Intergenerational Mobility, Occupational Decision and the Distribution of Wages

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Abstract

We analyze the determinants of occupational and educational decisions in a model of dynastic altruism where individuals invest in the education of their children. We show that the relevant wage gaps that drive these two decisions are associated with the expected skill premium and the expected premium that each skill class faces when choosing a more effort-demanding occupation. As the occupational and educational decisions determine the relative frequency of high wages, we analyze how these wage gaps affect the frequency of high wages within each skilled class. We show that the results from this analysis are consistent with empirical evidence based on cross-country data for several European economies.

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1 Introduction

There are important differences in the wage distribution across countries and across time. Table 1 compares the fraction of workers obtaining a wage above the mean for Austria, Italy, Portugal, Spain and UK in 2005 and 2012. The table distinguishes between skilled and unskilled individuals, where the later are those who have only finished compulsory education. The table shows huge differences in these fractions among countries for both skilled and unskilled individuals. For instance, in Austria there is a large fraction of skilled individuals earning wages above the mean, which obviously implies that the few skilled workers with wages below the mean receive an extremely low relative labor compensation. Note that in this country there is a small fraction of unskilled individuals with wages above the mean earning a relatively large wage. Observe that Portugal exhibits the opposite pattern since we find there both few skilled workers and many unskilled workers with wages above the mean. We also observe significant variation of these fractions across time for all countries and skill levels. For instance, during the great recession the fraction of skilled workers obtaining a relatively high wage increases in all these countries, whereas the fraction of unskilled workers earning a relatively high wage decreases.

[Insert Table 1]

The previous evidence leads naturally to the question of what factors determine that a given individual obtains a high wage. The literature on empirical labor has shown that two of the main determinants of high wages are the level of education and the occupational decision (see, among many others, Autor et al., 2006; and Topel, 1997). In this paper, we want to contribute to this literature by digging deeper into the determinants of both educational and occupational decisions.

There is a relevant difference between the two aforementioned decisions. The educational decision is mainly made by the parents when the descendant is still young and, hence, it involves an intergenerational decision. In contrast, the occupational decision is made by individuals at the beginning of their adult lives. Different strands of the literature have studied these two decisions. On the one hand, the labor literature has studied the determinants of the occupational decision (see, among many others, Boskin, 1974; Daniel and Sofer, 1998; or Bonin et al., 2007). This literature has outlined that this decision depends on the trade-off between the disutility caused by an occupation and the expected wage premium associated with this occupation. The disutility of an occupation is a broad concept that includes the direct disutility associated with the effort necessary to perform the occupation, its idiosyncratic risk, the degree of responsibility that involves, and many other costly characteristics defining an occupation. In this paper, we denote the disutility of an occupation simply as effort disutility even to it embeds a much broader concept. On the other hand, papers on social mobility have studied how intergenerational income inequality depends on the education decision (Galor and Zeira, 1993 and Eckstein and Zilcha, 1994). This literature has shown that the two main determinants of the educational decision are the cost of education and the expected skill premium. A crucial assumption in this literature is the introduction of capital market imperfections. These imperfections, that take the form of borrowing constraints, imply that parental income imposes some limits in the amount invested in the education of their descendants.

Credit market imperfections introduce an important interaction between the occupational decision of the parents and the investment in the education of their descendants: parents who choose a more effort-demanding occupation will more likely earn a high wage and, hence, they will be able to finance the education of their children. Obviously, this interaction has crucial implications on social mobility and income inequality as it is shown in Alonso-Carrera et al. (2016). In this paper, we show that it also determines how the frequency of high wages in the economy depends on the expected skill premium and the expected effort premium. More precisely, the purpose of the present paper is to build a model, based on the interaction between educational and occupational decisions, that captures the relationship between two characteristics of the wage distribution: the wage dispersion, which can be identified with skill and effort premia, and the relative frequency of high wages.

The model that we consider is a version of the classical models of social mobility of Galor and Zeira (1993), Eckstein and Zilcha (1994) or Galor and Moav (2004, 2006). These models generate different skill classes by assuming both indivisible investment in education and the presence of borrowing constraints. We extend this basic framework in three directions. First, we introduce uncertainty, which means that there is always a positive probability of obtaining high or low wages. Second, we introduce occupational decisions, as in Degan and Thibault (2012) and Alonso-Carrera et al. (2016). We assume that when an individual chooses a high effort-demanding occupation he increases the probability of obtaining a high wage. Finally, we assume dynastic altruism as in Barro (1974). This form of altruism implies that parents utility depends on their descendants' utility, which in turn depends on the expected wages. Obviously, the expected wage earned by an individual depends both on the amount of education paid by his parents and on the effort exerted by him. Thus, dynastic altruism introduces a framework, based on the interaction between effort and education, that can be used to understand how cross-country differences in the wage dispersion of the different skill classes explain the observed differences in the relative frequencies of high wages across skill classes and across countries.

We use the model to show that the frequency of high wages among both the skilled and the unskilled individuals increases with the expected skill premium and with the expected return from effort and it decreases with the cost of the investment in education. First, an increase in the skill premium increases the value of education, which makes parents choose a more effort-demanding occupation. This results in a higher probability that they can finance the education of their descendant. Moreover, this change in the occupational decision of parents ends up increasing the frequency of high wages. Second, an increase in the cost of education reduces the value of education and, hence, has the opposite effect on the effort decision of parents. This explains the reduction in the frequency of high wages. Finally, any increase in the return from effort makes individuals exert more effort, which directly increases the frequency of high wages.

From the previous analysis, we obtain two relevant insights. On the one hand, individuals exert more effort when the expected skill premium increases. Obviously, this occurs because individuals are dynastic altruistic towards their descendants. In fact, in the absence of altruism, individuals will not increase effort when the skill premium increases and, hence, the frequency of high wages would not depend on the expected skill premium. On the other hand, in the paper we also show that, when individuals are altruistic, the frequency of high wages among the skilled increases with the effort premium of the unskilled, whereas the frequency of high wages among the unskilled decreases with the effort premium of the skilled. In order to obtain this result, we show that there is a linear relationship between the skill premium and the effort premium of both skilled and unskilled workers according to which the expected skill premium increases with the effort premium of the unskilled and decreases with the effort premium of the skilled.

The previous linear relationship between skill and effort premia for both skill classes has several implications. First, if individuals are altruistic, the frequency of high wages among the skilled increases with the effort premium of the unskilled. Second, the increase in the frequency of high wages among the skilled due to an increase in the effort premium of the skilled would be larger if altruism were absent. Third, if individuals are altruistic, then the frequency of high wages among the unskilled declines when the effort premium of the skilled increases since this reduces the expected skill premium. Fourth, an increase in the effort premium of the unskilled results in a larger increase in the frequency of high wages among the unskilled when altruism is introduced.

We also empirically test the previous theoretical results. To this end, we follow an empirical strategy aimed to obtain the relative frequencies of high wages and the different wage gaps in a way that is consistent with the definitions used in the theoretical analysis and that preserves the linear relationship between the skill premium and the effort premiums. The empirical analysis is based on cross-country comparisons. We consider the changes in the frequencies of high wages for skilled and unskilled individuals and the change in the skill and effort premiums that occur in three different time periods: 2004-2008, 2008-2012 and 2012-2014. These time periods have been chosen to take advantage of the large changes in the wage distributions caused by the Great Recession. Our empirical results provide strong support to the theoretical findings on the effect that the skill premium and the effort premium of each skill class have on the frequency of high wages.

The paper is organized as follows. Section 2 presents the basic model. Section 3 characterizes the individual decisions and Section 4 obtains the relative frequencies from the individual decisions. Section 5 performs the empirical analysis aimed to test the results obtained in Section 4. Section 6 concludes the paper.

2 The model

We consider a small open economy populated by overlapping generations of individuals that belong to dynasties that are uniformly distributed on the interval $[0, 1]$. Each individual lives for two periods and he has one descendant at the beginning of the second period of his life. An individual makes decisions only during the second period of his life. In every period, youngest individuals neither consume nor work but they become skilled if their parents invest in their education. Individuals are assumed to be altruistic towards their children, which will give rise to the potential positive investment in the direct descendants' education. Individuals inelastically supply one unit of labor in the second period of their lives after choosing an occupation. There are occupations that require the same level of skills but different amount of effort and individuals derive disutility from the amount of effort exerted. The effort-occupation decision determines the probability of obtaining high or low wages: individuals have more chances of obtaining a high wage if they choose occupations requiring a large amount of effort. After knowing the wage they have earned, individuals consume and decide the investment in the education of their direct descendants.

We assume dynastic preferences and, therefore, the utility V_t of an individual that works in period t depends on the utility V_{t+1} of his descendant. We assume the following utility function:

$$V_t = c_t - \rho e_t + \beta V_{t+1},$$

where $\beta \in (0, 1)$ measures the intensity of altruism, c_t is the amount of consumption and e_t is the effort level. As effort is linked to the occupational decision, we assume that effort is a discrete variable that takes values one (high-effort occupation) or zero (low-effort occupation). Hence, the parameter $\rho > 0$ measures the disutility associated with effort. We assume that the value of the parameter ρ changes across dynasties but it is the same for all members of a dynasty.

The budget constraint in the second period of life of an individual working in period t is

$$c_t = w_t - x_t,$$

where w_t is the labor compensation (or wage) and x_t is the amount invested in the education of the descendant. We introduce a fix cost of education μ. Thus, an individual is skilled if his parent invests the amount $x_t \geq \mu$ in education and he is unskilled otherwise. It follows that the optimal investment in education is a discrete variable with values $x_t = 0$ or $x_t = \mu$. This optimal investment is limited by a borrowing constraint, as we assume that individuals cannot borrow to finance education. Thus, investment in education is constrained by the parents' wage, i.e., $x_t \leq w_t$.

Expected wages depend on both the education decision and on the effort-occupation decision. We assume that a skilled worker obtains a high wage, w_{sh}, with probability π_{se} if he exerts effort and with probability π_{sn} if he does not exert effort, where $\pi_{sn} < \pi_{se}$. The same skilled worker would obtain a low wage, w_{sl}, with probability $1 - \pi_{se}$ if he exerts effort and with probability $1 - \pi_{sn}$ if he does not exert effort. We also assume that an unskilled worker obtains a high wage, w_{uh}, with probability π_{ue} if he exerts effort and with probability π_{un} if he does not exert effort, where $\pi_{un} < \pi_{ue}$. The same unskilled worker would obtain a low wage, w_{ul}, with probability $1 - \pi_{ue}$ if he exerts effort and with probability $1 - \pi_{un}$ if he does not exert effort. Therefore, effort increases the probability of obtaining a high wage for both the skilled and the unskilled workers. Finally, we assume that $w_{sh} > w_{uh}$ and that $w_{sl} > w_{ul}$. These two inequalities imply that there is a positive skill premium when wages are high and also when they are low.

3 Individual decisions

Individuals only make decisions during the second period of life when they already know the skill class they belong to. In this second period, individuals first decide the effort-occupation, taking into account expected wages. After knowing the wage, they decide on the investment in the education of their descendant. This timing implies that we must follow a two step procedure to analyze the individual decisions. We first analyze the decision concerning the investment in education of the descendant for a given occupation (with the corresponding level of effort) and, afterward, we analyze the occupational decision. To perform this analysis, we will use the following notation. First, the skill class will be denoted by the index j, where $j = s$ and $j = u$ identify skilled and unskilled individuals, respectively. Second, we will use the indexes h and l to indicate respectively a high and low realization of wages. Finally, the index i will denote the decision on effort, where $i = e$ and $i = n$ will refer to an individual who makes effort and an individual who does not, respectively.

The decision of a worker belonging to skill class j and who obtains a high wage concerning the education of his descendant depends on whether or not he can afford the cost of education μ, i.e., $w_{jh} \geq \mu$. Therefore, the value function for this worker when he does not exert effort is

$$V(j,h) = \begin{cases} \max\limits_{x\in\{0,\mu\}} \{w_{jh} - \mu + \beta V(s), w_{jh} + \beta V(u)\} \text{ if } w_{jh} \geq \mu \\ \\ w_{jh} + \beta V(u) \text{ if } w_{jh} < \mu. \end{cases}$$

The decision of a worker of the same skill class and that obtains a low wage concerning the the education of his descendant depends on whether or not he can finance the education, which requires that $w_{jl} \geq \mu$. Therefore, the value function for this worker when he does not exert effort is

$$V(j,l) = \begin{cases} \max\limits_{x\in\{0,\mu\}} \{w_{jl} - \mu + \beta V(s), w_{jl} + \beta V(u)\} \text{ if } w_{jl} \geq \mu \\ \\ w_{jl} + \beta V(u) \text{ if } w_{jl} < \mu. \end{cases}$$

Second, the worker belonging to skill class j decides on the amount of effort exerted. This decision is characterized by the following value function:

$$V(j) = \max_{e\in\{0,1\}} \left\{ \begin{array}{l} \pi_{je}[V(j,h) - \rho] + (1-\pi_{je})[V(j,l) - \rho], \\ \\ \pi_{jn}V(j,h) + (1-\pi_{jn})V(j,l) \end{array} \right\}.$$

We define the expected wage of a worker belonging to skill class j and exerting effort i as $\overline{w}_{ji} = \pi_{ji}w_{jh} + (1-\pi_{ji})w_{jl}$. This definition is used in the following two assumptions that are introduced to simplify the individual decisions.

Assumption A Expected wages satisfy the following:

$$\beta(\overline{w}_{se} - \overline{w}_{ue}) > \mu,$$

$$\beta(\overline{w}_{se} - \overline{w}_{un} - \rho) > \mu,$$

$$\beta(\overline{w}_{sn} - \overline{w}_{un}) > \mu,$$

and

$$\beta(\overline{w}_{sn} - \overline{w}_{ue} + \rho) > \mu.$$

In Appendix A it is shown that these constraints on expected wages imply that $\beta V(s) - \mu > \beta V(u)$. Thus, Assumption A implies that individuals of any skill class always want to educate their descendant if they can afford the cost of education.

Assumption B Wages satisfy the following ranking: $w_{ul} < w_{sl} < \mu < w_{uh} < w_{sh}$.

Assumption B introduces two constraints on the value of the parameters. First, it introduces a ranking of wages and, mainly, it implies that $w_{sl} < w_{uh}$. This ranking is satisfied in all the countries and time periods considered in the empirical implementation that we will conduct later on. Second, the position of μ in the ranking of wages implies that in this model there is both upward and downward social mobility, as only parents with high wages can educate their descendant. There is upward mobility when unskilled parents obtain a high wage and, therefore, they invest in the education of their descendant. Alternatively, there is downward social mobility when skill parents obtain low wages and, therefore, they cannot invest in the education of their descendant. These two patterns of social mobility are clearly observed in the data and can only be explained in this model when Assumption B is satisfied.

Assumptions A and B imply that, regardless of the skill class parents belong to, parents with a high wage will educate their descendant and parents with a low wage will not educate their descendant. Hence, the value functions for high and low wage individuals simplify as follows:

$$V(j,h) = w_{jh} - \mu + \beta V(s),$$

and

$$V(j,l) = w_{jl} + \beta V(u).$$

Finally, we obtain that the value functions for both skilled and unskilled individuals are, respectively,

$$V(s) = \max_e \left\{ \begin{array}{l} \overline{w}_{se} - \pi_{se}\mu - \rho + \pi_{se}\beta V(s) + (1-\pi_{se})\beta V(u), \\ \\ \overline{w}_{sn} - \mu\pi_{sn} + \pi_{sn}\beta V(s) + (1-\pi_{sn})\beta V(u) \end{array} \right\} \tag{1}$$

and

$$V(u) = \max_e \left\{ \begin{array}{l} \overline{w}_{ue} - \pi_{ue}\mu - \rho + \pi_{ue}\beta V(s) + (1-\pi_{ue})\beta V(u), \\ \\ \overline{w}_{un} - \mu\pi_{un} + \pi_{un}\beta V(s) + (1-\pi_{un})\beta V(u) \end{array} \right\} \tag{2}$$

Note that the value function for a skilled worker depends on expected wage of skilled workers and it also depends on the value function for the unskilled workers when individuals are altruistic since the descendant can be unskilled. Note also that the value function for the unskilled workers depends on the expected wage of the unskilled worker and if individuals are altruistic it also depends on the value function for the skilled workers since the descendant can be skilled. Because dynastic altruism introduces this interaction between the two value functions, the value functions for skilled and unskilled individuals are obtained from solving the system formed by (1) and (2). When solving this system of equations, we distinguish among four cases that depend on the effort-occupation decision: (i) when both skilled and unskilled workers exert effort, we denote the value function for the skilled individuals $V_s^{e,e}$ and that for the unskilled individuals $V_u^{e,e}$; (ii) when only skilled workers exert effort, we denote the value function for the skilled individuals $V_s^{e,n}$ and that for the unskilled individuals $V_u^{e,n}$; (iii) when only unskilled workers exert effort, we denote the value functions by $V_s^{n,e}$ and $V_u^{n,e}$; and (iv) when none of them exerts effort, we denote the value functions by $V_s^{n,n}$ and $V_u^{n,n}$. In Appendix A we obtain the particular expressions for these eight value functions.

Individual decisions concerning effort arise from the Markov equilibrium of the game summarized in the payoff matrix shown in Table 2. This matrix shows the payoffs of a game played between parents and descendants and that takes into account that descendants may belong to a different skill class. In Appendix B we solve the Markov equilibrium and we show that: (i) if the unskilled workers exert effort, the skilled workers will exert effort when $V_s^{e,e} > V_s^{n,e}$, which happens when $\rho < \Gamma_s^e$; (ii) if the unskilled workers do not exert effort, the skilled workers will exert effort when $V_s^{e,n} > V_s^{n,n}$, which happens when $\rho < \Gamma_s^n$; (iii) if the skilled workers exert effort, the unskilled workers will exert effort when $V_u^{e,e} > V_u^{e,n}$, which happens when $\rho < \Gamma_u^e$; and, (iv) if the skilled workers do not exert effort, the unskilled workers will exert effort when $V_u^{n,e} > V_u^{n,n}$, which happens when $\rho < \Gamma_u^n$. These constraints on the value of the disutility of effort are summarized in Table 3 and the equations for the thresholds of utility are shown in Appendix B.

[Insert Tables 2 and 3]

Table 3 shows that members of dynasties with a sufficiently low effort disutility ρ will always choose effort-demanding occupations regardless of their skill class. On the contrary, members of dynasties with a sufficiently large effort disutility ρ will never exert effort. For intermediate values of the effort disutility, only individuals belonging to one of the skill classes choose an effort-demanding occupation. Table 3 provides the range of values for the effort disutility parameter ρ where either skilled or unskilled individuals decide to exert effort.

The thresholds of disutility of effort shown in Table 3 measure the return from choosing an effort-demanding occupation. Individuals that exert effort have a larger expected wage. As a consequence, these individuals benefit from a larger expected consumption, which is the direct return from effort and, indirectly, they benefit from the possibility of investing in the education of their offspring. Obviously, this indirect return will depend on the expected skill premium and on the intensity of altruism. These direct and indirect returns from choosing an effort-demanding occupation explain that the thresholds of disutility of effort shown in Appendix B depend on the fixed cost μ of education and on the following wage gaps:

$$\begin{aligned}\Delta_s &= w_{sh} - w_{sl},\\ \Delta_u &= w_{uh} - w_{ul},\\ \Delta_h &= w_{sh} - w_{uh},\\ \Delta_l &= w_{sl} - w_{ul}.\end{aligned}$$

The wage gap Δ_s is directly related to the return from effort for a skilled worker, Δ_u is related to the return from effort for an unskilled skilled worker, Δ_h measures the skill premium when wages are high and Δ_l measures the skill premium when wages are low. These wage gaps are linearly related so that

$$\Delta_l = \Delta_u + \Delta_h - \Delta_s. \tag{3}$$

Appendix B shows how these wage gaps affect the thresholds of the intensity of effort disutility. The results obtained in Appendix B are summarized in the following proposition:

Proposition 1 *Let us assume that Δ_l is determined by (3). Then, the following statements hold for $i = \{e, n\}$:*

(a) $\partial\Gamma_s^i/\partial\mu < 0$, $\partial\Gamma_s^i/\partial\Delta_s > 0$, $\partial\Gamma_s^i/\partial\Delta_u > 0$, $\partial\Gamma_s^i/\partial\Delta_h > 0$,

(b) $\partial\Gamma_u^i/\partial\mu < 0$, $\partial\Gamma_u^i/\partial\Delta_s < 0$, $\partial\Gamma_u^i/\partial\Delta_u > 0$, $\partial\Gamma_u^i/\partial\Delta_h > 0$.

An increase in the education cost μ reduces the value of education and, hence, reduces the expected return from effort. This causes the reduction in the threshold of effort disutility above which individuals do not make effort. On the contrary, an increase in the skill premia Δ_h or Δ_l causes an increase in the expected skill premium, which rises the value of education and, hence, the return from effort. Obviously, this gives rise to an increase in the thresholds of effort disutility since individuals are altruistic. In fact, from the expressions of the thresholds, we see that these effects are increasing in the value of the altruism parameter β. An increase in effort premium Δ_s of the skilled directly increases the return from effort for the skilled workers and, from using the linear relationship (3), it follows that reduces the expected skill premium. Thus, indirectly reduces the expected return from effort. This explains that an increase in Δ_s reduces the threshold Γ_u^i of disutility for unskilled workers since they are altruistic. It also explains that an increase in Δ_s rises the threshold of disutility Γ_s^i for the skilled workers since they are also altruistic. In this case, altruism reduces the net effect of Δ_s on this threshold. Finally, an increase in the effort premium Δ_u of the unskilled directly increases the return from effort for the unskilled workers and, indirectly, using (3), it also increases the expected skill premium. This results in an increase in the expected return from effort for the skilled workers. Therefore, as altruism is present, the increase in Δ_u increases the threshold of utility Γ_s^i for the skilled workers. However, as before, altruism enhances the effect of Δ_u on Γ_u^i since unskilled workers benefit directly from the increase in their effort premium Δ_u and indirectly from the increase in the skill premium of their descendants.

4 Relative frequencies

In this section, we use the individual decisions to explain how changes in the wage gaps modify the relative frequencies of high wages for both skilled and unskilled workers and the long run relative frequency of skilled workers. To this end, we assume a given distribution of ρ across dynasties and we use the results summarized in Table 3 to obtain the relative frequency of high wages among skilled workers,

$$\begin{aligned}\pi_s &= \left[\Pr\left(\rho < \min\left\{\Gamma_s^e, \Gamma_u^e\right\}\right) + \Pr\left(\rho \in \left(\Gamma_u^e, \Gamma_s^n\right)\right)\right] \times \pi_{se} \\ &\quad + \left[\Pr\left(\rho \in \left(\Gamma_s^e, \Gamma_u^n\right)\right) + \Pr\left(\rho > \max\left\{\Gamma_s^n, \Gamma_u^n\right\}\right)\right] \times \pi_{sn},\end{aligned}$$

and the relative frequency of high wages among unskilled workers,

$$\begin{aligned}\pi_u &= \left[\Pr\left(\rho < \min\left\{\Gamma_s^e, \Gamma_u^e\right\}\right) + \Pr\left(\rho \in \left(\Gamma_s^e, \Gamma_u^n\right)\right)\right] \times \pi_{ue} \\ &\quad + \left[\Pr\left(\rho \in \left(\Gamma_u^e, \Gamma_s^n\right)\right) + \Pr\left(\rho > \max\left\{\Gamma_s^n, \Gamma_u^n\right\}\right)\right] \times \pi_{un}.\end{aligned}$$

As the conditional probabilities, π_{se}, π_{sn}, π_{ue}, and π_{un}, are assumed to be independent of wages, we can use the results in Proposition 1 to establish the effect of changes in the wage gaps on the frequencies of high wages.

Proposition 2 *Let us assume that Δ_l is determined by (3). Then,*

(a) $\partial\pi_s/\partial\Delta_s > 0$, $\partial\pi_s/\partial\Delta_u > 0$, $\partial\pi_s/\partial\Delta_h > 0$, $\partial\pi_s/\partial\mu < 0$,

(b) $\partial\pi_u/\partial\Delta_s < 0$, $\partial\pi_u/\partial\Delta_u > 0$, $\partial\pi_u/\partial\Delta_h > 0$, $\partial\pi_u/\partial\mu < 0$.

As we have already explained in the previous section, an increase in the effort premium Δ_s for the skilled increases the return the obtain from choosing an effort-demanding occupation and, hence, there is an increase in the number of skilled individuals exerting effort. This explains the increase in the frequency of high wages among the skilled individuals. However, an increase in Δ_s reduces the return from effort for the unskilled and, hence, the number of unskilled workers exerting effort declines. This explains that the frequency of unskilled workers obtaining high wages declines when Δ_s increases. In the previous section, it is also explained that an increase in either Δ_u or Δ_h rises the expected return from effort for both the skilled and the unskilled workers. This explains the positive effect on the frequency of high wages for both class of workers. Finally, an increase in the education cost reduces the value of education and, thus, it reduces the expected return from effort for both skill classes. This explains the negative effect than an increase in μ has on the frequency of high wages.

In this simple economy, the relative frequencies of high wages for both skill classes determine the long-run (or ergodic) frequencies of skilled individuals. Those long-run frequencies coincide with the stationary frequencies in this environment. In order to obtain those frequencies, we define γ as the long-run frequency of skilled individuals in the economy. The value of γ is constructed as follows. A fraction π_s of skilled individuals obtain high wages and, hence, educate their descendant. Obviously, the long-run frequency of unskilled is $1-\gamma$ and a fraction π_u of these individuals obtain high wages and educate their descendant. It follows that the long-run frequency γ of skilled individuals must satisfy the following equation: $\gamma = \gamma\pi_s + (1-\gamma)\pi_u$. From this equation, we obtain that $\gamma = \pi_u/(1-\pi_s+\pi_u)$. Thus, the long relative frequency of skilled workers increases with both π_s and π_u. Therefore, it depends on the wage gaps and the comparative statics with respect to these gaps follow directly from the results in Proposition 2.

In the following section, we test if the results in Proposition 2 are consistent with the empirical evidence. Thus, we will analyze if the wage gaps modify the frequency of high wages. We focus our analysis on the effect of wage gaps on the relative frequency of high wages in each period under consideration instead of on their effect on the long-run frequency of skilled workers. The latter effect cannot be tested with the small number of time observations available in the data sample we use.

5 Empirical analysis

The first step in the empirical strategy consists in identifying the wage gaps and the relative frequencies from the data. We use EU-Statistics on Income and Living Conditions (SILC) 2004-14, where we find data on labor earnings on 15 countries.[1] For each country and each year, we obtain the distribution of skilled workers and the distribution of unskilled workers. Unskilled workers are defined as those workers that only have finished compulsory education. For each distribution, we compute the mean and we define the relative frequency of high wages as the fraction of individuals obtaining a wage above the mean. Finally, we obtain the high (low) wage as the median of the wages above (below) the mean. Therefore, for each country and each year we obtain the following information: $\pi_s, \pi_u, w_{se}, w_{sn}, w_{ue}$, and w_{un}. Obviously, from the wages we obtain the wage gaps:

[1] Our sample covers the following countries: Austria, Belgium, Bulgaria, Croatia, Iceland, Ireland, Italy, Lithuania, Germany, Hungary, Norway, Portugal, Spain, Switzerland and UK.

Δ_s, Δ_u, Δ_h.

Consistent with our theoretical model, we assume that country characteristics are time invariant. Thus, we assume that the distribution of ρ and the conditional probabilities, π_{se}, π_{sn}, π_{ue}, and π_{un}, are time invariant. This implies that the change in the relative frequency of high wages during a period is explained only by the changes during that period in the fraction of individuals choosing a more effort-demanding occupation. Then, the relevant equations are

$$\begin{aligned}\Delta\pi_u &= \Delta\left[\Pr\left(\rho < \min\left\{\Gamma_s^e, \Gamma_u^e\right\}\right) + \Pr\left(\rho \in \left(\Gamma_s^e, \Gamma_u^n\right)\right)\right] \times \pi_{ue} \\ &+\Delta\left[\Pr\left(\rho \in \left(\Gamma_u^e, \Gamma_s^n\right)\right) + \Pr\left(\rho > \max\left\{\Gamma_s^n, \Gamma_u^n\right\}\right)\right] \times \pi_{un},\end{aligned}$$

and

$$\begin{aligned}\Delta\pi_s &= \Delta\left[\Pr\left(\rho < \min\left\{\Gamma_s^e, \Gamma_u^e\right\}\right) + \Pr\left(\rho \in \left(\Gamma_u^e, \Gamma_s^n\right)\right)\right] \times \pi_{se} \\ &+\Delta\left[\Pr\left(\rho \in \left(\Gamma_s^e, \Gamma_u^n\right)\right) + \Pr\left(\rho > \max\left\{\Gamma_s^n, \Gamma_u^n\right\}\right)\right] \times \pi_{sn}.\end{aligned}$$

As the frequency of individuals exerting effort depends on wage gaps, the changes in these frequencies will also depend on the changes in the wage gaps. We can then propose the following equations relating changes in wage gaps during a period with changes in relative frequencies during the same period:

$$\Delta\pi_u = \theta_s^u \Delta \ln\left(\Delta_s\right) + \theta_h^u \Delta \ln\left(\Delta_h\right) + \theta_u^u \Delta \ln\left(\Delta_u\right), \tag{4}$$

and

$$\Delta\pi_s = \theta_s^s \Delta \ln\left(\Delta_s\right) + \theta_h^s \Delta \ln\left(\Delta_h\right) + \theta_u^s \Delta \ln\left(\Delta_u\right). \tag{5}$$

The changes in these frequencies and in the logarithm of the wage gaps are computed for three different time periods: a pre-crisis period (2004-2008), a post-crisis period (2008-2012) and a recovery period (2012-2014). This allows us to obtain 32 observations. We consider time dummies for all the periods considered and country dummies for all countries in the regression of π_u and only for some countries (Ireland, Hungary and Italy) in the regression of π_s. These dummies are introduced to account for country and time fixed effects, mostly explained by differentials in nominal wage inflation.

The results of the OLS estimation of equation (4) are summarized in Table 4. The sign of the estimated coefficients is consistent with the results in Proposition 2 and the coefficients are strongly significative. These results are displayed in Figure 1, which shows the partial regression plots with respect to the three wage gaps. As follows from Table 4 and Figure 1, an increase in the effort premium of the skilled individuals reduces the relative frequency of high wages among the unskilled individuals. In contrast, the relative frequency increases with the increase in either the skill premium measured by Δ_h, or the effort premium of the unskilled measured by Δ_u. Finally, Figure 2 shows the good performance of the model in explaining the time path of the dependent variable.

[Insert Table 4, Figure 1 and Figure 2]

The results of the OLS estimation of equation (5) are summarized in Table 5. The estimated coefficient θ_s^s is not significative and the sign is not consistent with the results in Proposition 2. We interpret this finding as showing that occupational decisions among the skilled workers are also driven by non-pecuniary motivations. The other two coefficients, θ_h^s and θ_u^s, are strongly significative and the sign is consistent with the results in Proposition 2. Figure 3 shows the partial regression plots with respect to the three wage gaps. Finally, Figure 4 shows the performance of the model in explaining the time path of the dependent variable.

[Insert Table 5, Figure 3 and Figure 4]

6 Conclusions

We have built a stylized model about the decisions concerning education and effort-occupation in order to explain the differences across countries and time in the relative frequencies of high wages. We use the model to identify the relevant wage gaps that provide the right incentives to choose a more effort-demanding occupation. Obviously, the wage gap that measures the return from effort has a positive effect on the frequency of high wages. However, we also show that the wage gaps measuring the expected skill premium increase the frequency of high wages for both the skilled and the unskilled workers. These results follow from the interaction between occupational and educational decisions, which is the main contribution of this paper. These findings are tested empirically and we show that evidence provides strong support to the relationship between relative frequency of high wages and wage gaps.

The results in this paper have relevant implications for the design of public policy, in particular, of those policy instruments that modify the wage distribution, such as labor income taxes or labor market regulations. In the paper, we have obtained explicitly the wage gaps that determine occupational and educational decisions. As taxes modify these wage gaps, the analysis in this paper is useful for deriving the effects that taxes have on inequality and social mobility. As a first insight, fiscal policies aimed at reducing inequality may indeed reduce social mobility. An example of this fiscal policy is the introduction of progressive income taxes that result in a reduction of wage gaps. This policy may limit social mobility since it may reduce the frequency of high wages. The analysis also suggests that progressive fiscal policies aimed at simultaneously reducing long-run inequality and increasing social mobility should discriminate between the income taxes paid by the skilled individuals and those taxes paid by the unskilled individuals.

To the best of our knowledge, this paper is the first attempt to study how the wage distribution affects the occupational decision, taking into account the interaction between the two fundamental decisions that determine labor income: educational and occupational decisions. However, a note of caution is in order as the wage gaps are taken as given in our analysis. We do not consider in this paper how the changes in relative frequencies may affect the wage gaps. This may be a limitation to quantify the effect of government policies, mainly when the purpose is to study the long-run implications of some policies.

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Appendix

A Value functions

From equations (1) and (2), we can obtain the expressions for the value functions and we also obtain the constraints on the parameters shown in Assumption A. We distinguish among the following four cases:

1. Skilled and unskilled workers exert effort.

$$V(s) = \frac{(\overline{w}_{se} - \pi_{se}\mu - \rho)[1-(1-\pi_{ue})\beta] + (1-\pi_{se})\beta(\overline{w}_{ue} - \pi_{ue}\mu - \rho)}{(1-\pi_{se}\beta)[1-(1-\pi_{ue})\beta] - (1-\pi_{se})\pi_{ue}\beta^2} \equiv V_s^{e,e}$$

$$V(u) = \frac{\pi_{ue}\beta(\overline{w}_{se} - \pi_{se}\mu - \rho) + (\overline{w}_{ue} - \pi_{ue}\mu - \rho)(1-\pi_{se}\beta)}{(1-\pi_{se}\beta)[1-(1-\pi_{ue})\beta] - (1-\pi_{se})\pi_{ue}\beta^2} \equiv V_u^{e,e}$$

The condition $\beta V(s) - \mu > \beta V(u)$ in Assumption A holds when $(\overline{w}_{se} - \overline{w}_{ue})\beta > \mu$.

2. Skilled workers exert effort and unskilled workers do not exert effort.

$$V(s) = \frac{(\overline{w}_{se} - \pi_{se}\mu - \rho)[1-(1-\pi_{un})\beta] + (1-\pi_{se})\beta(\overline{w}_{un} - \mu\pi_{un})}{(1-\pi_{se}\beta)(1-(1-\pi_{un})\beta) - (1-\pi_{se})\pi_{un}\beta^2} \equiv V_s^{e,n}$$

$$V(u) = \frac{(\overline{w}_{un} - \mu\pi_{un})(1-\pi_{se}\beta) + \pi_{un}\beta(\overline{w}_{se} - \pi_{se}\mu - \rho)}{(1-\pi_{se}\beta)(1-(1-\pi_{un})\beta) - (1-\pi_{se})\pi_{un}\beta^2} \equiv V_u^{e,n}.$$

The condition $\beta V(s) - \mu > \beta V(u)$ holds when $\beta(\overline{w}_{se} - \overline{w}_{un} - \rho) > \mu$.

3. Skilled and unskilled workers do not exert effort.

$$V(s) = \frac{(\overline{w}_{sn} - \mu\pi_{sn})[1-(1-\pi_{un})\beta] + (1-\pi_{sn})\beta(\overline{w}_{un} - \mu\pi_{un})}{(1-\pi_{sn}\beta)[1-(1-\pi_{un})\beta] - (1-\pi_{sn})\pi_{un}\beta^2} \equiv V_s^{n,n},$$

$$V(u) = \frac{(1-\pi_{sn}\beta)(\overline{w}_{un} - \mu\pi_{un}) + \pi_{un}\beta(\overline{w}_{sn} - \mu\pi_{sn})}{(1-\pi_{sn}\beta)[1-(1-\pi_{un})\beta] - (1-\pi_{sn})\pi_{un}\beta^2} \equiv V_u^{n,n}.$$

The condition $\beta V(s) - \mu > \beta V(u)$ holds when $\beta(\overline{w}_{sn} - \overline{w}_{un}) > \mu$.

4. Unskilled workers exert effort and skilled workers do not exert effort.

$$V(s) = \frac{[1-(1-\pi_{ue})\beta](\overline{w}_{sn} - \mu\pi_{sn}) + (1-\pi_{sn})\beta(\overline{w}_{ue} - \pi_{ue}\mu - \rho)}{[1-(1-\pi_{ue})\beta](1-\pi_{sn}\beta) - (1-\pi_{sn})\beta\pi_{ue}\beta} \equiv V_s^{n,e},$$

$$V(u) = \frac{(\overline{w}_{ue} - \pi_{ue}\mu - \rho)(1-\pi_{sn}\beta) + \pi_{ue}\beta(\overline{w}_{sn} - \mu\pi_{sn})}{[1-(1-\pi_{ue})\beta](1-\pi_{sn}\beta) - (1-\pi_{sn})\beta\pi_{ue}\beta} \equiv V_u^{n,e}.$$

The condition $\beta V(s) - \mu > \beta V(u)$ holds when $\beta(\overline{w}_{sn} - \overline{w}_{ue} + \rho) > \mu$.

B Solution of the Markov equilibrium

We use the expressions of the value functions obtained in Appendix A to obtain the utility thresholds and to prove the results in Proposition 1. We distinguish among the following four cases:

1. The skilled workers exert effort when the unskilled exert effort if $V_s^{e,e} > V_s^{n,e}$, which happens when $\rho < \Gamma_s^e$, where

$$\Gamma_s^e \equiv (\pi_{se} - \pi_{sn}) \left(\frac{[1 - \beta (1 - \pi_{ue})] \Delta_s + \beta \Delta_h + \beta (1 - \pi_{ue}) \Delta_u - \mu}{1 + \beta (\pi_{ue} - \pi_{se})} \right).$$

We obtain the following comparative statics:

$$\begin{aligned}
\frac{\partial \Gamma_s^e}{\partial \mu} &= -\frac{\pi_{se} - \pi_{sn}}{1 + \beta (\pi_{ue} - \pi_{se})} < 0, \\
\frac{\partial \Gamma_s^e}{\partial \Delta_s} &= \frac{[1 - \beta (1 - \pi_{ue})] (\pi_{se} - \pi_{sn})}{1 + \beta (\pi_{ue} - \pi_{se})} > 0, \\
\frac{\partial \Gamma_s^e}{\partial \Delta_h} &= \frac{\beta (\pi_{se} - \pi_{sn})}{1 + \beta (\pi_{ue} - \pi_{se})} > 0, \\
\frac{\partial \Gamma_s^e}{\partial \Delta_u} &= \frac{\beta (1 - \pi_{ue}) (\pi_{se} - \pi_{sn})}{1 + \beta (\pi_{ue} - \pi_{se})} > 0.
\end{aligned}$$

2. The skilled workers exert effort when the unskilled do not exert effort if $V_s^{e,n} > V_s^{n,n}$, which happens when $\rho < \Gamma_s^n$, where

$$\Gamma_s^n \equiv (\pi_{se} - \pi_{sn}) \left(\frac{[1 - \beta (1 - \pi_{un})] \Delta_s + \beta \Delta_h + (1 - \pi_{un}) \beta \Delta_u - \mu}{1 + \beta (\pi_{un} - \pi_{sn})} \right).$$

We obtain the following comparative statics:

$$\begin{aligned}
\frac{\partial \Gamma_s^n}{\partial \mu} &= -\frac{\pi_{se} - \pi_{sn}}{1 + \beta (\pi_{un} - \pi_{sn})} < 0, \\
\frac{\partial \Gamma_s^n}{\partial \Delta_s} &= \frac{[1 - \beta (1 - \pi_{un})] (\pi_{se} - \pi_{sn})}{1 + \beta (\pi_{un} - \pi_{sn})} > 0, \\
\frac{\partial \Gamma_s^n}{\partial \Delta_h} &= \frac{(\pi_{se} - \pi_{sn}) \beta}{1 + \beta (\pi_{un} - \pi_{sn})} > 0, \\
\frac{\partial \Gamma_s^n}{\partial \Delta_u} &= \frac{(1 - \pi_{un}) \beta (\pi_{se} - \pi_{sn})}{1 + \beta (\pi_{un} - \pi_{sn})} > 0.
\end{aligned}$$

3. The unskilled workers exert effort when the skilled exert effort if $V_u^{e,e} > V_u^{e,n}$, which happens when $\rho < \Gamma$, where

$$\Gamma_u^e \equiv (\pi_{ue} - \pi_{un}) \left(\frac{[1 + \beta(1 - \pi_{se})]\Delta_u + \beta\Delta_h - \beta(1 - \pi_{se})\Delta_s - \mu}{1 + \beta(\pi_{ue} - \pi_{se})} \right).$$

We obtain the following comparative statics:

$$\begin{aligned}
\frac{\partial \Gamma_u^e}{\partial \mu} &= -\frac{\pi_{ue} - \pi_{un}}{1 + \beta(\pi_{ue} - \pi_{se})} < 0, \\
\frac{\partial \Gamma_u^e}{\partial \Delta_s} &= -\frac{\beta(1 - \pi_{se})(\pi_{ue} - \pi_{un})}{1 + \beta(\pi_{ue} - \pi_{se})} < 0, \\
\frac{\partial \Gamma_u^e}{\partial \Delta_h} &= \frac{\beta(\pi_{ue} - \pi_{un})}{1 + \beta(\pi_{ue} - \pi_{se})} > 0, \\
\frac{\partial \Gamma_u^e}{\partial \Delta_u} &= \frac{[1 + \beta(1 - \pi_{se})](\pi_{ue} - \pi_{un})}{1 + \beta(\pi_{ue} - \pi_{se})} > 0.
\end{aligned}$$

4. The unskilled workers exert effort when the skilled do not exert effort if $V_u^{n,e} > V_u^{n,n}$, which happens when $\rho < \Gamma_u^n$, where

$$\Gamma_u^n \equiv (\pi_{ue} - \pi_{un}) \left(\frac{(1 + \beta(1 - \pi_{sn}))\Delta_u + \beta\Delta_h - \beta(1 - \pi_{sn})\Delta_s - \mu}{1 + \beta(\pi_{un} - \pi_{sn})} \right).$$

We obtain the following comparative statics:

$$\begin{aligned}
\frac{\partial \Gamma_u^n}{\partial \mu} &= -\frac{(\pi_{ue} - \pi_{un})}{1 + \beta(\pi_{un} - \pi_{sn})} < 0, \\
\frac{\partial \Gamma_u^n}{\partial \Delta_s} &= -\frac{\beta(1 - \pi_{sn})(\pi_{ue} - \pi_{un})}{1 + \beta(\pi_{un} - \pi_{sn})} < 0, \\
\frac{\partial \Gamma_u^n}{\partial \Delta_h} &= \frac{\beta(\pi_{ue} - \pi_{un})}{1 + \beta(\pi_{un} - \pi_{sn})} > 0, \\
\frac{\partial \Gamma_u^n}{\partial \Delta_u} &= \frac{(1 + \beta(1 - \pi_{sn}))(\pi_{ue} - \pi_{un})}{1 + \beta(\pi_{un} - \pi_{sn})} > 0.
\end{aligned}$$

C Tables and Figures

Table 1. Frequencies of high wages

Country	2005 Skilled	2005 Unskilled	2012 Skilled	2012 Unskilled
Austria	0.8669	0.1331	0.8913	0.1087
Italy	0.6236	0.3749	0.7054	0.2796
Portugal	0.3086	0.6585	0.3971	0.6024
Spain	0.5718	0.4175	0.6539	0.3417
UK	0.7913	0.1190	0.8393	0.0806

Source: EU- Statistics on Income and Living Conditions (SILC) 2004-14

Table 2. Payoff matrix

Unskilled \ Skilled	Effort	No Effort
Effort	$V_s^{e,e}, V_u^{e,e}$	$V_s^{n,e}, V_u^{n,e}$
No Effort	$V_s^{e,n}, V_u^{e,n}$	$V_s^{n,n}, V_u^{n,n}$

Table 3. Thresholds of effort disutility

Unskilled \ Skilled	Effort	No Effort
Effort	$\rho < \min\{\Gamma_s^e, \Gamma_u^e\}$	$\rho \in (\Gamma_s^e, \Gamma_u^n)$
No Effort	$\rho \in (\Gamma_u^e, \Gamma_s^n)$	$\rho > \max\{\Gamma_s^n, \Gamma_u^n\}$

Table 4. Variation in fraction of unskilled individuals: $\Delta\pi_u$

Dep. variable	Coef.	Estimator	Standardized coeff.
$\Delta \ln(\Delta_s)$	θ_s^u	-0.373197^{***} (0.061379)	-1.766389
$\Delta \ln(\Delta_h)$	θ_h^u	0.281965^{**} (0.088305)	0.866566
$\Delta \ln(\Delta_u)$	θ_u^u	0.077487^{**} (0.031725)	0.454744

R-squared: 0.909533

Included: Temporal and country dummies

P-values: * p<0.1 ** p<0.05 *** p<0.01

Table 5. Variation in fraction of skilled individuals: $\Delta\pi_s$

Dep. variable	Coef.	Estimator	Standardized coeff.
$\Delta \ln(\Delta_s)$	θ_s^s	-0.022989 (0.024127)	-0.246905
$\Delta \ln(\Delta_h)$	θ_h^s	0.067530^{**} (0.030896)	0.470931
$\Delta \ln(\Delta_u)$	θ_u^s	0.0502404^{***} (0.013321)	0.668538

R-squared: 0.828148

Included: Temporal and country dummies

P-values: * p<0.1 ** p<0.05 *** p<0.01

Figure 1. Partial regression plots. Unskilled individuals

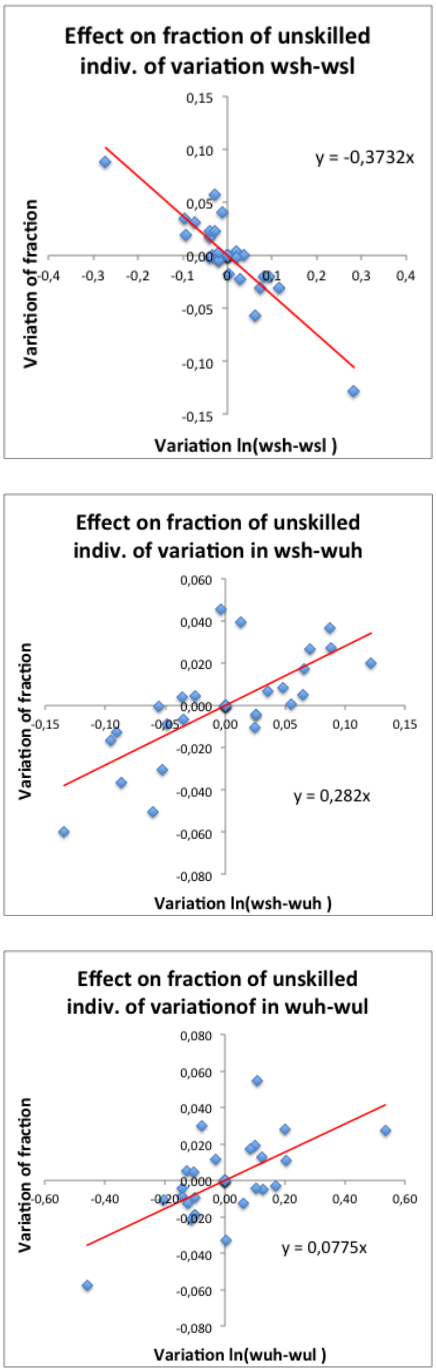


Figure 2. Actual vs. fitted dependent variable. Unskilled individuals

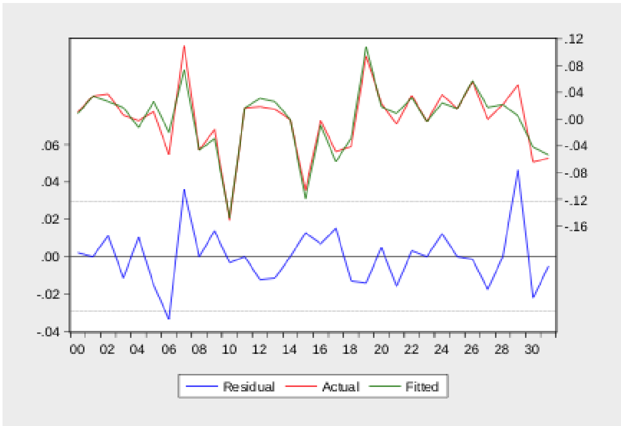
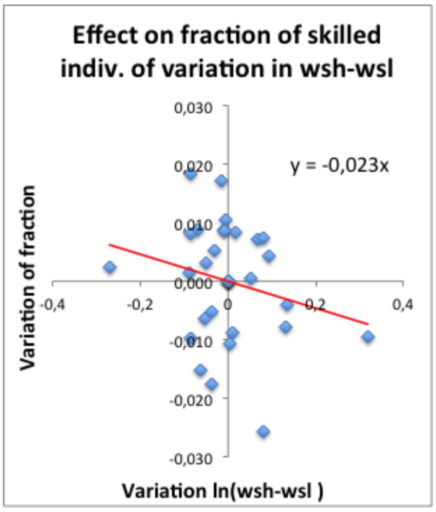
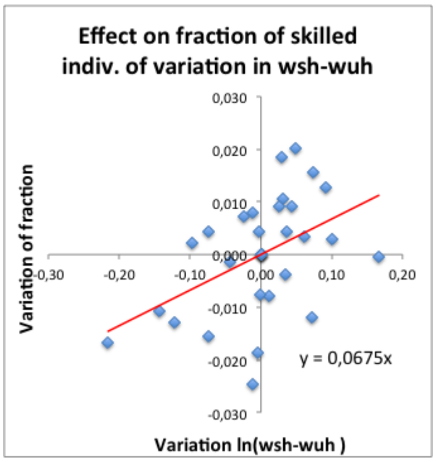


Figure 3. Partial regression plots. Skilled individuals





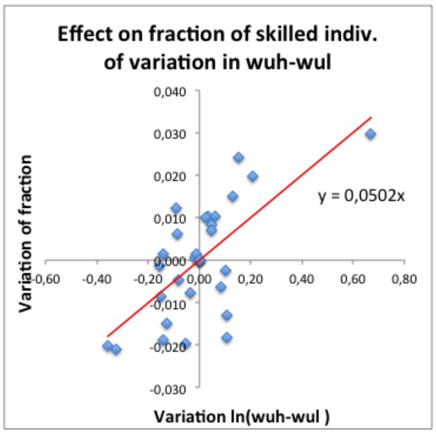


Figure 4. Actual vs. fitted dependent variable. Skilled individuals