $1-\beta = \frac{1}{2}$. Similarly, if the bad state of nature happens at time t, the capital stock at the beginning of period $t+1$, k^l_{t+1} therefore writes as

$$k^l_{t+1} = \frac{1}{2}\left(\frac{1}{2}k_t + d\right)^\alpha \begin{cases} A_l - \frac{2\eta^2}{1+\eta^2}(1-\alpha)\, m(\sigma)\left[1 - \frac{1}{1+\eta^2}\right] \text{ if no contingent debt} \\ (\tau+\phi)\, A_l - \frac{\eta^2}{1+\tau\eta^2}(1-\alpha)\, m(\tau)\left[\tau + \phi - \frac{1}{1+\eta^2}\right] \text{ otherwise} \end{cases} \tag{5.2}$$

This expression is similar to the above one apart three distinct features. First When contingent debt is available firms default in the bad state of nature and recoup only a fraction τ of their output while lenders are able to seize a fraction ϕ of this output, the difference between $\tau+\phi$ and one being the social loss coming from default. Second, the technological shock is good in the latter case and bad in the former case. Third the share of the wage bill workers dedicate to consumption which is large is the latter case and low in the former case. We then establish the following result as regards expected growth.

Proposition 1. *When firms can issue contingent debt, the average growth rate of the economy's capital stock writes as*

$$E \log \frac{k^s_{t+1}}{k_t} = \log \frac{(1-\alpha)\, m}{2} + \alpha \log\left(\frac{1+\mu}{2}\right) - (1-\alpha)\log k_t + \frac{1}{2}\log \Omega(\tau,\phi) \tag{5.3}$$

where μ represents the equilibrium firm debt equity ratio, i.e. $\mu \triangleq \frac{d_i}{k_i}$ and

$$\Omega(\tau,\phi) = \left[\frac{A_l}{(1-\alpha)\, m(\tau)} - \frac{\eta^2}{1+\tau\eta^2}\left[\tau + \phi - \frac{1}{1+\eta^2}\right]\right]\left[\frac{A_h}{(1-\alpha)\, m(\tau)} - \frac{\eta^2}{1+\tau\eta^2}\left[1 - \frac{\eta^2}{1+\eta^2}\right]\right]$$

The same expressions apply to the case where contingent debt is not available with $\tau = 1$ and $\phi = 0$.

Proof. Using the (5.2) and (5.1), the expected capital growth rate expression (5.3) is immediate to obtain.

■

The expected growth expression (5.3) can be decomposed along classical growth determinants on the one hand and labor contracts specific effects on the other hand. Among the classical determinants of growth, appears the standard catch-up effect: due to decreasing marginal returns to capital, growth in the capital stock is bound to go to zero as the economy accumulates capital in the absence of any other source of growth.

$$E \log \frac{k_{s,t+1}}{k_t} = \underbrace{\log \frac{(1-\alpha)}{2} m(\sigma)}_{\text{TFP effect}} + \underbrace{\alpha \left[\log \left(1 - \frac{\theta(1-\theta)}{\frac{1-\sigma}{1-\alpha} - 2\theta^2} \right) \right]}_{\text{TFI effect}} - \underbrace{(1-\alpha) \log k_t}_{\text{Catch-up effect}} + \underbrace{\frac{1}{2} \log \Omega(\tau, \phi)}_{\text{Heterogenity effect}}$$

Now apart from the standard catch up effect, firms choices as to the optimal wage contract and the optimal technology they adopt generate three different sources of growth. When firms adopt more flexible wage contracts, that helps them increase the volume of capital they can borrow. Hence the volume of firms investment is larger with more flexible labor contracts. The total factor input effect of labor market flexibility is therefore positive and the economy grows faster with more flexible labor contracts. On the contrary when firms adopt more flexible labor contracts, they more likely to optimally invest in less productive technologies the lower the financial development. Hence the total factor productivity effect of labor market flexibility depends positively on financial development, here the capacity of firms to issue contingent debt. Finally there is a third effect called heterogenity effect: when firms propose more flexible labor contracts, workers reduce their beginning-of-period consumption and increase their average end-of-period consumption. Therefore with more flexible labor contracts, the volume of capital workers borrow at the beginning of the period is reduced while the volume of consumption at the end of the period is increased. Now since workers propensity to save is zero, workers beginning of period consumption acts as an investment whose productivity is equal to the interest rate r. On the contrary, workers end-of-period consumption acts to reduce the volume of capital in the economy at the end of the period. Therefore more flexible labor market will tend to reduce capital accumulation because workers are less willing to borrow and more willing to rely on their labor income to finance their consumption.

6. Emprical Evidence.

We take data from four different sources. Data for standard macroeconomic variables comes from OECD Economic Outlook. Data on financial development comes from the World Bank database on financial structure. Finally data on the labor market comes from Botero et al. and OECD labor force survey. From Botero et al., we take the firing difficulty index as an inverse measure of labor market flexibility. From the OECD labor force survey, we take the share of part time employment in total employment. This last variable has the advantage to be a time varying variable while the Botero et al. database only contains variables varying in the cross section of countries in the sample. We compute our estimations on the 1985-2005 period or on the 1985-2000 period whenever data availability restricts the time sample. The basic regression we carry out is the following

$$y_{i,t} - y_{i,t-1} = \alpha_i + \beta_t + \gamma X_{i,t-1} + \delta y_{i,t-1} + \eta lm_{i,t-1} + \theta km_{i,t-1} + \lambda lm_{i,t-1} km_{i,t-1} + \varepsilon_{i,t}$$

The dependent variable $y_{i,t} - y_{i,t-1}$ is alternatively the growth rate of GDP per worker or per capita. Standard growth regressors are included in the vector $X_{i,t}$. Explanatory variables are all lagged one period. The lagged value of GDP per worker or per capita $y_{i,t-1}$ represents neo-classical catch-up effects. Labor market rigidity or flexbility indicators are represented by the $lm_{i,t-1}$ variable and $km_{i,t-1}$ represents the financial development variable. Finally we try to catch the interaction effect of these two variables through a simple linear specification by considering the financial development variable times the labor market rigidity or flexbility indicator. In table 1, we consider the effect of labor market rigidity on the growth rate of GDP per worker. The labor market rigidity indicator is the firing difficulty indicator of the Botero et al. database while the financial development indicator is the ratio between banking credit to the private sector and banking deposits. The regressions show that larger difficulties for firms to fire their workers are positively associated with GDP per worker growth. However this positive effect is mitigated by financial development up to the point where the growth effect of firing difficulties can become negative for sufficiently large levels of financial development. The threshold above which firing difficulites become detrimental to growth is computed at the bottom of table 1. Finally compute what would be the growth gain or loss for a move from French type labor market institutions to US type labor market institutions. Although the exercise has some limits, the compution shows that the average gain for such a move in terms of GDP per worker growth is not that large as it would be at most 1/5 percentage point of extra annual productivity growth.

[Insert table 1 here]

Now conducnting a similar exercise with the GDP per capita growth rate as a dependent variable, we end up with similar qualitative and quantitative results. Labor market rigidity in the form of large firing costs is bad for productivity growth if and only if financial development is sufficiently large. In countries with low a financial development level, labor market rigidity is good for growth according to the empirical estimation. However as is clear, the growth gain that may come out of a reduction in firing costs conditional on financial development being at Frech standards, is much smaller in this latter case since it is at most 1/10 percentage point of extra annual GDP per capita growth with the possibility that the gain could be negative. Labor market flexibility would then reduce GDP per capita growth.

[Insert table 2 here]

The next two tables (table 3 and table 4) conduct similar exercices with a different variable proxying financial development which is the ratio between private credit to financial system deposits. Th result that labor market flexibility is good for GDP per capita (per worker) growth if and only if financial development is sufficiently large is still true. However it is interesting to note that in this last configuration, countries which present rather more bank based financial systems are more likely to be in a situation where reducing labor market rigidity may be detrimental to GDP per capita (per worker) growth.

[Insert table 3 here]

[Insert table 4 here]

Finally we present some last regressions (table 5 and 6) where the labor market flexibility indicator is represented by the share of part time employment in total employment with a greater proportion of part time employment representing greater labor market flexibility. Three elements are woth noting. First the prediction that labor market flexibility effects on productivity growth are enhanced by financial development is still true. Second we observe that the coefficient of the labor market flexibility indicator is negative and significant, this implying that labor market flexibility has a significantly negative effect on growth when financial development is low. Finally it is interesting to note that in the case of France, increasing labor market flexibility may have serious adverse consequences for productivity growth.

7. Conclusion.

We have built a model in which the structure of workers compensation and firms productivity are endogenous. This has enabled us to build a theory of the labor market flexibility effects of growth. *To be completed....*

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8. Appendix.

8.1. Optimal individual wage contracts. Proof to proposition 1.

If firm i decides to propose a contigent compensation scheme $\{w_l, w_h\}$ such that $w_l = \eta w$, and w is the fixed wage proposed by other firms, then workers participation constraint implies that if $w_h = \eta_h w$ then $\eta_h = \eta^{-1}$. Moreover the bad state of nature determines firm i borrowing constraint if and only if

$$\eta^2 \geq \frac{1-\alpha-\sigma}{1-\alpha+\sigma}$$

Therefore assume that $\lambda = 1$, expected profits of firm i $E\Pi$ can be written as

$$E\Pi(\eta) = \max[R(\eta);1](1+r)k_i$$

where

$$R(\eta) = \frac{\left[\sigma + (1-\alpha)\left[\frac{2\eta^2}{1+\eta^2} - 1\right]\right]}{\left[\sigma + (1-\alpha)\left[\frac{2\eta^2}{1+\eta^2} - 1\right]\right] - \left[\alpha - \frac{1+r}{m(\sigma)}\left[\frac{w}{(1-\alpha)m(\sigma)}\frac{1+\eta^2}{2\eta}\right]^{\frac{1-\alpha}{\alpha}}\right]}$$

and the optimal compensation scheme $\{w_l, w_h\}$ is the solution to the program

$$\max_{\eta} R(\eta)$$
$$\text{s.t. } \eta^2 \geq \tfrac{1-\alpha-\sigma}{1-\alpha+\sigma}$$

Deriving the first order condition for the last problem we end up with

$$\frac{1}{4\eta}\frac{\left(1+\eta^2\right)^2}{1-\alpha}\frac{\partial R(\eta)}{\partial \eta} = \frac{1+r}{m(\sigma)}\left[\frac{w}{(1-\alpha)m(\sigma)}\frac{1+\eta^2}{2\eta}\right]^{\frac{1-\alpha}{\alpha}}\left(1+\frac{1-\eta^4}{4\eta^2}\frac{\sigma+(1-\alpha)\left(\frac{2\eta^2}{1+\eta^2}-1\right)}{\alpha}\right)-\alpha$$

Let us then note φ the right hand side variable of the last expression

$$\varphi(\eta) = \frac{1+r}{m(\sigma)}\left[\frac{w}{(1-\alpha)m(\sigma)}\frac{1+\eta^2}{2\eta}\right]^{\frac{1-\alpha}{\alpha}}\left(1+\frac{1-\eta^4}{4\eta^2}\frac{\sigma+(1-\alpha)\left(\frac{2\eta^2}{1+\eta^2}-1\right)}{\alpha}\right)-\alpha$$

Then φ is a strictly decreasing function of η since

$$\frac{\partial \varphi(\eta)}{\partial \eta} \equiv -\frac{1-\eta^4}{4\eta^2}\left[\frac{1}{\alpha}+\frac{1+\eta^4}{\left(1-\eta^2\right)^2}\frac{2}{1-\alpha}\right]\left[\sigma+(1-\alpha)\left(\frac{2\eta^2}{1+\eta^2}-1\right)\right]$$

This implies that a necessary and sufficient condition for firms to adopt a contingent compensation schemes writes as $\left.\frac{\partial R(\eta)}{\partial \eta}\right|_{\eta=1} < 0$. which simplifies as

$$\frac{1+r}{m(\sigma)}\left[\frac{w}{(1-\alpha)m(\sigma)}\right]^{\frac{1-\alpha}{\alpha}} - \alpha < 0$$

At the equilibrium of the labor market, the wage rate w is such that $w = (1-\alpha)m(\sigma)(k+d)^{\alpha}$. The necessary and sufficient condition therefore writes as

$$\alpha m(\sigma)(k+d)^{\alpha-1} > 1+r$$

This condition simply states that the expected marginal productivity of capital is larger than the gross interest rate. In other words the amount of debt d firms can borrow is not enough the reach the first best capital stock. This means that the optimal compensation scheme $\{w_l^*, w_h^*\}$ is such that $w_l^* < w < w_h^*$ if and only if firms are credit constraint and cannot issue contingent debt.

Then assuming that $\left.\frac{\partial R(\eta)}{\partial \eta}\right|_{\eta=1} < 0$ (firms are credit constrained), due to the fact that φ is a strictly decreasing function of η and a strictly increasing function of r, the optimal wage $\{w_l^*, w_h^*\}$ is such that $w_h^* - w_l^* = \frac{1-\eta^2}{\eta} w$ is a decreasing function of the interest rate r. In other words a larger interest rate reduces optimal wage procyclicity.

Table 1
Growth effects of Labor Market Rigidity.
Dependent variable: GDP per worker Growth
Estimation: GLS with White heteroscedasticity correction

Banking Development	0.866***	0.534	0.377	1.789*
Labor Market Rigidity	0.075***	0.065***	0.063***	
Labor Market Rigidity×Banking Development	-0.063***	-0.054***	-0.051**	-0.083***
Control Variables				
Schooling		-0.100	-0.102	0.262
Investment to GDP	0.429	-0.226	-0.358	0.112***
Labor Force Growth	-0.388***	-0.402***	-0.398***	-0.550***
Lagged GDP per worker	-0.058	-0.100	-0.122	-0.163***
Exports to GDP	0.075***	0.132***	0.172***	0.554***
Imports to GDP	-0.072***	-0.127***	-0.170***	-0.396***
Inflation	-0.066**	-0.064**	-0.054*	-0.248***
Public Spending to GDP	-0.016	-0.032*	-0.036**	0.094**
Terms of Trade Shocks	-0.962**	-1.101	-2.169	2.153
Time Effects/Fixed Effects	no/yes	no/yes	no/yes	yes/yes
Time Span	1985-2005	1985-2001	1985-2000	1985-2000
No. countries/No. observations	22/437	17/340	16/319	16/319
Turning point for productivity growth reducing effects of labor market rigidity				
Banking Development larger than	1.190	1.204	1.235	
Would France gain from reducing LMR?	yes	yes	yes	
Growth gain if France had US LMR	0,19% pts	0,16% pts	0,10% pts	

Table 2
Growth effects of Labor Market Rigidity.
Dependent variable: GDP per capita Growth
Estimation: GLS with White heteroscedasticity correction

Banking Development	0.741***	0.526	0.323	0.021**
Labor Market Rigidity	0.089***	0.084***	0.081***	
Labor Market Rigidity×Banking Development	-0.068***	-0.067***	-0.063**	-0.089***
Control Variables				
Schooling		-0.226***	-0.215**	0.319
Investment to GDP	0.784	-0.059	-0.196	0.126***
Population Growth	-0.290***	0.095	0.022	-0.199***
Lagged GDP per capita	-0.108	-0.120	-0.136	-0.148***
Exports to GDP	0.104***	0.182***	0.222***	0.588***
Imports to GDP	-0.093***	-0.174***	-0.216***	-0.383***
Inflation	-0.078***	-0.094***	-0.081***	-0.103***
Public Spending to GDP	0.045***	-0.094***	-0.058***	0.051
Terms of Trade Shocks	-0.581	-1.810	2.892*	3.916*
Time Effects/Fixed Effects	no/yes	no/yes	no/yes	yes/yes
Time Span	1985-2005	1985-2001	1985-2000	1985-2000
No. countries/No. observations	22/ 413	17/340	16/319	16/319
Turning point for productivity growth reducing effects of labor market rigidity				
Banking Development larger than	1.309	1.254	1.286	
Would France gain from reducing LMR?	no	yes	yes	
Growth gain if France had US LMR	-0,18% pts	0,09% pts	0,03% pts	

Table 3
Growth effects of Labor Market Rigidity.
Dependent variable: GDP per worker Growth
Estimation: GLS with White heteroscedasticity correction

Financial Development	1.118***	1.160***	0.013***	0.010*
Labor Market Rigidity	0.070***	0.069***	0.076***	
Labor Market Rigidity×Financial Development	-0.051***	-0.047***	-0.052***	-0.046**
Control Variables				
Schooling		-0.091***	-0.087*	0.310
Investment to GDP	0.008	0.007	-0.045	0.108***
Labor Force Growth	-0.367***	-0.398***	-0.391	-0.532***
Lagged GDP per worker	0.033	0.006	-0.007	-0.167***
Exports to GDP	0.079***	0.132***	0.171***	0.555***
Imports to GDP	-0.069***	-0.119***	-0.160***	-0.384***
Inflation	-0.062**	-0.060**	-0.053**	-0.087***
Public Spending to GDP	0.002	-0.014	-0.015	0.089***
Terms of Trade Shocks	-1.289	0.541	1.557	0.023
Time Effects/ Fixed Effects	no/yes	no/yes	no/yes	yes/yes
Time Span	1985-2005	1985-2001	1985-2000	1985-2000
No. countries/No. observations	22/437	17/340	16/319	16/319
Turning point for productivity growth reducing effects of labor market rigidity				
Financial Development larger than	1.373	1.468	1.462	
Would France gain from reducing LMR?	no	no	no	
Growth loss if France has US LMR	0,11% pts	0,24% pts	0,25% pts	

Table 4
Growth effects of Labor Market Rigidity.
Dependent variable: GDP per capita Growth
Estimation: GLS with White heteroscedasticity correction

Financial Development	0.974^{***}	1.246^{***}	1.409^{***}	0.898
Labor Market Rigidity	0.082^{***}	0.085^{***}	0.094^{***}	
Labor Market Rigidity×Financial Development	-0.051^{***}	-0.054^{***}	-0.060^{***}	-0.047^{**}
Control Variables				
Schooling		-0.178^{*}	-0.165	0.393
Investment to GDP	0.816	0.100	0.038	0.124^{***}
Population Growth	-0.221	-0.033	-0.074	-0.253
Lagged GDP per capita	0.009	0.011	-0.003	-0.153^{***}
Exports to GDP	0.102^{***}	0.171^{***}	0.212^{***}	0.586^{***}
Imports to GDP	-0.085^{***}	-0.153^{***}	-0.194^{***}	-0.366^{***}
Inflation	-0.078^{***}	-0.084^{***}	-0.076^{***}	-0.100^{***}
Public Spending to GDP	-0.028^{*}	-0.034^{*}	-0.037^{*}	0.042
Terms of Trade Shocks	-0.010	-0.948	2.024	3.872^{*}
Time Effects/ Fixed Effects	no/yes	no/yes	no/yes	yes/yes
Time Span	1985-2005	1985-2001	1985-2000	1985-2000
No. countries/No. observations	22/ 413	17/340	16/319	16/319
Turning point for productivity growth reducing effects of labor market rigidity				
Financial Development larger than	1.608	1.574	1.567	
Would France gain from reducing LMR?	no	no	no	
Growth loss if France had US LMR	0,47% pts	0,44% pts	0,48% pts	

Table 5
Growth effects of Labor Market Flexibilty.
Dependent variable: GDP per worker Growth
Estimation: GLS with White heteroscedasticity correction

Financial Development	0.055***	0.069***	0.063***
Labor Market Flexibility	-0.044***	-0.050***	-0.046***
Labor Market Flexibility×Financial Development	0.031***	0.035***	0.032***
Control Variables			
Schooling		0.168	0.325
Investment to GDP	0.099***	0.099***	0.111***
Labor Force Growth	-0.631***	-0.654***	-0.663***
Lagged GDP per worker	-0.094***	-0.108***	-0.124***
Exports to GDP	0.316***	0.459***	0.539***
Imports to GDP	-0.307***	-0.339***	-0.389***
Inflation	-0.221***	-0.246***	-0.239***
Public Spending to GDP	0.063**	0.091**	0.106***
Terms of Trade Shocks	-0.037**	-0.005	-0.011
Time Effects/ Fixed Effects	yes/yes	yes/yes	yes/yes
Time Span	1985-2005	1985-2001	1985-2000
No. countries/No. observations	23/407	17/301	16/280
Turning point for productivity growth enhancing effects of labor market flexibility			
Financial Development larger than	1.419	1.429	1.437
Would France gain from increasing LMF?	no	no	no
Growth loss if France had Netherlands LMF	-0,37% pts	-0,45% pts	-0,44% pts

Table 6
Growth effects of Labor Market Flexibilty.
Dependent variable: GDP per worker Growth
Estimation: GLS with White heteroscedasticity correction

Banking Development	0.057***	0.078***	0.080***
Labor Market Flexibility	-0.046***	-0.054***	-0.056***
Labor Market Flexibility×Banking Development	0.034***	0.043***	0.046***
Control Variables			
Schooling		0.067	0.323
Investment to GDP	0.099***	0.102***	0.113***
Labor Force Growth	-0.620***	-0.665***	-0.690***
Lagged GDP per worker	-0.095***	-0.112***	-0.133***
Exports to GDP	0.317***	0.438***	0.508***
Imports to GDP	-0.303***	-0.312***	-0.350***
Inflation	-0.248***	-0.255***	-0.241***
Public Spending to GDP	0.064**	0.092**	0.097**
Terms of Trade Shocks	-0.037**	-0.008	-0.015
Time Effects/ Fixed Effects	yes/yes	yes/yes	yes/yes
Time Span	1985-2005	1985-2001	1985-2000
No. countries/No. observations	23/407	17/301	16/280
Turning point for productivity growth reducing effects of labor market rigidity			
Banking Development larger than	1.353	1.256	1.217
Would France gain from increasing LMF?	no	yes	yes
Growth gain if France had Netherlands LMF	-0,18% pts	0,19% pts	0,38% pts