

# What if Ageing was the Only Investment? The Role of Credit Market Imperfections and the Age Profile of Earnings\*

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## Abstract

There are sizeable differences in the hourly wage of old and young worker across European countries. While Germany, UK, Sweden and the EU-15 average all display an inverted U-shape age profile of earnings - hourly earnings peak for workers in their forties or fifties and fall later on-, other European countries, like Italy and Belgium, display a monotonically increasing age profile of earnings.

This paper proposes a rationalization of this evidence that relies only upon cross-country differences in credit access for entrepreneurs. The main result is that economies characterized by well functioning credit markets have an inverted U-shape age profile of earnings, while imperfect credit markets determine a delay in the undertaking of investment opportunities that is responsible for the fact that workers' wages monotonically increase with age. This observation suggests a different perspective in the policy debate regarding labor market liberalization and the relationship between wage and productivity.

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# 1 Introduction

Does it pay relatively more to be an old age worker in one country with respect to another? The short answer is yes. In 2002 Eurostat reports a sizeable cross-country difference within Western Europe in the age profile of earnings, i.e. relationship between age and employees' earnings. I present in Figure 1 the evidence. Germany, UK, Sweden and the EU-15 average all display a non monotonic behavior of earnings in age: employees' (hourly real) earnings peak for workers in their forties or fifties and fall during later stages of their life. Italy and Belgium, present instead hourly earnings that are monotonically increasing in age. Moreover, the countries that display a monotonically increasing age profile of earnings also features lower average wage.

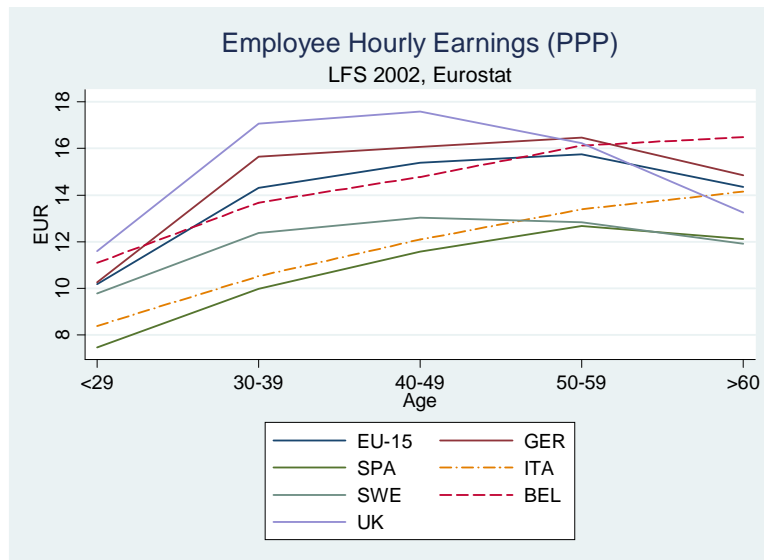


Figure 1

This evidence is interesting in its own right and its interpretation is relevant for welfare and policy implications. In this paper I stress the importance of credit market imperfections - instead of labor market rigidities - in explaining the discussed above cross-country differences in the age-profile of earnings. In order to do so I will study a set of economies where credit market imperfections are central in the agents decision to become entrepreneurs<sup>1</sup>. To highlight the role of credit, I will shut done all other channels that may in

<sup>1</sup>There is a well developed empirical literature that tests, mostly indirectly, the importance of credit market imperfections in the choice to become entrepreneurs (Blanchflower and Oswald (1998), Evans and

reality affect the age profile of earnings. This is not to say that there are no alternative mechanisms, beginning with labor market imperfections, that are not important in reality<sup>2</sup>. This paper shows that even in the presence of perfectly competitive labor markets, the difference in credit market access for entrepreneurs can explain the cross-country heterogeneity in the age profile of earnings. Highlighting the role of credit market imperfections also helps to refocus welfare and policy analysis. In a society where workers have to wait until old age to "cash in" their value, it is even more important, both for consumption smoothing and social mobility, to have well functioning credit markets. Unfortunately, as I argue in this paper, it is precisely in the economies where credit markets work the least well, that young workers are most likely to earn less than older workers and wages increase with age. When credit markets fail to work effectively, these workers can not improve their position by becoming entrepreneurs and they are left with only one investment choice: ageing.

There evidence is supportive of the point of view that considers the centrality of credit market imperfections. OECD indicators on overall employment protection legislature (EPL) in the late nineties and the share of workers affected by collective bargaining show that there is substantial similarities across Western European countries, with the noticeable exception of the UK (Figure 2). This is suggestive of the fact that we should

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Jovanovic (1989), Quadrini (2008) for a comprehensive review). Hurst and Lusardi (2004) interestingly provide evidence against the importance of wealth in the decision to become entrepreneurs using PSID data for the US. There is a general consensus that, even if wealth may not be too important in the decision to become entrepreneurs, it has an effect on the ability of the firm to develop. From the point of the paper the choice to become an entrepreneur or the ability to develop once you have become one are the same and so I can safely assume the importance of credit markets imperfections for entrepreneurial decisions.

<sup>2</sup>Most of the literature on related questions would suggest to focus on labor market rigidities: Bertola and Rogerson (1997), Mortensen and Pissarides (1994) and Wasner (2006).

not only focus on labor market rigidities.

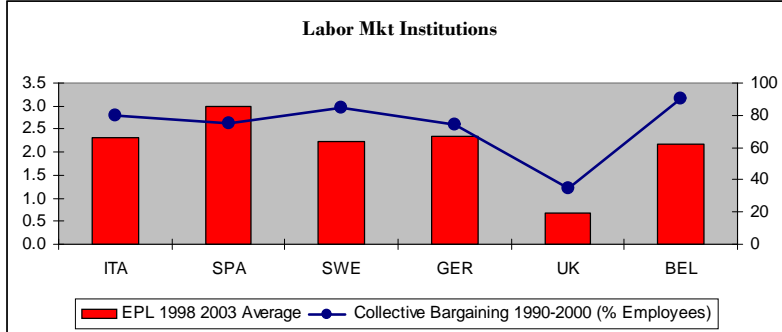


Figure 2

Instead, there seems to be substantial cross-country heterogeneity in the level of credit markets imperfections, especially in the ability to channel credit to the corporate sector and young firms in particular. Figure 3 reports the (average and maximal) ratio between

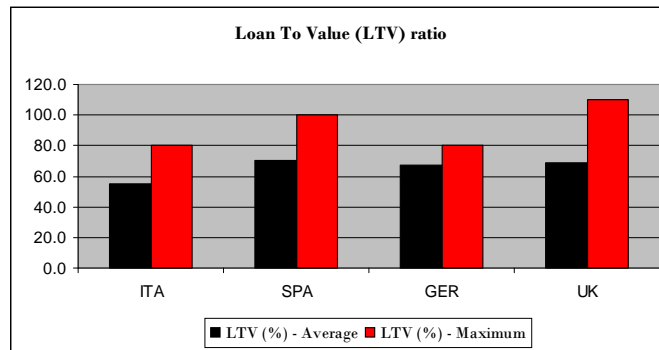


Figure 3

the size of the loan and the value of the underlying collateral in the case of the mortgage markets. Although this is not a direct measure of credit access imperfections for entrepreneurs, there is a general consensus that Loan to Value ratio (LTV) is highly correlated across credit to households and credit to firms within a country<sup>3</sup>. More interestingly one can observe that the countries with more advanced credit markets, i.e. higher LTV ratios, such as UK, Sweden and Germany, have a non monotonic age profile of earnings, while this is not the case with countries, like Belgium and Italy, where credit markets seem to

<sup>3</sup>On the issue see Jappelli and Pagano (1994).

work much less well. The conclusion I draw from this descriptive evidence is that, while it is difficult to draw a correlation between the shape of the age profile of earnings and labor market rigidities, there seems to be a correlation between credit market development and the profile.

The contribution of this paper is to show the effect of the simplest form of credit access imperfections on the choice between remaining a worker and becoming an entrepreneur. This helps to interpret the cross-country heterogeneity mentioned above, generate relevant predictions about labor market behavior and the macroeconomy and, finally, contribute to a novel policy perspective on welfare analysis. To fix ideas, let us consider overlapping generations economies where individuals live through three ages: they born as young, they become middle aged and finally old. In each of the three periods of their life, they work and decide how to allocate their income between consumption and savings.

The structure of the economy is similar to Bernanke and Gertler (1989) there are two goods in the economy: output and capital. Output is produced by employing capital and labor. Labor is supplied and demanded competitively but is not a completely homogeneous input. Workers are distinguished according to their age or experience, and this difference is priced since they receive different wages. This assumption implies that labor markets are sophisticated: they are segmented by age classes so that two units of labor coming from workers with equivalent qualification/education but of different age are treated differently in the production function. The production technology recognizes experience.

Capital is produced through specific investment opportunities initiated by private individuals (entrepreneurs) that decided to stop being workers. As agents become middle and old age, they are presented with the opportunity to become entrepreneurs undertaking an investment opportunities that materializes in front of them. These investment opportunities differ in two ways. First, in any given age class, opportunities differ in terms of productivity across individuals; second, investment opportunities depreciate over time, i.e. they are on average productive for younger agents. This assumption is made for the sake of realism: I want to capture the idea that the timing of investment is a crucial determinant of its productivity. Therefore, middle age agents have on average - *ex ante* - a more productive investment technology than elderly individuals.

The crucial choice in this economy is whether an individual becomes an entrepreneur or passes on the opportunity and remains a worker. If an agent becomes an entrepreneur, he seizes the investment opportunity he was presented, pays upfront the setup cost in terms of labor cost, produces and sells capital. Alternatively, he remains a worker employed directly in the production of output or capital. For simplicity, agents face the choice between

remaining a worker and becoming an entrepreneur up to two times in their lifetime: when they are middle aged and when they are elderly. The only difference is that the investment opportunity they face when they are old is *on average* less productive.

In principles, agents should decide to become entrepreneurs anytime the investment opportunity is sufficiently productive to justify the amount of upfront funds it requires. In reality though this trade-off is not the only determinant of investment decisions. In fact the decision also depends on how easily credit flows to entrepreneurs, i.e. on how well credit markets work. If there were no credit market imperfections, any positive net present value opportunity would be funded until the aggregate supply of funds/savings is exhausted at the prevailing interest rate. As more productive investment opportunities are undertaken, two general equilibrium effects take place on wages: first, the average wage in the economy increases since more capital is produced and the overall marginal productivity of labor increases; second, the wage of workers belonging to the age class from which most entrepreneurs come from increases relatively more. The latter effect is due to two reasons: as more people from a given age class become entrepreneurs, first, less workers of that class remain available for employment (*supply effect*); second, when an agent becomes an entrepreneur he starts a project that is highly correlated with his own skills and so he tends to hire workers that are more similar to him (*demand effect*). This two effects generate a more than proportional increase in the demand for the skills of the workers belonging to the same age class of most of the entrepreneurs.

Two are therefore the main implications of well functioning credit markets: first, the economy becomes more rich in capital, labor productivity increases and wages increase on average; second, the wage increases relatively more for those workers that belong to the age class where most of the entrepreneurs come from. Since credit moves efficiently in the economy, most of the entrepreneurs in turn comes from the age class where entrepreneurs are the most productive. Thus, as more entrepreneurs are middle aged in equilibrium, workers in the middle age group benefit relatively more and the age earnings relationship is non monotonic: wages first grow from young to middle age, then they fall when workers become old age.

In economies, instead, where credit markets face relevant imperfections, credit is offered only in some inefficient proportion of the net present value of the investment opportunities.<sup>4</sup> Therefore it happens that a big chunk of the agents is forced to pass over valuable

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<sup>4</sup>This is the simplest way of rendering credit market imperfections and it is a common shortcut shared by Kiyotaky and Moore (1995), Caballero and Krishnamurthy (2001) and Krishnamurthy (2003) and among others.

investment opportunities and remain a worker. Since many potential entrepreneurs are credit constrained, they remain workers and accumulate enough savings to rely less on external credit when they face the same choice in the future. Therefore, when compared with economies with perfect credit markets, in this set of economies less new investment opportunities are undertaken by middle age agents and, when credit market imperfections are sufficiently bad, there will be less entrepreneurs coming from the middle age class than from the old age. This depresses aggregate capital production and thus the average wage in the economy. Individual wages increase with age, following the distribution of entrepreneurs across age classes that is skewed toward the elderly. As the entrepreneurial class becomes older on average, wages also monotonically increase with age: these are two sides of the same credit imperfections.

The central contribution of this paper is to stress the importance of credit market access for entrepreneurs and its effect on the age profile of earnings and its cross-country heterogeneity. This approach has other interesting implications regarding job tenure, job-to-job transitions and composition of the entrepreneurial class. This paper does not wish to rule out the common wisdom - although unformalized - explanation for this evidence, based on labor market institutional differences and rigidities<sup>5</sup>. By arguing how credit market imperfections can interpret the observed evidence, this paper wishes to broaden the policy perspective regarding factor markets reforms. First, it points out that a specific shape of the age profile of earnings is not necessarily a reflection of the fact that wages are not following productivity. In fact I argue that the correlation between workers productivity and age should be viewed as an endogenous outcome due to entrepreneurial choice in interaction with credit market imperfections. Second, it argues that, even though the role of labor market *imperfections* may be very important, even the most flexible and competitive of the labor markets could not, in principles, resolve the cross-country difference in the age profiles of earnings. Therefore, the policymaker interested in affecting the age profile of earnings should target credit and labor market imperfections together. The alternative - this paper suggests - lies between a joint reform of both factor markets or no reform.

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<sup>5</sup>See Bertole and Rogerson (1997) and Wasmer (2002)

## 2 The Economy Setup

### 2.1 Workers and Entrepreneurs

The analysis is conducted in the context of a production economy with two goods, capital and output, and overlapping generations living for three periods: young ( $y$ ), middle ( $m$ ) and old age ( $o$ ). We define generation  $t$  to be the set of all individuals born at the beginning of period  $t$  and endowed with the amount of labor,  $L_t = 1$ . Generation  $t$  leaves the economy at the end of period  $t + 2$ . Every generation consumes in each period of her life the amount:  $c_{it}$ ,  $i = y, m, o$ , represents the units of consumption at age  $i$  by generation  $t$ . Generation  $t$  utility function,  $U_t$ , is defined as:

$$U_t = u(c_{yt}) + E_{\{w,e\}} [u(c_{mt})] + E_{\{w,e\}} [u(c_{ot})] \quad (1)$$

$$u' > 0; u'' < 0$$

where  $u(\cdot)$  denote the instantaneous utility from consumption and the expectation takes into account that individuals have to decide whether they are entrepreneurs or workers, as I will describe later. Maximizing (1), generation  $t$  faces three different age specific budget constraints. When young, agents can only be workers:

$$c_{yt} = w_{yt} - s_{yt} \quad (2)$$

where  $w_t(i)$   $i = y, m, o$  represents the wage per worker of age  $i$  and  $s_{it}$  savings.

At the end of their youth, when consumption  $c_{yt}$  and saving  $s_{yt}$  decisions have been made, individuals receive an investment opportunity of random quality  $j$ . Each individual must decide whether to supply labor as a worker or become an entrepreneur right before becoming middle-aged. If he decides to remain a worker, he faces the following budget constraint when middle aged:

$$c_{mt}^w = w_{mt+1} + R_{t+1} \cdot s_{yt} - s_{mt} \quad (3)$$

where  $R_t$  is the gross interest rate paid on savings at  $t$ . If instead an agent becomes an entrepreneur and starts project  $j_m$ , he receives profits  $\pi^{j_m}$  when middle aged. His budget constraint in this case is:

$$c_{mt}^e = \pi_{t+1}^{j_m} + R_{t+1} \cdot s_{yt} - s_{mt} \quad (4)$$

Finally, at the end of their middle age and before becoming old, individuals again receive a random investment opportunity of quality  $j_o$ . Once again each of these agents must decide whether to remain a worker or become an entrepreneur. Analogously to the previous case, when workers they face the standard budget constraint:

$$c_{ot}^w = w_{ot+2} + R_{t+2} \cdot s_{mt} \quad (5)$$

while the agents that become entrepreneurs face:

$$c_{ot}^e = \pi_{ot+2}^j + R_{t+2} \cdot s_{mt} \quad (6)$$

## 2.2 The Technology of the Economy and the Labor Market

### 2.2.1 The Production of Capital

The economy is endowed with two sectors or production activities. The first sector involves the production of capital. Each individual is a potential entrepreneur endowed in any given period with a project  $j_{z=\{m,o\}} \in [0, 1]$ . Project  $j$  can be started by paying upfront the fixed cost:

$$F^{jz} w_z \quad (7)$$

$$F^{jz} \sim U(\underline{F}, \bar{F})$$

in terms of unit of labor<sup>6</sup> of age class  $z$ , the same of the entrepreneur. The assumption that entrepreneurs hire only workers of their age class is made for simplicity and is meant to represent the fact that, when an individual becomes an entrepreneur, he creates a firm that is strongly complementary to his own skills.<sup>7</sup> This then implies that, by starting the project, he generates a demand for his type of skills. Since skills are highly correlated with age/experience, the increase in the demand for specific skills due to entrepreneurial innovation translates into the demand for workers of a specific age class. This is the realistic feature that the assumption (7) wishes to capture.

After paying the fixed cost, the entrepreneur can produce  $A^{z=\{m,o\}}$  units of capital that will be sold at the market price  $q$ :

$$A^{z=\{m,o\}} \cdot q$$

It should be noted that I assume that entrepreneurs' productivity depends on their age. In particular I assume:

$$A^m > A^o \quad (8)$$

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<sup>6</sup>Notice the similarity with [17].

<sup>7</sup>This assumption is in the spirit of the vintage human capital model in Hopenhayn and Chari (1991) and Kredler (2008). I could assume that entrepreneurs hire workers of any age classes. The only important assumption is that they employ proportionately more workers with skills similar to theirs, i.e. coming from the same age class.

Inequality (8) implies that the projects undertaken by younger entrepreneurs are more productive, for given  $F^j$ , than the ones undertaken by elder entrepreneurs. This is a reduced form equivalent to assuming that the *timing* of the investment opportunities matters. This could be due to the fact that investment projects depreciates over time, becoming less productive as time goes on. Alternatively, one could think that all projects are equally productive but, the sooner an entrepreneur starts an investment projects, the more she can benefit from it during her lifetime as the present value of all profits coming from the project is increased by an early undertaking. The entrepreneur earns the profits of the investment project defined by:

$$\pi^{jz} = A^z \cdot q - R \cdot (F^{jz} w_z) \quad (9)$$

where  $R$  is the interest rate paid on savings. For the sake of simplicity but without loss of generality, I will assume that there is a storage technology producing  $R$  units of output for a unit of input. This technology pins down the equilibrium gross interest rate  $R$ . Entrepreneurs produce capital so that the aggregate capital of the economy at time  $t$  is

$$K_t = A^m \eta_t^m + A^o \eta_t^o$$

where  $\eta_t^{z=\{m,o\}}$  is the measure of agents of age  $z$  that become entrepreneurs in period  $t$  and thus we have by construction  $\eta_t^m < L_{t-1} = 1$  and  $\eta_t^o < L_{t-2} = 1$ .

### 2.2.2 The Corporate Sector and the Labor Market

Once produced, capital is employed in the *corporate sector* that produces output  $Y_t$  that can be consumed and saved. The technology is a continuous and differentiable constant returns to scale function in capital,  $K_t$ , and three labor inputs,  $L_{it}$   $i = y, m, o$ , satisfying the law of diminishing returns to single factors:

$$\begin{aligned} Y_t &= G(K_t, L_{yt}, L_{mt}, L_{ot}) \\ G_K &> 0, \quad G_{L_i} > 0 \\ G_{KK} &< 0, \quad G_{L_i L_i} < 0 \\ G_{L_i L_j} &< 0, \quad i \neq j \end{aligned} \quad (10)$$

where  $G_x = \frac{\partial G(\cdot)}{\partial x}$  and  $G_{xy} = \frac{\partial^2 G(\cdot)}{\partial x \partial y}$ .

The structure of (10) implies that workers are distinguished by their age or, equivalently, their level of experience. Consistently with this fact, the labor market is segmented in three age classes (youth, middle and old age). This assumption is made to capture

the fact that workers with similar qualifications but different age/experience are in reality treated differently when they apply for jobs. Although different levels of experience are treated differently by the market, these inputs are complementary in the production process. This complementarity among workers of different age classes ensures that, as one type of labor input becomes relatively scarcer, his marginal productivity increases ( $G_{L_i L_i} < 0$ ) while the more abundant inputs become less useful, i.e. less productive ( $G_{L_i L_j} < 0, i \neq j$ ).

The segmentation of the labor market by age classes is not in contradiction with its competitiveness. In fact all factor markets are competitive in this economy. Therefore capital and labor inputs are all rewarded according to their marginal productivity because the corporate sector maximizes profit:

$$\begin{aligned} q_t &= G_{K_t} \\ w_{it} &= G_{L_{it}}, i = y, m, o \end{aligned}$$

where  $w_{i,t}$  is the wage paid to worker of age class  $i$  in period  $t$ .

### 2.3 Credit Markets

I take the simplest possible approach to modelling credit markets imperfections, as in [7], [14] or [?]. This can be seen as the result of some unmodelled informational or institutional frictions. When an entrepreneurs applies for credit, creditors are willing to lend only up to share  $\alpha$  of the proceedings of the investment project:

$$\alpha \cdot (A_z \cdot q) \tag{11}$$

where

$$\alpha \in (0, 1]$$

is the measure of credit market development that is relevant for our purpose.  $\alpha = 1$  corresponds to the case of perfect credit markets while  $\alpha < 1$  highlights the presence of credit market imperfections. Assumption (11) is crucial because entrepreneurs have to put up the amount  $F^{j_z}$  before starting project  $j_z$  and, when they run out of internal funds ( $R \cdot s$ ), they have no choice but accessing the credit market.

### 2.4 Competitive Market Equilibrium: Definition

The market equilibrium is defined by consumption vector  $(c_{it}, i = y, m, o)$ , middle aged entrepreneurs share  $\eta_t^m$ , old aged entrepreneurs share  $\eta_t^o$ , capital production  $K_t$  and price vector  $(q_t, w_{i,t}, i = y, m, o)$  such that:

1. individuals optimize

$$(c_{it}, i = y, m, o) \in \arg \max U_t$$

$$\text{s.t. (2), (3), (5), } \forall t$$

2. individuals become entrepreneurs when

$$\pi^{jz} = A^z \cdot q_t - R \cdot (F^{jz} w_{z,t}) \geq w_{z,t}$$

and the corporate sector maximizes

$$G(K_t, L_{yt}, L_{mt}, L_{ot}) - q_t K_t - w_{yt} L_{yt} - w_{mt} L_{mt} - w_{ot} L_{ot}$$

3. good market clears:

$$c_{yt} + c_{mt-1} + c_{ot-2} = Y_t$$

4. capital market clears:

$$K_t = A^m \eta_t^m + A^o \eta_t^o \tag{12}$$

where we have that the capital stock is the sum of capital production by entrepreneurs of both middle and old age. The assumption of capital full depreciation does not affect the results.

The stationary competitive equilibrium of this economy satisfies conditions 1 through 4 and in addition:

5. all variables are constant across time, i.e.  $x_t = x, \forall t$

### 3 The Equilibrium with Perfect Credit Market

From now on I focus on the stationary equilibrium of this economy. In this section I analyze an economy where  $\alpha$  defined by (11) is equal to one. This is equivalent to assuming that all projects with positive net present value will be financed if the economy income is large enough. Consumer optimization delivers that an agent chooses to be an entrepreneur instead of a worker if it satisfies the following inequality:

$$\pi_z^j \geq w_z$$

$$\Leftrightarrow$$

$$A^z \cdot q - R \cdot (F^{jz} w_z) \geq w_z$$

which, by (9), results into:

$$j_z^* : \frac{A^z \cdot q - w_z}{Rw_z} = F^{j_z^*} \geq F^j \quad (13)$$

(13) defines the threshold entrepreneur  $j_z^*$  with a fixed cost  $F^{j_z^*}$  below which a project has positive value, net of the opportunity cost for working and saving at the storage technology rate. With perfectly working credit markets all those projects  $j < j_z^*$  such that  $F^{j_z^*} \geq F^{j_z}$  should be undertaken<sup>8</sup>. I rule out by assumption the fact that the economy runs out of aggregate savings  $S_t$  at the interest rate  $R$ , i.e.  $K_t > S_t$ , where

$$S_t = s_{yt} + s_{mt-1} \cdot (1 - \eta_t^m) + s_{ot-2} \cdot (1 - \eta_t^o)$$

It is worthwhile to comment further on (13). The number of projects undertaken in equilibrium depends on the relative price of capital  $q$  over the wage for workers of age  $z$   $w_z$ . There is a double general equilibrium effect of entrepreneurial activity: on the one hand, the more investment projects are undertaken, the more capital there is, the lower is its productivity and price  $q$  and the higher is labor productivity and wages  $w_z$ ,  $\forall z$ ; on the other hand, when more capital is being produced by entrepreneurs of a given age class  $z$ , the demand for the skills and the labor of workers in age group  $z$  increases disproportionately. Thus entrepreneurial activity boosts average labor productivity and wage in the economy but it also increases the relative scarcity of workers in the age class where most entrepreneurs come from. This delivers the following proposition:

**Proposition 1** *With perfect capital markets ( $\alpha = 1$ ), if middle age entrepreneurs are more productive on average than old age entrepreneurs*

$$A_m > A_o$$

*and the production technology (10) gives equal weight to all labor inputs, we have:*

1. *more middle age agents become entrepreneurs with respect to old age agents*

$$F^{j^o} < F^{j^m} \quad (14)$$

2. *the age profile of wages takes an **inverted U-shape**, i.e. the wage of middle age workers is highest:*

$$w_m > w_o$$

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<sup>8</sup>If one wants to be rigorous, it would be necessary to check that there is enough savings in the economy to supply all firms. Without loss of generality, for the analysis of this paper we can assume that this is always the case.

and

$$w_m > w_y$$

The first result of the proposition above is a direct consequence of inequality (13) which delivers that

$$j_*^m > j_*^o$$

implying that

$$\eta^m > \eta^o$$

As more entrepreneurs are coming from middle age instead of old age, two crucial effects shape the age profile of earnings. First, there is a relative scarcity of middle age workers in the economy because more of them become entrepreneurs and, most importantly, their skills become in (relatively) greater demand. This scarcity will be priced in equilibrium so that

$$w_m > \max \{w_y, w_o\}$$

The resulting age profile of earnings will thus be an **inverted U-shape**. For workers wages will increase from youth to middle age and they will fall later on toward the end of their life.

## 4 The Equilibrium with Imperfect Credit Markets

When credit markets are imperfect, agents can borrow only up to a share smaller than 1 of the present value of future proceedings:

$$\alpha \cdot (A^z \cdot q)$$

with  $\alpha < 1$ . Therefore the potential entrepreneur in age class  $z$  needs to borrow

$$w_z F^{jz} - s_{z-1}$$

necessary to start project  $j$ . Therefore, with credit market imperfections an agent becomes an entrepreneur if, in addition to having a fixed cost satisfying inequality (13), the following condition is also satisfied

$$\alpha \cdot (A^z \cdot q) \geq w_z F^{jz} - s_{z-1} \tag{15}$$

The interpretation of (15) is that only projects that require an amount of borrowing by their entrepreneur smaller than what credit markets are willing to supply can be undertaken. This amount of credit is in turn a function of credit market imperfections, indexed by  $\alpha$ .

If  $\alpha$  is small enough, only very productive potential entrepreneurs - the ones endowed with low  $F^j$  - will be able to undertake their project when middle age. Most of the potential entrepreneurs will then be forced by the tightness of the credit market to wait until the time they will be older and they have accumulated enough savings to rely as little as possible on external funds.

In the presence of credit markets imperfections, there is positive measure of investment projects like  $\hat{j}_z$  such that:

$$\frac{A_z \cdot q - w_z}{w_z R} \geq F^{\hat{j}_z} \geq \alpha \cdot (A_z \cdot q) + s_{z-1} \quad (16)$$

The projects satisfying the double inequality in (16) are productive enough to have positive net present value, but fail to be funded because of the imperfections in the credit market. Thus, it becomes now optimal for agents to anticipate the option value of becoming an entrepreneur in their saving decision. They accumulate more savings in the perfect credit markets economy described in the previous section. The introduction of credit market imperfections introduces a precautionary motive in the decision to save and this fact makes individuals save more on average and even more as they age:

$$s_m \gg s_y$$

By inequalities (16), we can now define the threshold level of fixed cost below which agents become entrepreneurs as:

$$F^{\tilde{j}_z} = \min \left\{ \alpha \cdot (A_z \cdot q) + s_{z-1}, \frac{A_z \cdot q - w_z}{w_z R} \right\}$$

Therefore, credit imperfections bite for potential entrepreneurs of age class  $z$  if

$$\alpha \cdot (A_z \cdot q) + s_{z-1} < \frac{A_z \cdot q - w_z}{w_z R} \quad (17)$$

If inequality (17) holds, more investment projects will be undertaken by old age entrepreneurs, i.e.

$$F^{\tilde{j}_o} > F^{\tilde{j}_m}$$

as long as

$$\alpha \cdot (A_o \cdot q) + s_m > \alpha \cdot (A_m \cdot q) + s_y$$

which reduces to:

$$\frac{(s_m - s_y)}{(A_m - A_o) \cdot q} > \alpha \quad (18)$$

There is always a level of credit market imperfections that satisfy inequality (18). The reasoning is as follows. First, notice that the level of savings of individual of age  $z$  is in general a function  $s_z(w_z, R, \alpha)$  of the wage, the interest rate and the level of credit market imperfections. As  $\alpha$  falls, the level of capital falls and so does labor productivity and the wage  $w_z$ . Under standard normality assumption this depresses the level of savings. Formally, we can calculate

$$\frac{\partial \left( \frac{(s_m - s_y)}{(A_m - A_o) \cdot q} \right)}{\partial \alpha} = \frac{1}{(A_m - A_o)} \cdot \frac{\left( \frac{\partial s_m}{\partial \alpha} - \frac{\partial s_y}{\partial \alpha} \right) q - \frac{\partial q}{\partial \alpha} (s_m - s_y)}{q^2}$$

which is smaller or equal than 1 because  $\frac{\partial s_z}{\partial \alpha} < 0$  and

$$\left| \frac{\partial s_m}{\partial \alpha} \right| > \left| \frac{\partial s_y}{\partial \alpha} \right| \quad (19)$$

The inequality (19) is satisfied because a fall in  $\alpha$  depresses relatively more the wage of middle aged workers with respect to the wage of young workers. This is due to the fact that an increase in credit market imperfection does not just depress overall labor productivity, but it has a disproportionate effect on the age class that makes Therefore it is possible to define

$$\frac{(s_m - s_y)}{(A_m - A_o) \cdot q} = \alpha^*$$

where  $\alpha^*$  is the minimal level of credit market imperfections that guarantee that there are more old entrepreneurs than middle age. This allows to state the following proposition:

**Proposition 2** *If the level of credit market imperfections is sufficiently strong, i.e.  $\alpha < \alpha^*$ , then the entrepreneurial class is characterized by proportionately more old age individuals and the age profile of wages is monotonically increasing*

$$w_y < w_m < w_o$$

Credit market imperfections have two general equilibrium effects on wages. The first is that the average wage is now lower with respect to the case of perfect credit markets because capital production is reduced by credit markets imperfections. The second is that, as workers are forced to delay their choice to become entrepreneurs, there are relatively more old age entrepreneurs than middle age. This creates a disproportionate demand for old over middle age workers and it boosts the relative wage of old worker with respect to middle age worker. The economy displays a **monotonically increasing** age profile of earnings.

## 5 Labor Mobility and Workers' Tenure on the Job

(Preliminary) There are also two additional implications of the perspective set forward in this paper. The shape of the age profile of earnings affects both the difference among age classes in tenure on job and job-to-job mobility. In the cross-country comparizon, there should be relatively more turnover in the age class where more entrepreneurs come from. Measuring labor market turnover by tenure on the job and job-to-job mobility by age class (measured by percentage of job changers over employees in given age class), I find some theoretically consistent evidence: when earnings grow monotonically with age as in Italy, workers tend to have a longer tenure in their job for any age class but this tenure falls toward the end of people career (Figure 4). Moreover job-to-job mobility is lower for italian middle aged workers when compared to Germans, in all age classes but the last one (Figure 5).

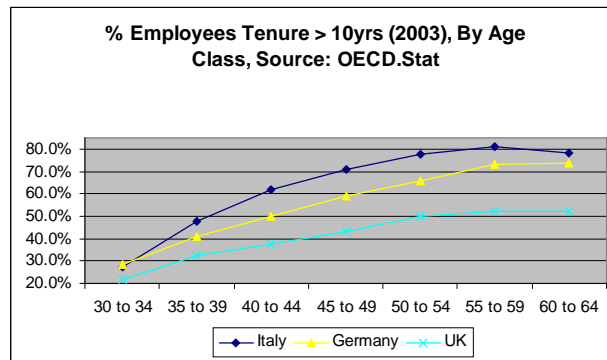


Figure 4

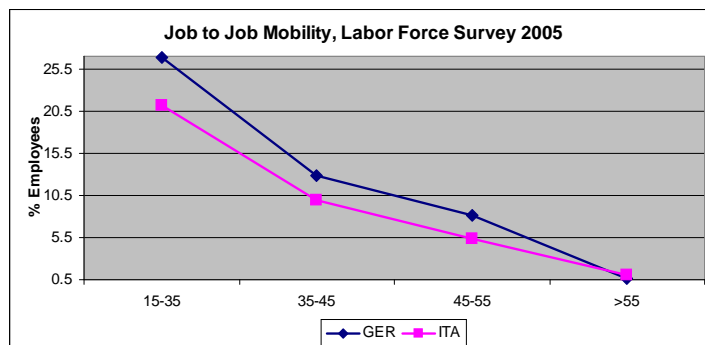


Figure 5

There are two additional implications of this approach, beside what it says regarding the age earnings relationship. The first implication is that in economies where the age earnings relationship is non monotonic (inverted U-shape), the entrepreneurial class is more concentrated in one age class, while in economies where earnings monotonically grow with age the entrepreneurial class is more uniformly distributed across different age classes. Prat et al. (2006) provide some evidence in support of this claim comparing the age profile of the CEO's of the top 40 Italian firms and the top 40 US firms. While the average ages are quite close, 58 in Italy and 56 in the US, in the US most CEO's are between 50 and 60, in Italy there are 20 CEO's over 60 and 13 in their forties. The other implication is obtained using WHIP, a dataset dedicated to track italian workers career through social security contribution. The entrepreneurial choice as instrumented by the self employment displays a spike for workers in their sixties, differently from what the theory would predict if credit markets were working propoerly. The evidence in Figure 6 is instead consistent with the case of a country where agents need to save more to rely less on external funding if they wish to become entrepreneurs.



Figure 6

## 6 Conclusions

[...]

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