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Human Capital, Trade Unions and Banks

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Abstract

A process of endogenous human capital formation is analyzed in combination with the existence of trade unions and banks. By lowering opportunity costs for schooling, trade unions provide incentive for human capital investments for parts of the workforce. Imperfect competition in the banking sector creates a self-selection situation favorable for long-term investment giving firms the possibility to invest in human capital intensive technologies and providing jobs for skilled labor. The complementarity of skilled labor and long-term finance in the production function of innovative firms gives rise to a coordination problem leading to multiple stationary states characterized by distinct industrial specialization and different growth rates and welfare levels.

JEL-Codes: G20, J24, O17, O41

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1 Introduction

Historical accounts about countries with seemingly identical initial positions but afterwards divergent economic performance are abound (see Landes, 1998, for a more recent one). Countries starting ahead of their rivals end up with productivity and living standard levels well below after half a century of under-performing. This is not only limited to very far history but concerns also more recent experiences between developed and developing countries (Pritchett, 1997) or among Western European countries (Olson, 1982). In this respect, institutional factors are almost always considered to be of major importance in the explanation of the observed divergence.

These factors have by now also been recognized in the endogenous growth literature. So are the development of a financial market and the presence of distortionary forces on the labor market (asymmetric information, trade unions, minimum wage legislation) believed to explain differences in country performance over the long-run. For example, financial intermediaries may help to overcome agency costs when the quality of a research project is not fully known to the market (King and Levine, 1993) and reduce inefficient signaling occurring under the pressure of takeovers (Stein, 1988). On the labor market, unions may set incentives for employers to reallocate skilled labor from the final goods production to R&D and thus increasing the speed of design of new products thus pushing up the growth rate of the economy (Palokangas, 1996). Moreover, reduced wage disparity through collective bargaining may give incentives to employers to invest in general skills of their workforce (Acemoglu and Pischke, 1999).

However, individual institutional characteristics do not seem to provide a sufficient explanation for divergence. Flanagan (1999, p. 1162), e.g., recognizes that - beyond the theoretical disagreements - the empirical literature does not provide a stable link between trade unionism and macroeconomic performance. As has already been suggested in earlier work (Ernst, 2000), therefore, at least imperfections on the labor and the financial market should be studied in combination. There may actually exist a relationship between the two which makes a solution for solving the existing obstacles to economic growth dependent on structural similarities on both markets. Under certain conditions trade unions and banks have positive effects on the growth rate of the economy and are reinforcing each other. Following Milgrom and Roberts (1990a, b) and Aoki (1994) the existence of this kind of positive cross derivatives has been called institutional complementarity.

In this contribution we study a relation of institutional complementarity under dynamical aspects where the existence of institutions is not exogenously given but arises out of the development of the economy and the institutional interplay. In a dynamic context this opens for an understanding of the conditions of existence and stability of the arising (very long-run) institutional equilibria, questions which have not yet been addressed in the existing literature. Moreover, introducing the concepts of the endogenous growth literature allows for the characterization of the macroeconomic stationary states in terms of growth rate and sectoral composition.

For that purpose we use a process of endogenous human capital formation as a source of economic growth. As the education process comes at a cost for workers, they may initially not be interested in building up skills. Furthermore, underdeveloped financial

markets do not allow long-term investment strategies and exclude firms from offering interesting opportunities for workers to leave the 'no-skill' trap. Growth therefore only occurs if workers are willing to invest in human capital and can expect to find opportunities to 'money' these investments; in this respect skilled labor and long-term finance are complementary 'inputs' for the innovative technology.

Institutional actors on different sectors in the economy may help to provide the necessary incentives. In a mechanism similar to Cahuc and Michel (1996), trade unions are supposed to rise the wage over the competitive level, reducing job offers for unskilled workers and hence producing unemployment which gives incentives (by lowering opportunity costs) to these unemployed to switch - after a schooling period - into the innovative sector. Banks, on the other hand, will only be present if there is a demand for long-term capital by innovative firms as the oligopolistic structure of the banking sector raises loan costs above the costs of finance on the stock market making them unattractive for homogenous goods firms. However, this self-selection situation with a interest rate differential creates the incentives to single out good entrepreneurs who find the necessary finance for their innovative projects. The resulting relation between trade unions and banks resembles that of an institutional complementarity.

The dynamical process takes place when both institutions are allowed to change size with respect to the number of firms and workers. While increasing unionization leads to higher militancy and union wages, it creates also higher unemployment and undermines the long-term conditions of existence of unions. On the other hand, an increasing banking sector allows more and more firms to produce innovative goods; however, the raising competition between banks reduces the selection quality allowing even less able entrepreneurs to enter the innovative market. Therefore and under certain conditions, the dynamic relationship between banks and trade unions gives raise to multiple equilibria of which the stability is analyzed. This is then be used to address policy questions and questions of structural change (disappearance of equilibria) due to problems through the coordination process between innovative firms and skilled workers.

The paper is organized as follows: In the next section, the macroeconomy is presented. Section 3 discusses the microeconomic relationships between the different actors, first on the homogenous good market with trade unions bargaining over wages, then on the innovative market. Section 4 analyzes the institutional dynamics and discusses question of structural change and policy issues. Section 5 concludes.

2 The Macroeconomy

Consumption. The economy is composed of households of mass $L + H = \text{const.}$ with L : unskilled labor and H : skilled labor. An individual household whether it is skilled, unskilled, employed or unemployed has an intertemporal utility function $\int_0^\infty \frac{c_i^{1-\sigma}}{1-\sigma} e^{-\rho t} dt$ with c_i the household's consumption, ρ its time preference rate and σ its constant risk aversion. This utility is maximized under the asset constraint:

$$\dot{a} = ra + Y_i - c_i \tag{1}$$

where a stands for the accumulated asset and Y_i for the household's income.

According to standard maximization procedures, the growth rate of household's consumption follows the simple rule:

$$\dot{c}_i = \frac{1}{\sigma} (r - \rho) c_i. \quad (2)$$

This relationship can be aggregated over households given its linear character. With $C = \sum c_i$ we obtain the Keynes-Ramsey rule: $\frac{\dot{C}}{C} = \frac{1}{\sigma} (r - \rho)$.

Production. The economy is composed by two sectors which evolve endogenously. The first produces new intermediate capital goods which spill over to the rest of the economy; the second - composed of firms supposed to be heterogenous with respect to their elasticity of labor demand - produces with a constant returns to scale technology using the existing intermediate capital goods which is supposed to increase linearly total factor productivity. Final output is then produced according to the following production function:

$$Y = A_{1t} \int_0^1 k_i^{1-\alpha_i} l_i^{\alpha_i} \cdot di + A_2 H_p^{1-\beta} \int_0^M x_j^\beta \cdot dj \quad (3)$$

with $A_{1t} \equiv A^c \cdot M$, M : number of intermediate capital goods, A^c : a positive constant, k_i and l_i : capital and unskilled labor respectively, used in firm i in the homogenous goods sector, x_j : amount of intermediate capital input in firm j in the innovative sector, $\alpha_i \in (0, 1) \forall i$, $\beta < 1$. Following Romer (1990), the number of intermediate capital goods increase according to $\dot{M} = \frac{M}{\eta} (H - H_p)$ with $H = \sum_{j \in I} h_j$ and H_p : skilled labor used in the production of intermediate capital goods, where I contains indices of all firms in the innovative sector. Clearly, the growth rate amounts to $\frac{\dot{Y}}{Y} = \frac{\dot{M}}{M} = \frac{H - H_p}{\eta}$; if $H = 0$ then there will be no long run growth.

Skill is supposed not to increase productivity of workers in the unskilled labor process. However, in the innovative sector skilled workers may be employed on two tasks: research and production of new intermediate capital goods.

Institutional Dynamics. Individuals are assumed to be imperfectly rational. They consider institutional variables as parameters in their optimal program. This allows us to analyze institutional dynamics with trajectories on which the economy is in steady state whereas the dynamic system is still evolving. This may be justified by two considerations: First, if institutional adjustments take much more time than economic ones, we can argue that there exists two different time scales as in Lordon, 1994. Second, the intertemporal utility function we used to derive the growth rate of consumption is a proxy for an overlapping generation framework with intergenerational altruism (Barro, 1974). In this case, the time horizon of each generation does not exceed the life span (up to an altruism consideration). Together, this may be called institutional myopia.

3 Microeconomic Relations

There are three labor markets: the first one is a competitive market for unskilled labor with an ongoing wage w^c , the second a unionized for unskilled labor where unions negotiate

a wage w^u and the third one a competitive for skilled labor. Workers may switch from the competitive to the unionized labor market by incurring an organization fee. There they may expect a higher job value due to higher union wages. In the unionized sector they face unemployment at least for some short periods of time. Obviously, only organized members in the unemployment pool can be hired for a union job. If union workers have to undergo a strike in order to get their higher wage, they run the risk to fail and to return to the competitive part having passed a period of (search) unemployment.

In order to get into the skilled labor market, workers have to pass a period of (schooling) unemployment where they obtain the necessary skills to be able to apply in this sector. Skilled workers are not used in industries for unskilled workers and vice versa (one could imagine a separation along job demarcations). Figure 1 illustrates the interaction between the three markets where the financial side has already been sketched.

[Figure 1 about here]

3.1 The homogenous goods market

3.1.1 Job offerings for unskilled workers

Let us first turn to the number of jobs is firm is offering. As there are no informational asymmetries on this market, firms will finance their capital needs by raising funds on the bond market at rate r . Bank credits will never be used by homogenous good firms as they are more expensive. Per period profits can then be calculated as (where we suppress the time index):

$$\pi_i = A_1 k_i^{1-\alpha_i} l_i^{\alpha_i} - w^c l_i - r k_i . \quad (4)$$

The labor demand schedule then can be derived by calculating the first-order condition:

$$\frac{\partial \pi_i}{\partial l_i} = 0 \Leftrightarrow A_1 \alpha_i l_i^{\alpha_i-1} k_i^{1-\alpha_i} = w^c \Rightarrow l_i^d = \left(\frac{A_1 \alpha_i}{w^c} \right)^{\frac{1}{1-\alpha_i}} k_i \quad (5)$$

leading to a labor demand elasticity of $\varepsilon^{l,w} = -1/(1-\alpha_i)$. We want to assume that labor demand is non-decreasing with α_i , i.e. firms with higher labor demand elasticity will not offer a smaller absolute number of jobs. We are now able to calculate the loss of employment in a firm depending on its labor demand elasticity if market power can be gained on the labor supply side due to unions. Given a union firm wage $w_i^u > w^c$, labor intensity will be reduced to $l_i^{d,u}/k_i^u = (A_1 \alpha_i / w_i^u)^{\frac{1}{1-\alpha_i}}$ which can be used as a proxy for an employment loss. Given the change in labor intensity:

$$\phi_i = \frac{l_i^d}{k_i} - \frac{l_i^{d,u}}{k_i^u} = \left(\frac{A_1 \alpha_i}{w^c} \right)^{\frac{1}{1-\alpha_i}} - \left(\frac{A_1 \alpha_i}{w_i^u} \right)^{\frac{1}{1-\alpha_i}} . \quad (6)$$

we can calculate its derivative with respect to α_i :

$$\frac{\partial \phi_i}{\partial \alpha_i} = \frac{a (a \alpha_i)^{\frac{\alpha_i}{1-\alpha_i}}}{1-\alpha_i} - \frac{b (b \alpha_i)^{\frac{\alpha_i}{1-\alpha_i}}}{1-\alpha_i} + \frac{(a \alpha_i)^{\frac{1}{1-\alpha_i}} \log(a \alpha_i)}{(1-\alpha_i)^2} - \frac{(b \alpha_i)^{\frac{1}{1-\alpha_i}} \log(b \alpha_i)}{(1-\alpha_i)^2} > 0 \quad (7)$$

with $a := A_1/w^c$ and $b := A_1/w_i^u$, thus $a > b$. Thus, labor intensity decreases (and therefore lay-offs raise) with increasingly elastic labor demand. This derivative leads to the following proposition:

Proposition 1 *Suppose $\alpha_j > \alpha_i$ and let N_t denote the number of organized workers and n_t the number of jobs for union workers at time t . The organization of workers in one additional firm leads to an increase in the overall organization N_{t+1} but only to an underproportional increase, $\Delta n = h(\Delta N)$, in the number of jobs for union workers n_{t+1} . Furthermore the increase of jobs Δn depends negatively on the labor demand elasticity:*

- (i) $N_{t+1} = N_t + \Delta N \Leftrightarrow n_{t+1} = n_t + h(\Delta N)$, $h(\Delta N) < \Delta N$.
- (ii) $\Delta n(\alpha_j) < \Delta n(\alpha_i)$.

Hence, if firms with low elasticities get organized first, increasing organization of the labor market leads to higher unemployment. Moreover, we want to assume that workers undergo a time Δt of unemployment before they can find a new job. This unemployment period may follow the distribution $F(\Delta t)$ but is supposed to have a lower limit which is positive: $\Delta t_{\min} > 0$.

3.1.2 Unions and wage bargaining

Unions are supposed to bargain with firms over wages. They use their (endogenously determined) bargaining power s to raise wages above w^c by taking into account the consequent job loss. With capital \bar{k}_i preinstalled, the fallback position is $\pi_i^v = -r\bar{k}_i$. We assume a Nash bargaining situation in each firm i (see Layard *et al.*, 1990) with the Nash maximand being:

$$\begin{aligned}\Omega_i &= (w_i^b - Z)^s [l_i^d(w_i^b)]^s [\pi_i(w_i^b) - \pi_i^v] \\ &= (w_i^b - Z)^s [l_i^d(w_i^b)]^s [A_{1t}\bar{k}_i^{1-\alpha_i}l_i^{\alpha_i} - w_i^b l_i]\end{aligned}\quad (8)$$

where w_i^b stands for the outcome of the bargaining and Z for the alternative income in case the worker gets laid off. Maximization leads to:

$$\frac{\partial \log \Omega_i}{\partial w_i^b} = \frac{s}{w_i^b - Z} + \frac{s}{l_i^d} \frac{\partial l_i^d}{\partial w_i^b} - \frac{l_i^d}{\tilde{\pi}_i} = 0 \quad (9)$$

with $l_i^d = -\partial \pi_i(\bar{k}_i)/\partial w$ and $\tilde{\pi}_i \equiv A_{1t}\bar{k}_i^{1-\alpha_i}l_i^{\alpha_i} - w_i^b l_i$. Dividing by w_i^b and rearranging terms leads to the determination of the union mark-up:

$$\frac{w_i^b - Z}{w_i^b} = \left(-\frac{w_i^b}{l_i^d} \frac{\partial l_i^d}{\partial w_i^b} + \frac{w_i^b l_i^d}{s\tilde{\pi}_i} \right)^{-1}. \quad (10)$$

Given the fact that $\varepsilon_i^{w,l} \equiv \frac{w_i^b}{l_i^d} \frac{\partial l_i^d}{\partial w_i^b} = -(1 - \alpha_i)^{-1}$ and $\frac{\tilde{\pi}_i}{w_i^b l_i^d} = \frac{1 - \alpha_i}{\alpha_i}$, this can be rewritten as:

$$\frac{w_i^b - Z}{w_i^b} = \frac{1 - \alpha_i}{1 + \alpha_i/s} \Leftrightarrow w_i^b = \frac{s + \alpha_i}{\alpha_i(1 + s)} Z. \quad (11)$$

Obviously, the bargaining wage will only be the wage actually paid to the worker if it exceeds w^c as otherwise the worker would prefer not to get organized, i.e. $w_i^u = \max[w_i^b, w^c]$ with w_i^u the actual wage under unionization. Given (11), the union mark-up decreases with increasing labor demand elasticity and increases with bargaining power. Note that α_i is individual to each firm while s depends on the economy-wide organization rate.

3.1.3 Join and Strike: workers' arbitrage between being organized or not

Joining. Workers decide according to an arbitrage equation whether or not to leave the competitive part of the labor market. Switching is supposed to be costly with sunk cost $c^o = \zeta$ due to organization cost (which will be specified in the next subsection). With ρ the worker's time preference rate, the present discounted value of a job for an insider in the competitive part of the unskilled labor market at t_0 is:

$$J^c = \int_{t_0}^{\infty} w^c \cdot e^{-\rho(t-t_0)} dt. \quad (12)$$

On the other hand, switching to the organized sector leads to an expected job value:

$$J^u = \int_{t_0}^{\infty} [n_i w_i^u + (1 - n_i) Z] \cdot e^{-\rho(t-t_0)} dt - \zeta \quad (13)$$

where n_i and w_i^u depend on the specific elasticity ε_i of the firm whose workers are getting organized.

As we have supposed institutional myopia, the per-period values under the integrals do not change over time, such that a direct comparison is possible. Workers switch if the union job gives at least as high a value than the competitive one:

$$\begin{aligned} w^c &\leq n_i w_i^u + (1 - n_i) Z - \rho \zeta \\ \Leftrightarrow n_i &\leq \frac{\alpha_i (1 + s)}{s(1 - \alpha_i)} \cdot \frac{w^c + \rho \zeta - Z}{Z}. \end{aligned} \quad (14)$$

Let $i = i^*$ be the firm where this is an equality and let $n^* = n_{i^*}$. Then workers in firms with α_i such that $n_i \geq n^*$ will switch, all others decide to stay on the competitive side. At the same time, n^* determines the maximum α_i which one will observe in the organized sector, i.e. we can define $\alpha^* = \max_{i \in O} \alpha_i$ where O contains all indices of organized firms. Notice that proposition 1 allows us to describe α^* as a monotonically increasing function of N : the value of a union job decreases with the labor elasticity as the probability to be retained given the higher wage decreases. For a given union wage only workers in firms with sufficiently low labor demand elasticities decide to switch, the more workers decide to switch the higher will get α^* .

Moreover, in- and outflow into union membership between t and $t + 1$ is determined by $\Theta^n = n_t^* - n_{t+1}^*$. In the following we want to assume ζ to be high enough such that switching back to the competitive part for those workers who are unemployed does not occur. Then Z simply equals the unemployment benefits and is exogenously given¹.

¹In a more complex version one could envision to allow Z to represent the alternative income with

Strike. Union bargaining power evolves with increasing organization of the homogenous goods labor market. This has an influence on labor militancy s - which therefore is also an indicator for unions' bargaining power - and also on the value of a unionized job.

Suppose that the union members can undertake a strike action in order to obtain the higher union wage. Suppose further that the union organizes the strike in such a way that all members can expect to obtain the median union wage² $w^u \equiv \text{med}_{i \in O} w_i^u = \frac{1}{2} \max_{i \in O} w_i^u$ with O containing the indices of organized firms. The strike action involves some effort s (which is sunk; this explains ζ) and thus some cost $\varphi = \varphi(s)$, $\varphi' > 0$, $\varphi'' > 0$ (except from physical effort this could include unpaid wages). The higher the effort the higher the probability that the strike succeeds and that they get the same or a better contract next period, i.e. they lose the value J^s of their contract with probability $d = d(s)$, $d' < 0$, $d'' > 0$. Therefore, if the strike fails they return to the competitive section of the labor market with probability $d(s)$. There, they expect to obtain the competitive wage with $1 - \frac{N}{L}$. Thus job value under strike writes as:

$$\begin{aligned} \rho J^s &= w^u - \varphi(s) + d(s) [(1 - N/L) w^c - J^s] \\ \Leftrightarrow J^s &= \int_{t_0}^{\infty} [w^u - \varphi(s) + d(s) (1 - N/L) w^c] \cdot e^{-(\rho+d(s))(t-t_0)} dt. \end{aligned} \quad (15)$$

Supposing that the problem is concave in s , i.e. $J_{ss}^s < 0$, the optimal degree of militancy $s^* = \arg \max J^s$ can be used to calculate its derivative with respect to the competitive wage and the size of the organized sector:

$$\frac{ds^*}{dw^c} = -\frac{J_{sw^c}^s}{J_{ss}^s} = -d'(s) \frac{[1 - N/L] \rho}{(\rho + d(s))^2} (J_{ss}^s)^{-1} < 0 \quad (16a)$$

$$\frac{ds^*}{dN} = -\frac{J_{sN}^s}{J_{ss}^s} = d'(s) \rho \frac{1}{L} \frac{w^c}{(\rho + d(s))^2} (J_{ss}^s)^{-1} > 0. \quad (16b)$$

This establishes the following proposition:

Proposition 2 *Higher wages and higher employment in the competitive sector leads to reduced union bargaining power, s , and to a reduced union wage, w^u . Moreover, s^* is concave in N for sufficiently impatient workers, i.e. $\rho > \rho'$.*

Proof. The first part of the claim follows from derivatives (16a) and (16b). Calculating the derivative $J_{ssN}^s = -\frac{w^c \rho (-2d'(s)^2 + (\rho+d(s))d''(s))}{L(\rho+d(s))^3}$, this will be negative for sufficiently high ρ given $d'' > 0$, establishing $\frac{d^2 s^*}{dN^2} < 0$. ■

Furthermore, this result can be used to calculate the relationship between the number of firms getting organized and the actual organization, N .

Proposition 3 *The relation between the firms for which $n \geq n^*$ and the actual degree of organization N is non-monotonic. Moreover n^* is convex in N for $\rho \leq \rho'$.*

workers switching back to the competitive part. This would increase complexity considerably without adding any explanatory value.

²A different possibility would be to assume that the worker can gain the expected wage which is the mean of all union wages. This would only complicate the analysis without changing the results.

Proof. Given equation (14) we can write $\alpha^* \equiv \max_{i \in O} \alpha_i := \alpha^*(N)$ with O containing the indices of organized firms and $\frac{d\alpha^*}{dN} > 0$. Then, deriving (14) with respect to N we obtain:

$$\frac{\partial \log n^*}{\partial N} = \frac{d\alpha^*/dN}{\alpha^*(1-\alpha^*)} - \frac{s'}{s(1+s)} \quad (17)$$

which has an ambiguous sign. For $\frac{d\alpha^*}{dN} > s' \forall N$ this derivative is positive.

Furthermore we have uniformity of the distribution of α_i over the mass of firms and the assumption that l_i^d is non-decreasing with α_i , i.e. $\frac{d\alpha^*}{dN} = \alpha^c + O(N)$ with $O(N)$ being Landau's O and α^c a positive constant. From (15) can be concluded $ds^*/d\rho < 0$ while from (16b) follows $d^2s^*/(dNd\rho) > 0$. As $\alpha^*(N)$ does not depend on ρ and $s' = 0$ for $\rho = 0$, a positive ρ'' exists such that for all $\rho \leq \rho''$ we have $\frac{\partial^2 \log n^*}{\partial N^2} > 0$. ■

This means that higher unionization of the homogenous goods market does not necessarily increase the inflow into unionization (which is the higher the lower is n^*). On the contrary if strike effort reacts less elastically to unionization than the average labor demand (which increases with α^*) then there will be a continuous outflow of the unionization sector. The following assumption is supposed to hold through the rest of the paper:

Assumption 1 *The interval (ρ'', ρ') is not empty and includes the economy's time preference rate.*

Therefore and in the absence of a skilled labor market, the union is never strong enough to keep the current unionization rate independent of the initial membership N_0 .

3.2 The differentiated goods market

When workers have the possibility to switch to the innovative sector, they first have to undergo an investment in their human capital before they can apply for a job opportunity there. This educational process comes at a cost which is influenced by the personal ability of the worker. On the other hand, innovative firms need skilled labor to develop and to produce new intermediate capital goods. Furthermore and due to asymmetric information firms can only raise capital from banks in order to be present on the innovative goods market because of banks being able to screen out less innovative firms by setting higher interest rates. Trade unions are not supposed to exist on the labor market for innovative workers.

3.2.1 Innovative firms and wages for skilled labor

We assume that skilled labor does not search for job on the unskilled labor market. The education process therefore benefits entirely the skilled labor market. Outflow through retirement is assumed to be exogenously given (and being set to zero without loss of generality). Once he has innovated a new product with probability $\delta_i \in (0, 1)$, the entrepreneur i is supposed to be able to set a price $p_i = \partial Y / \partial x_i$ for his product while hiring innovative labor at rate w^R and financing his projects through banks at rate R . The time

at which he sets up his new plant is denoted by $t_{0,i}$. The present value of the innovation of a new intermediate capital good then writes as:

$$V_i(t) \equiv \int_{t_{0,i}}^{\infty} (p_i - 1) x_i \cdot e^{-R(v,t_{0,i})(v-t_{0,i})} dv \quad (18)$$

where $R(v, t_0) = (v - t_0)^{-1} \int_v^{t_0} R(z) dz$ stands for the average interest rate over time. Profit maximization leads to $p_i = p = 1/\beta$ and $x_i = x = H_p \cdot A_2^{1/(1-\beta)} \beta^{2/(1-\beta)}$. Given wage $w^R = \frac{\partial Y}{\partial H_p} = A_2^{1/(1-\beta)} (1 - \beta) \beta^{2\beta/(1-\beta)} M$, we can calculate the interest rate in steady state using the fact that the wage rate for skilled workers on both tasks - research and production of the innovative good - equal, i.e. $V_i(t) = w^R \eta / M$. However, contrarily to the standard Romer model, the labor supply in this model is not fixed over time and evolves according to the trajectory the economy is taking. We have to take this into account when we are calculating V_i .

However, due to institutional myopia, each firm entering the differentiated goods market will consider the institutional background as exogenous. Thus, for the firm the decision process boils down to the standard Romer framework with the rate of return being a constant. Given the fact that all trajectories end in a steady state (which will be shown in the next part), the average rate of return on each trajectory exists partly justifying the assumption even though it creates a systematic bias leading to under- or overevaluation of the innovation value depending on whether the economy ends in the low- or high-growth equilibria. This, however, will only have an impact on the speed at which the economy moves along the trajectories, not on the existence or stability of the steady state(s).

Given this constancy of the interest rate and substituting price and quantity of the intermediate good into (18) we obtain the following rate of return by continuously integrating by parts:

$$\widehat{R} = \frac{\mathcal{H}_p}{\eta} \beta \quad (19)$$

with $\mathcal{H}_p = \sum_{j=0}^{\infty} \left[(-1)^j \frac{\partial^{(j)} H_p(t_{0,i})}{\partial t^{(j)}} \right]$ which does not depend on time. Moreover, given that $H = H_R + H_p$, H_p increases monotonically with H in steady state. The return on investment of each firm increases therefore with the size of the innovative sector, H , at the moment it opened its plant. Interestingly, the rate of return of each firm does not only depend on the actual size of the innovative sector but also on all the other - dynamic - aspects of the trajectory on which the economy moves along at the moment of the investment. As can be seen from the wage equation, the following proposition holds.

Proposition 4 *An increasing offer of skilled labor leads to more innovative employment, to higher wages and to a higher growth rate of the economy.*

Furthermore, this result does not depend on the actual behavior of the labor market for skilled workers. On a trajectory with an increasing innovative sector, the new firms can offer higher wages to their employees than the older ones. Thus the average wage increases whether skilled labor is completely mobile or not.

3.2.2 Skilled workers and the education decision

In order to be able to be present on the skilled labor market, workers have to undergo an educational process at cost $c_e(\theta_j)$. The cost depends negatively on the worker's personal ability, θ_j (the more intelligent he is the less it costs) and is supposed to follow the distribution $\theta_j \sim \Phi(\theta)$ with $\theta_j \in [0, 1]$. Without loss of generality the amount of education the worker gets during schooling necessary to switch to the innovative sector is supposed to be fixed.

This cost actually has two components due to a two-step educational process: the first step is the acquirement of a certain education level, the other is the process of continual learning in order to keep this level constant as older knowledge becomes obsolete after some time. The latter process may be seen as on-the-job-learning but the former comes nearer to a period of institutionalized learning in schools. This however impose an opportunity cost on the worker as he cannot apply for any job during this period.

Given the fact that workers in the unskilled sector receive w^c , for the marginal worker who decides to switch the following condition has to hold:

$$\begin{aligned} & \int_{t_0}^{\infty} u(w^c) e^{-\rho(t-t_0)} dt \\ &= \int_{t_0}^{t_1} Z \cdot e^{-\rho(t-t_0)} dt + \int_{t_1}^{\infty} [u(w^R) - c_e(\theta^*)] e^{-\rho(t-t_1)} dt \end{aligned} \quad (20)$$

where t_0 : time of switching decision, t_1 : time of actual employment in the innovative sector, and θ^* : individual ability of marginal worker for which this equation holds. Suppose that this worker has index j^* and that indices are ordered in a way that $j < j^* \Leftrightarrow \theta < \theta^*$, $j \in [0, 1]$, then $m = 1 - j^*$ workers would enter the innovative sector. In the following we want to normalize m in such a way that it is zero whenever $n = 0$ in order to analyze the effect of the presence and development of trade unions.

Now suppose that a trade union is present in the homogenous goods market. Given the normalization $m = 0$ *ex ante* nobody who is considering union membership enters the innovative sector as the job value of the marginal worker who decides to get organized equates the ongoing wage on the competitive side of the market. *Ex post*, however, the situation may change. Once, the membership decision is taken, the marginal worker may undergo a period of unemployment of at least Δt_{\min} and only earning the reservation wage Z . That means that during this period equation (20) writes as:

$$\begin{aligned} & \int_{t_0}^{t_0+\Delta t_{\min}} Z \cdot e^{-\rho(t-t')} dt + \int_{t_0+\Delta t_{\min}}^{\infty} u(w^c) e^{-\rho(t-t'')} dt \\ & < \int_{t_0}^{t_1} Z \cdot e^{-\rho(t-t_0)} dt + \int_{t_1}^{\infty} [u(w^R) - c_e(\theta^*)] e^{-\rho(t-t_1)} dt \end{aligned} \quad (21)$$

and would decide to enter the innovative sector given a sufficiently high individual ability. On the other hand, once employed in the innovative sector, changing back to the organized sector he can only expect a wage at most as high as the competitive wage. The *ex ante-ex post* differentiation leads to an irreversibility of the decision making process.

Thus, the presence of trade unions on the homogenous goods market lead to an increasing inflow of workers in the innovative sector as they produce short periods of unemployment where the opportunity costs of switching are lower than for those employed in the competitive sector. This creates higher wages in the innovative sector (see proposition 4) and further inflow from either competitively employed or organized unskilled labor.

3.2.3 Finance for innovative investment and banks

Innovative projects are supposed to give rise to problems of asymmetric information leading to myopia when financed on the bond market (Stein, 1988, Shleifer and Vishny, 1990). In this case, a screening mechanism can help to overcome the financing problem which innovative firms face, especially in a situation where firms can not signal their financial position which we want to assume here. Banks - formed by colluding financial investors - can provide the necessary screening by raising the interest rate they charge above the ongoing rate on the bond market. Given the same amount of collateral, those firms which have good innovative abilities choose to pursue them while those which do not prefer to continue to produce on the homogenous goods market. Raising interest rates provides in this case an effective way of sorting out bad risks and no rationing occurs. In the following, we use a reduced version of a Monti-Klein model in an oligopolistic setting (see Klein, 1971, Monti, 1972).

Given an existing size of the innovative sector, new lenders face the return differential $R - r$. On the other hand, there may exist organization costs, c^b , which are supposed to increase linearly with the amount of loans: $c = c^b(L) = \varpi L$. The banking sector is composed of F banks which provide loans L to the innovative sector at rate $R(L)$. In order to make loans, banks can borrow from the bond market at rate r . Banks are profit-maximizers with the following objective function which includes the loans provided by their competitors:

$$\pi_j^b = \left[R \left(L_j + \sum_{k \neq j} L_k \right) - r \right] L - c^b(L). \quad (22)$$

Considering a symmetric Nash equilibrium with $L_j^* = \frac{L^*}{F}$ and using the elasticity of demand for loans $\varepsilon_L = -R \cdot L'(R) / L(R)$ we can write the first-order condition as follows:

$$\begin{aligned} \frac{\partial \pi_j^b}{\partial L_j} &= R'(L^*) \frac{L^*}{F} + R(L^*) - r - \varpi = 0 \\ \Leftrightarrow \frac{R^* - (r + \varpi)}{R^*} &= \frac{1}{F \varepsilon_L(R^*)} \end{aligned} \quad (23)$$

which correspond to the standard oligopolistic price setting behavior. In the case that there is only one bank present ($F = 1$), this bank can charge (almost) the full difference between the value of the innovation and the financial market rate, $R^* \approx \widehat{R}$. The optimal interest rate for loans then falls monotonically from \widehat{R} to r with increasing banking and innovative sector.

As we already noted, firms differ in their (unobservable) ability to innovate, δ_i . We suppose that there are no problems to enforce the loan contract (due to the collateral). Therefore, firms only borrow if their expected value of the innovation is greater than the ongoing interest rate. The maximum number of firms which borrow is given by the following arbitrage equation:

$$E[V_i] = \delta_i \cdot \hat{R} \stackrel{!}{=} R^*. \quad (24)$$

This means that with increasing number of banks, the innovative success of the marginal firm falls. We have the following proposition.

Proposition 5 *With increasing size of the innovative sector, the number of banks increases and thus the competition among them. This leads to a reduced rate of interest the bank can charge for its loans and to an increased rate of bank failures as more and more less successful firms enter the market.*

3.3 Coordinating banks and innovative workers

Given the technological complementarities in starting an innovative firm, workers and banks face a coordination game where the effectivity of the action undertaken by one party depends on what the other party does. If financial investors collude unilaterally but the workers do not invest in their human capital then the collusion will be worthless. If on the other hand workers invest in their human capital without financial investors colluding to banks then firms will not be able to invest in the innovative technology. The incentive structure of investing in schooling and forming a bank therefore crucially depends on what the other side does.

Firms can be considered as the residual in this game which choose the appropriate technology depending on whether financial investors and workers find the innovative coordinated equilibrium. Thus the following coordination game can be written down with payoffs being reduced from intertemporal to one-period values as only their relative values are important. Financial investors choose columns and decide whether or not to form a banks; workers choose rows and decide whether or not to invest in education:

	Not colluding (NC)	Forming a bank (C)
no education (NE)	$u(w^c), r$	$u(w^c), r - c_b$
education (E)	$u(w^c) - c_e(\theta), r$	$u(w^R) - c_e(\theta), R - c_b$

Game 1: Coordination game between workers and banks

In order to analyze this game we want to make use of the trembling-hand perfect equilibrium concept introduced by Selten (1975). Both players assume that the other player plays all strategies with a certain, small probability, i.e. that he makes errors in choosing his best response. This concept applies somewhat naturally in our setting as the education process and the collusion of financial investors to banks takes time and may fail for different reason. Thus, we suppose that both players are not sure if the other is playing his best response and assume that he may make errors with a certain probability $\varepsilon > 0$. Making use of some well-known theorems on trembling-hand perfect equilibria, we can prove the following:

Proposition 6 *For the marginal worker we have $u(w^R) - c_e(\theta_m) = u(w^c)$. The coordination game between this worker and the financial investor has only one perfect equilibrium where both play the status-quo strategy, i.e. (NE,NC).*

Proof. For the marginal worker his pure strategy 'education' as well as his mixed strategy are weakly-dominated by the pure strategy 'no education'. However, as has been shown elsewhere (van Damme, 1983, p. 31), every perfect equilibria is undominated. Thus, in a perfect equilibria the marginal worker will not play 'education' and the only remaining equilibrium will be (NE,NC). ■

Therefore, at most every firm with workers of ability $\theta > \theta_m$ can be expected in the innovative sector. This is true even if initially workers' abilities are unequally distributed over the different firms as firms can always fire a low ability worker and hire a high ability worker on the competitive labor market.

However, the inflow in the innovative sector in the uncoordinated world is only limited from above but not from below and the coordination between banks and workers is by no means guaranteed. Hence, we want to introduce a coordination parameter $\psi \in [0, 1]$ which gives us the fraction of workers with ability $\theta > \theta_m$ which actually enter the innovative sector. The higher this parameter, the better the coordination. This parameter is supposed to underlie exogenous changes which influence the coordination process. It plays a crucial role in the determination of the existence of certain equilibria.

Given an expected probability p' of bank entry, we can determine whether it is profitable for the worker to invest in education or not. These workers are represented by

$$\{\theta | E[u(w^R) - c_e(\theta) | p'] > E[u(w^c) | p']\} \Rightarrow p' \geq \hat{p} = \frac{c_e(\theta)}{u(w^R) - u(w^c)}, \quad (25)$$

i.e. all workers for whom $\hat{p} \leq p'$ will decide to switch. On the other hand, financial investors expect q' workers to invest in education and to enter the innovative sector. Hence, they would only decide to form or join a bank when their expected pay-off is higher than in the bond market:

$$E[R - c_b | q'] \geq E[r | q'] \Rightarrow q' \geq \hat{q} = \frac{c_b}{R^* - r} \quad (26)$$

where we suppose that financial investors base their entry decision on the assumption that their entry would not change the maximum interest rate they can charge on loans. In (expectational) equilibrium, these two values (beliefs) have to be equal as the coordination only succeed when both sides enter the innovative sector, thus $q' = p' \equiv \psi$.

Clearly, if the maximum interest rate is not high enough then coordination fails completely (i.e. $\hat{q} > 1$). In this case, no bank would ever enter the market and no worker would have an incentive to invest in education. A similar conclusion holds for the case where the wage in the innovative sector is not high enough to give workers an incentive to switch (i.e. $\hat{p} > 1$).

Proposition 7 *Assuming organization costs of zero (i.e. $c_b = 0$), banks would always enter the market for any rate of innovative worker. In this case, the entry process in the innovative sector is determined by the distribution of learning abilities among workers.*

Proof. When $c_b = 0$, the collusion strategy becomes the dominant strategy for banks. In this case, all workers for which $\theta \geq \theta_m$ would invest. θ_m in turn depends on the distribution $\Phi(\theta)$ of workers' learning abilities. ■

4 Reciprocal evolution of banks and trade unions

Given institutional myopia the agents in the economy take the institutional environment as a parameter when they may make intertemporal decisions. The two main dynamic variables which govern the institutional dynamics - the union membership of employed organized workers, $n = \sum_{i \in O} l_i^{d,u}$, O : set of indices of organized firms, and the number of banks, b - can then be put into a dynamic relationship.

Corollary 1 *The stream of in- and outflow into unionization, Θ^n , is a function of the number of existing unions, n , and of the number of banks, b with $\partial\Theta^n/\partial n < 0$ and $\partial\Theta^n/\partial b > 0$.*

Proof. According to our assumption 1, unions are unable to keep their rate in the absence of any other institutional activity, thus $\partial\Theta^n/\partial n < 0$. Only in case of banking activity the strike effort can be increased such as to increase union mark-up sufficiently to attract new members (proposition 2 and equation (11)). Banks increase union bargaining power as they reduce the number of unemployed in the organized sector by giving them incentives to switch to the innovative sector (proposition 7) which in turn increases the member's strike effort and thus the union wage. ■

We can then write for the union membership dynamics:

$$\dot{n} = \Theta^n(n, b) \quad (\text{D1})$$

with $\Theta_1^n < 0$, $\Theta_2^n > 0$ meaning that the membership process is not explosive.

Corollary 2 *The stream of inflow, Θ^b , into the banking sector is a function of the number of existing banks and of the number of trade unions in the homogenous goods sector with $\partial\Theta^b/\partial b < 0$, $\partial\Theta^b/\partial n > 0$. The stream of outflow, *exit*, is a function of the numbers of banks only.*

Proof. The inflow into the banking sector depend on the interest rate differential net of organization cost, $R^* - r - c_b$. This differential decreases with the number of banks (proposition 5). Furthermore, an increasing rate of innovation failures leads to a higher outflow of banks, $\text{exit} = \text{exit}(b)$, $\text{exit}' > 0$.

The inflow into the banking sector is however sustained by union membership as the increasing unemployment creates incentives for workers to switch into the innovative sector. However, this may depend on the rate of successful coordination, ψ , which increases the inflow rate. ■

The growth of the banking sector writes thus as follows:

$$\dot{b} = \Theta^b(b, n, \psi) - \text{exit}(b) \quad (\text{D2})$$

with $\Theta_1^b < 0$, $\Theta_2^b > 0$, $exit' > 0$. As before the inflow process is non-explosive as $\Theta_1^b - exit' < 0$. Only the shape of the isocline depends on the distribution of innovation failures which influences the exit rate $exit(b)$.

In order to analyze the dynamical system (D) we calculate the slope of the two isoclines $\dot{n} = 0$ and $\dot{b} = 0$ by total differentiating (D1) and (D2):

$$\dot{n} = 0 : \frac{db}{dn} = \frac{-\Theta_1^n}{\Theta_2^n} > 0, \quad (27)$$

$$\dot{b} = 0 : \frac{db}{dn} = \frac{\Theta_2^b}{exit' - \Theta_1^b} > 0. \quad (28)$$

The next two corollaries give us a hint about the shape of these isoclines.

Corollary 3 *The $\dot{n} = 0$ -isocline describes the geometrical space of (b, n) -points for which the number of trade unions is stable. This space is convex in n (or equivalently concave in b).*

Proof. An increasing number of banks increases the bargaining power of trade unions which in turn attracts new members. From proposition 1 follows that a linear increase in the wage differential leads only to a concave increase in the membership as more and more workers of firms with higher labor demand elasticities become organized. ■

Corollary 4 *The $\dot{b} = 0$ -isocline describes the geometrical space of (b, n) -points for which the banking sector is stable. This space is concave in n (or equivalently convex in b).*

Proof. An increasing number of trade unions means increasing unemployment and thus increasing potential switch of workers in the innovative sector. According to proposition 5 the interest rate differential decreases which makes it interesting only for a smaller number of financial investors to enter the banking sector. Furthermore, equation (26) shows that with a decreasing interest rate differential, the minimum number of workers who have to switch increases with convex speed. Thus, a linear increase of trade unions lead to a concave increase in banks. ■

Given the existence of threshold values which follow from assumption 1 and the normalization $m = 0$ (see page 11) we can expect multiple equilibria as in figure 2:

[Figure 2 about here]

Given our non-explosiveness assumptions, two of the equilibria are stable (E and O) and sinks while F is an unstable one; this justifies our assumption about the non-degenerativeness of the rate of return on all trajectories (see page 10). The outcome of the complementarity process between banks and trade unions depend on the initial position of the economy. Given the fact that equilibrium F is a saddle-point, the basins of attraction can be calculated by deriving the stable branch (S-S) of this saddle. Every initial point below or to the left of this stable branch leads to a reduction of both institutions; the economy produces then only the homogenous good and has a completely competitive labor market. Every initial point above or to the right of the stable branch

of F leads to equilibrium E where a highly organized labor market for the homogenous good production and a big banking sector for the innovative sector prevails.

Government intervention in the process can improve the innovative equilibrium or provide necessary conditions for its existence. The shape of the isocline $\dot{b} = 0$ depends on the reaction of the inflow into the banking sector which in turn is influenced by the interest rate banks can charge and the failure of innovation. Any government policy which decreases the rate of innovation failure or which changes the distribution of success rates towards less drop-offs reduces the exit-rate out of the banking sector. This leads to a steeper isocline and to a higher cutting point E (or to the development of a second equilibrium if there had not been before).

An interesting role is played by the coordination failure parameter ψ . As ψ goes down, coordination fails more and more often. The inflow in the innovative sector reduces and the equilibrium position exposes reduced organization of trade unions and banks. Notice that it is possible for ψ to reach a point where both isoclines do not cross any more. In this case, the level of coordination failures does not allow an institutionalized equilibrium any more. Again, government intervention may help to overcome this problem by providing signals such as certified school leaving exams to increase the matching rate.

5 Conclusion

In this article we aimed at providing an explanation for divergence in economic performance through a mechanism of institutional complementarity. We discussed an endogenous growth model where incomplete markets do not allow human capital accumulation in an institution-free world. We showed that under the condition that two complementary factors are necessary in order to start the production of an innovative, growth-enhancing intermediate capital good - namely skilled labor and long-term finance - an institutional relationship may exist where incentives are set by both institutions in a way as to simultaneously enhancing the supply of the complementary inputs. This relationship has been identified as institutional complementarity and its dynamic behavior has been analyzed under the assumption that institutional variables react to economic performance.

In such a coevolutionary dynamics, two equilibria may arise with distinct growth rates and welfare levels. Whereas in the first equilibrium, both labor and financial markets function under competitive conditions, this fails to give rise to positive externalities and the build-up of human capital and long-term finance; in this equilibrium therefore, long-term growth is bound to the exogenous rate. In the institutionalized equilibrium, on the other hand, unions reduce job offers for unskilled labor giving incentives for some of the unemployed to spend time in the educational system and to switch to the innovative sector. Moreover, oligopolistic banks create a self-selection situation with an interest rate differential that helps to single out good from bad innovators and to finance the related innovative capital. This second equilibrium is therefore characterized by a steady endogenous growth rate of technological change, combining continuous innovative activity and a strong institutional environment. However, the existence of this equilibrium is not guaranteed.

In a more complete model of this process, one could imagine to introduce interactions

with the structure on the product market or with different monetary transmission mechanisms. Moreover, firms could be analyzed as playing a more active role. For example, in order to escape unionization firms may invest in labor skills and signal an investor friendly environment in order to get the necessary credits. On the other hand, the analysis of the existing institutions should be continued in more detail. Unions can be seen as necessary for the skilling process of workers and on the finance side, more and different institutions - such as financial markets for high risk or the differentiation between commercial and universal banks - can be introduced and the effect on the institutional dynamics analyzed.

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7 Figures

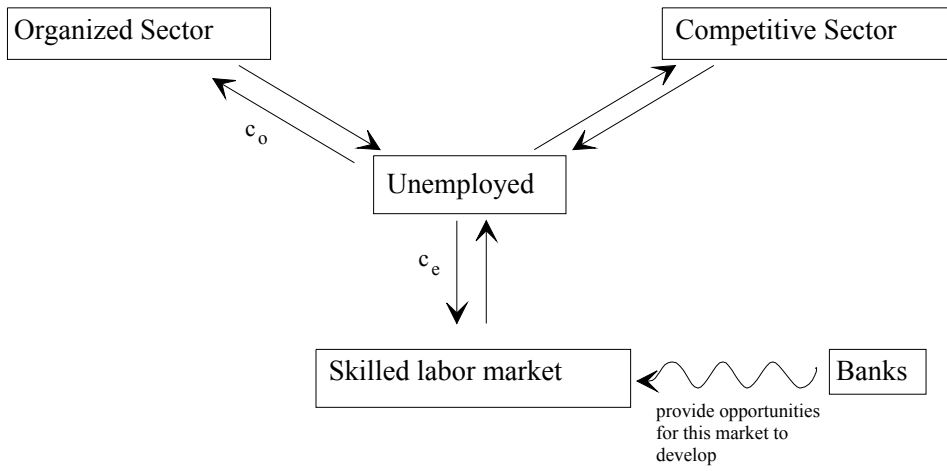


Figure 1: Labor Markets

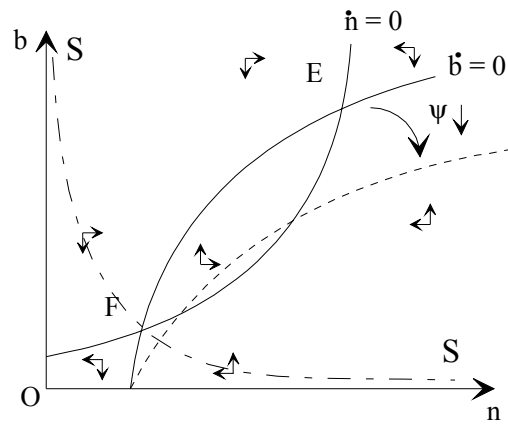


Figure 2: Institutional Dynamics