The Effects of Redistribution on Occupational Choice and Intergenerational Mobility: Does Wage Equality Nail the Cobbler to His Last?*

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Abstract

In this study we extend the classical Roy-model of selection on the labor market by introducing uncertainty about ones ability linked to family background. In our model, this mechanism rather than differences in access to capital markets links occupational outcomes of offspring to parents. Income redistribution is studied and we find that redistribution has implications for intergenerational mobility and talent allocation trough its influence on individual occupational choices. We conclude that the presence of a trade-off between redistribution and intergenerational mobility depends on the extent of similarity of occupations with regard to ability sensitivity and wage rates, and on the degree of individual risk aversion. Whether redistribution occurs within an occupation or simultaneously within and across occupations is also important.

Keywords: Intergenerational mobility, occupational choice, talent allocation, redistribution.

JEL classification: J24, J31,J62

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1. Introduction

Intergenerational mobility, or the degree to which economic and social status are transmitted from parents to offspring, has received attention both in the theoretical and the empirical literature.[1] While sociologists have focused on occupational or class mobility, economists have taken a greater interest in income mobility.

There are both equality and efficiency implications of intergenerational mobility. Concern for equality of opportunity calls for attention to the extent to which individual welfare is determined by choices and efforts within control of the individual and to what extent it is predetermined by genes and upbringing. Furthermore, it is of relevance to what extent the degree of predetermination is influenced by institutional factors that can be affected by policy. With regard to efficiency, it is of interest whether family background constrains individual choices in such a way that the allocation of talent is not optimal from society's point of view. Baumol (1990) and Murphy, Shleifer and Vishny (1991) argue that the allocation of talent has growth implications. The reason is that failure of talented children to exploit their full potential simply because they are born into the wrong families may deprive the economy of valuable externalities from human capital.

The presence and magnitude of such a loss to society and the possibility that a compressed wage structure could reduce or aggravate the loss have been subject to debate in Sweden.[2] In discussing the consequences for long run economic growth of poor incentives for higher education allegedly due to progressive income taxes and labor market regulations, it has been hypothesized that individuals from weak educational/social background require stronger economic incentives in order to opt for higher education than do individuals with well educated parents. The logic of this hypothesis has fuelled arguments for policies that would increase wage dispersion, e.g. reduced taxes, since too little wage dispersion is said to deter brilliant children from educationally weak background from higher education since the returns are too low.

The aim of this paper is to further the understanding of the relation between the incentive structure, talent allocation, earnings patterns and intergenerational mobility in an attempt to answer the question "Does wage equality nail the cobbler to his last?" or put differently: Is there a trade-off between redistribution and intergenerational mobility?

[1] See e.g. Becker and Tomes (1979, 1986), Solon (1992), Zimmerman (1992), Björklund and Jäntti (1993), Mulligan (1995,1996), Eriksson and Jonsson(1996) and Rustichini et al (1996).

[2] See e.g. Henreksson (1993) and Erikson and Jonsson (1994).

Previous theoretical work by economists on intergenerational mobility, e.g. Becker and Tomes (1986) and Mulligan (1996) has focused mainly on the transmission of income earning capacity through mechanisms connected to human capital investments and bequests.[3] Such models suggest that because inequality of opportunity is a result of inequality of outcome in the parent generation working through imperfect capital markets, policies aimed at providing equal access to education would lead toward equality of opportunity.

This paper analyzes a different mechanism by which economic status is transmitted from one generation to the next by modelling how occupational choice is influenced by family background. It can be argued that occupational choice is of particular relevance for intergenerational mobility in societies where other ways of transferring wealth and status across generations, e.g. financial bequests or human capital investments are of reduced importance because of heavy taxation or because education is free.

Family background becomes important because we assume that the occupation of the parents may influence the quality of the information a child has about what it takes to succeed in different types of careers and about the child's talent for different jobs. In particular, we assume that individuals face more uncertainty when considering a career in an unfamiliar occupation than when judging prospects in the family occupation. We thus introduce family background determined differences in access to information of a kind which is similar to what has previously been discussed by sociologists, into the study of intergenerational mobility.[4] However, we do not make the common assumption that people from a particular background (generally those from well educated families) always have access to better information. Instead, we assume that people have good information about occupations close to that of their parents and poor information about unfamiliar occupations.

By introducing family background effects into a simplified version of Willis' (1991) formulation of Roy's classic occupational choice model from 1951, we derive how the degree of occupational mobility and how earnings patterns of people with different family background depend on the incentive structure of the economy, i.e. on wage differences between occupations and the sensitivity of earnings to

[3]Sociologists, on their part, have been more interested in social mobility, i.e. the transmission of socioeconomic status or class, which is generally measured as some combination of mobility with regard to occupation, education and income.

[4]See e.g. Erikson and Jonsson (1996).

ability within different occupations.[5] We also analyze the effects on mobility and talent allocation of two forms of redistribution. First, we look at the effects of solidarity wage policy, or redistribution within an occupation. Second, we turn to redistributive taxation which redistributes income both within and across occupations.

Contrary to the results in the human capital models of intergenerational mobility, this paper illustrates that equality of outcome in the parent generation or free education do not guarantee equality of opportunity of the young generation. The information differences introduced in our model make the allocation of talent and, thus, individual earning capacity in the young generation depend on family background also in the absence of the human capital investment costs and credit market imperfections or genetic transmission of ability for that matter, that are the driving forces behind the transmission of inequality in the Becker-Tomes model.

Our results further imply that both inter and intraoccupational wage differences are important for the degree of occupational mobility and for the link between family background and allocation of ability and thus earnings patterns. While wage differences between occupations always provide an incentive to opt for the high wage occupation, regardless of family background, high sensitivity of earnings to ability, i.e. the potential for earnings differences within an occupation, can attract or deter people depending on their background and attitude towards risk. The effects on total mobility, allocation of talent and earnings patterns of changes in the incentive structure will therefore depend on the degree of risk aversion of individuals, as well as on how different occupations are with respect to wage rates and sensitivity of earnings to ability.

We thus find no unambiguous answer to if redistributive policies enhance or reduce overall mobility. The effects of redistribution on mobility and talent allocation depend on how and where it takes place, i.e. if it takes place between or within occupations. In the latter case, it also matters if wage compression occurs in an occupation in which earnings are sensitive or not to ability. We find that upward mobility is stimulated by large interoccupational wage differences. We also find that strongly risk averse individuals become more prone to choose an

[5] Our treatment of occupation is close to that of Roy (1951) and Sicherman and Galor (1990). In Roy occupations differ because the require input of different abilities (or combinations of abilities). Because people are heterogeneous with respect to their endowment of abilities they will have comparative advantage for some ocupations. Sicherman and Galor define occupations according to the level and the type human capital required.

unfamiliar occupation, i.e. be mobile, with the introduction of a redistributive tax system which reduces both inter and intra occupational wage dispersion while moderately risk averse individuals become less mobile.

If changes in wage dispersion are restricted to one occupation, e.g. as a result of solidarity wage policy, effects on mobility are complex, but it is interesting to note that regardless of risk aversion, upward mobility will be encouraged by a further increase in the wage dispersion of an already highly ability sensitive occupation in which earnings are low or mediocre for people with mediocre ability.

The paper proceeds as follows. Section 2 outlines a model in which occupational choice is influenced by family background. Section 3 analyses the implications of the model for the allocation of talent and for earnings patterns. The fourth section uses the tools developed in sections 2 and 3 to address the question in the title of the paper by analyzing the effects of two forms of redistribution, solidarity wage policy, which redistributes within an occupation and progressive taxation, which redistributes within and across occupations, on mobility and earnings patterns. Section 5 concludes.

2. The Model

This section outlines a simple model of how young individuals, who are heterogeneous both with regard to their endowment of abilities and with regard to their family background, make occupational choices. The structure of the model is inspired by Willis' (1986) version of the occupational choice model described in Roy (1951). The Roy-model does not deal directly with intergenerational mobility. Instead it focuses on how occupational choice governed by comparative ability advantages and on the implications of such choices on the distribution of income and allocation of talent. We introduce uncertainty about ability into the Roy-model. In order to capture that family background matters for occupational choice, we assume that people can assess their ability to work in their parents' occupation but that they are uncertain about how able they are to work in other, unfamiliar, occupations. We shall see that the degree of risk aversion will be crucial for how uncertainty regarding ability affects occupational choices. Moderately risk averse individuals may have so much to gain if they make it in the high return occupation that mobility will tend increase with intraoccupational wage dispersion and uncertainty. If risk aversion is strong enough, mobility will decrease with intraoccupational wage dispersion since individuals care more about the risk than about the potential gain.

2.1. Basic structure

This model attempts to capture how the occupational choice of an individual is influenced by the occupation of the parents when the individual is better at assessing his ability to work in the family occupation than at assessing his ability to work in other occupations. We will think of individuals as young and as workers. When they are young, individuals are supported by their parents. In working life individuals live off their own earnings. In their youth, individuals choose a future occupation. In order to abstract from inequality of opportunity we will assume that all individuals receive the same amount of money from their parents and that education is free. This implies that the individual's choice of occupation does not influence the level of consumption as young. The individual chooses the occupation which yields the highest expected working life utility.

Working life utility of an individual who chooses occupation i depends on the level of consumption, c_i, that is achieved while working in occupation i. This level of consumption may be subject to uncertainty because the individual cannot be sure how well he will succeed in the chosen occupation. The individual cares about expected working life utility:

$$E\left[U(c_i)\right] \qquad U' > 0,\ U'' < 0. \tag{2.1}$$

We assume that the utility function has constant relative risk aversion. The coefficient for relative risk aversion is γ and the higher is γ the more risk averse the individual:

$$U(c) = \frac{1}{1-\gamma} c^{1-\gamma}. \tag{2.2}$$

The individual influences his level of consumption as a worker through the choice of occupation. Because we disregard savings, consumption as a worker is determined by the wage earnings:

$$c_i = Y_i(A_i), \tag{2.3}$$

where earnings, Y_i, in occupation i depend on the individual's endowment of the occupation specific ability A_i. We define the value to the individual choosing occupation i in terms of ability as the utility level achieved if the occupation is chosen:

$$V_i(A_i) = \frac{1}{1-\gamma} \left(Y_i(A_i)\right)^{1-\gamma}. \tag{2.4}$$

While the Roy-model assumes that each occupation requires a combination of abilities, we assume that there is one ability specific to each occupation. For

simplicity, it is further assumed that there are only two occupations and two abilities. We also assume that each individual is endowed with ability specific to each occupation and that occupations differ precisely because they require different abilities. Each individual j has ability A_j

$$A_j = \{A_{ij}\}, \quad i = 1, 2, \tag{2.5}$$

where A_{ij} is individual j's endowment of ability specific to occupation i. In the entire population of individuals, abilities are assumed to be joint log normally distributed with the same mean and variance such that $\ln A_1$ and $\ln A_2$ are joint normally distributed with zero mean, unit variance and correlated with ρ. Log normality implies that ability is always greater than zero and, furthermore, that the ability distribution is skewed since there is no upper bound to ability. The natural logarithm of ability, which will be used later in the analysis, is symmetrically distributed around zero.

We will make the simplifying assumption that the individual has full information about his endowment of the ability specific to his family occupation, but that he faces uncertainty about his endowment of the ability specific to the unfamiliar occupation. The individual thus forms a prior belief about the uncertain ability based on knowledge about ability in the family occupation, knowledge about how abilities are distributed in the population in general and on how abilities are correlated. For clarity, we denote the individual's family occupation, f and unfamiliar occupation, u.

We define:

$$a_i \equiv \ln A_i. \tag{2.6}$$

The individual thus forms a prior belief about a_u based on a_f and ρ. The prior distribution for a_u is:

$$f(a_u \mid a_f) = n(a_f \rho, \sqrt{1 - \rho^2}). \tag{2.7}$$

The standard deviation of the prior distribution is larger the closer to zero the correlation between the two abilities.[6]

[6] The density function of the conditional distribution $f(a_u \mid a_f)$ is:

$$f(a_u \mid a_f) = \frac{1}{\sqrt{2\pi(1-\rho^2)}} \exp\left\{-\frac{1}{2(1-\rho^2)}(a_u - \rho a_f)^2\right\}.$$

We follow Willis (1986) in assuming that earnings in occupation i take the following form:

$$Y_i = W_i A_i^{\beta_i} \quad i = f, u, \tag{2.8}$$

where earnings, Y_i, depend on the wage rate, W_i, on the individual's endowment of occupation i specific ability A_i, and on the occupation specific parameter β_i which determines the sensitivity to ability of earnings in occupation i. Henceforth, $A_i^{\beta_i}$ will be referred to as the individual's productivity in occupation i. Note that productivity and earnings increase with ability sensitivity, β_i, if ability A_i, is larger than one. If ability is less than one, increasing ability sensitivity is no good for individual productivity. As an analogue to the Roy model, we can see that if individuals are randomly assigned to occupations, the distribution of the natural logarithm of earnings in each occupation i is: $\ln Y_i \backsim n(\ln W_i, \beta_i)$. There is thus a positive relation between the ability intensity of an occupation and the standard deviation of earnings within the occupation. The actual distribution of earnings within an occupation will, however, deviate from this because occupational choice depend on ability and because individuals may differ in their occupational choices simply because they are of different background.

We assume that the individual sticks to the family occupation if working life value achieved in the family occupation is at least as high as the expected working life value achieved in the unfamiliar occupation.

$$V_f \geq E\left[V_u\right]. \tag{2.9}$$

Using the utility function and the earnings function we can derive the value, V, to the individual in terms of the known ability of choosing the family occupation or the unfamiliar occupation. The value for an individual who chooses to stay in the family occupation is:

$$V_f(A_f) = \frac{1}{1-\gamma}\left(W_f A_f^{\beta_f}\right)^{1-\gamma}, \tag{2.10}$$

while expected value if the individual should choose the unfamiliar occupation is:

$$E\left[V_u\right] = \frac{1}{(1-\gamma)} \int_{-\infty}^{\infty} \left(W_u A_u^{\beta_u}\right)^{1-\gamma} f(a_u \mid a_f) da_u. \tag{2.11}$$

Developing the integral by making use of the conditional distribution of a_u, results in the following expression for the expected value if the individual leaves the family

occupation:

$$E\left[V_u\right] = \frac{1}{(1-\gamma)}\left(W_u A_f^{\beta_u \rho}\xi\right)^{1-\gamma}, \tag{2.12}$$

where

$$\xi = e^{\frac{\beta_u^2}{2}(1-\rho^2)(1-\gamma)}.^{7} \tag{2.13}$$

ξ is related to the uncertainty involved in choosing the unfamiliar occupation. Depending on the coefficient of relative risk aversion, γ, this risk related factor ξ is smaller or greater than one. The individual's expected ability in occupation u is $A_f\rho$. The productivity associated with the expected ability is $A_f^{\rho\beta_u}$, while the expected productivity is:

$$E\left[A_u^{\beta_u} \mid A_f\right] = A_f^{\beta_u \rho} e^{\frac{\beta_u^2}{2}(1-\rho^2)}. \tag{2.14}$$

These differ because of the uncertainty involved. Expected productivity is greater than the productivity associated with the expected ability as long as there is uncertainty about ability, i.e., as long as the correlation between abilities is not perfect ($\mid \rho \mid = 1$). The greater the uncertainty (the closer ρ is to zero) and the greater is β_u, the more will the expected productivity exceed the productivity at expected ability. This holds also for the relation between expected earnings and earnings associated with expected ability. The reason behind this is that productivity and earnings are convex in the natural logarithm of ability.

What about value? The value associated with the expected ability would be:

$$V\left[Y\left[E\left[A_u \mid A_f\right]\right]\right] = \frac{1}{(1-\gamma)}\left(W_u A_f^{\beta_u \rho}\right)^{1-\gamma}. \tag{2.15}$$

This value measure exceeds the *expected value* if ξ is smaller than one. This is the case when risk aversion is strong, i.e. if the coefficient of relative risk aversion is larger than one. If risk aversion is moderate the *expected value* will exceed the value associated with the expected ability.

2.2. The choice of occupation

The individual chooses to stay in the family occupation if the value of doing so is at least as high as the expected value of choosing the unfamiliar occupation.

[7] See appendix

We can thus combine (2.9), (2.10) and (2.12) to derive the following condition for when the individual chooses the family occupation:

$$\frac{1}{(1-\gamma)}\left(W_f A_f^{\beta_f}\right)^{1-\gamma} \geq \frac{1}{(1-\gamma)}\left(W_u A_f^{\beta_u \rho}\xi\right)^{1-\gamma}. \tag{2.16}$$

The condition is satisfied when

$$(\beta_f - \rho\beta_u)\, a_f \geq \ln\left(\frac{W_u}{W_f}\right) + (1-\gamma)\left(1-\rho^2\right)\frac{\beta_u^2}{2}, \tag{2.17}$$

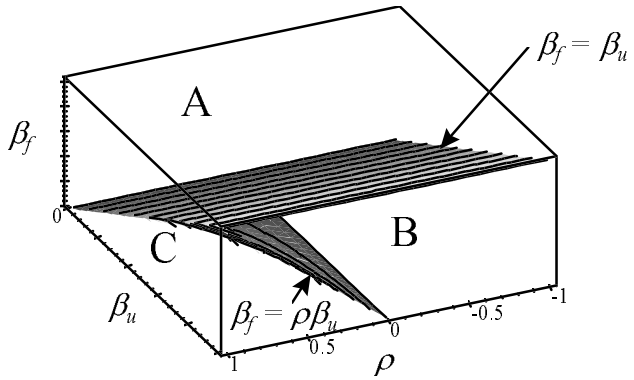
where we have used the fact that $a_f = \ln A_f$. We will henceforth refer to a as ability.

Condition (2.17) tells us that the individual's choice of occupation depends on the difference in productivity at expected ability (the left hand side), the difference in wage rates and the last term on the right hand side which captures how the value of the unfamiliar occupation is affected by the uncertainty involved. The size of the last term on the right hand side, the risk factor, depends the degree of risk aversion. The more the individual cares about risk, the greater the risk factor. The sign of this risk factor is positive or negative depending on the degree of risk aversion. If risk aversion is strong, $\gamma > 1$, the risk factor is negative, implying that the individual will demand a higher wage to compensate for the risk in order to choose the unfamiliar occupation if the return to expected ability is the same in both occupations. If risk aversion is moderate, $\gamma < 1$, the risk factor is positive. The reason for this is that strong risk aversion is enough to curb the convexity of the earnings function with respect to ability and render the expected value concave in ability. With moderate risk aversion, the convexity of the earnings function is not dominated by the concavity of the utility function and expected value is thus convex in ability.[8] The risk factor also depends on how informative the known ability a_f is about the uncertain ability a_u. The stronger the correlation the less uncertain is a_u and the smaller is the risk factor. The sensitivity to ability of the unfamiliar occupation also affects the size of the risk factor.

The condition implies that if the productivity difference is positive for positive ability, i.e. the family occupation is perceived to be more ability sensitive than the unfamiliar, individuals above a certain ability level will stick to the family occupation. If the unfamiliar occupation is perceived to be more ability sensitive,

[8] This result regarding the sign of the risk premium is analogous to the discussion in Caballero (1991) regarding the sign of the investment - uncertainty relationship.

Figure 2.1: States



A: State 1, $\beta_f - \beta_u > 0$.
B: State 1, $\beta_f - \beta_u < 0$ and $\beta_f - \rho\beta_u > 0$.
C: State 2, $\beta_f - \rho\beta_u < 0$. State 3, $\beta_f = \rho\beta_u$.

individuals below a certain ability level will stay in the family occupation. In general, the occupation which is perceived as more ability sensitive will attract the most able people. We define a cut off ability, a^*, for which expected value is the same in both occupations:[9]

$$a^* \equiv \left(\frac{\ln\left(\frac{W_u}{W_f}\right) + (1-\rho^2)(1-\gamma)\frac{\beta_u^2}{2}}{(\beta_f - \rho\beta_u)} \right). \tag{2.18}$$

When analyzing the determinants and consequences of the individual's choice to stay in or leave the family occupation, three states can be distinguished based on the sign of the denominator in 2.18, i.e. depending on which occupation the individual perceives to be most sensitive to ability. Figure 2.1 illustrates these states and shows how the difference in perceived ability sensitivity between the two occupations relates to the true difference in ability intensity.

[9] Remember that the individual chooses the family occupation if expected utility is the same in both occupations.

State 1: The individual sticks to the family occupation if his f-ability is at least as high as the cut off ability:

$$a_f \geq a^*. \tag{2.19}$$

The family occupation is perceived to be the more sensitive to the known ability, $\beta_f - \rho\beta_u > 0$. This implies that earnings at the expected ability are higher in the family occupation, provided that ability is above average ($a_f > 0$).

The cut off ability is positive or negative i.e. above or below average ability, depending on the wage rates in the two occupations and depending on the risk factor:

$$a^* \gtrless 0 \quad if \quad \ln\left(\frac{W_f}{W_u}\right) \lesseqgtr (1-\gamma)\left(1-\rho^2\right)\frac{\beta_u^2}{2}. \tag{2.20}$$

State 2: The individual stays in the family occupation if his $f-$ability is smaller than or equal to the cut off ability:

$$a_f \leq a^*.$$

The perceived sensitivity of earnings to $f-$ability is higher in the unfamiliar occupation, $\beta_f - \rho\beta_u < 0$. This condition can only be satisfied for positive correlation between abilities. Again the level of the cut off ability depends on wage rates and risk factor.

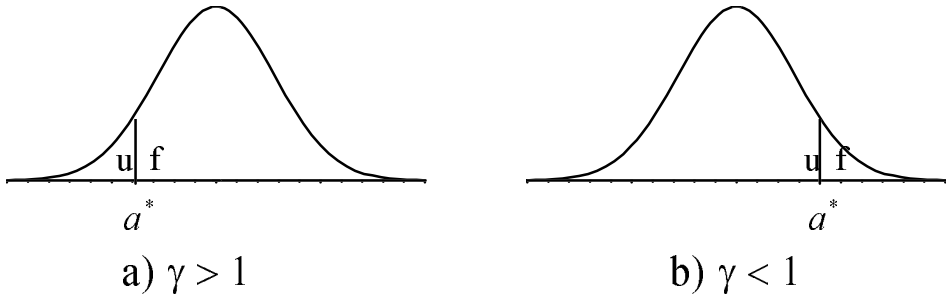
$$a^* \gtrless 0 \quad if \quad \ln\left(\frac{W_f}{W_u}\right) \gtrless (1-\gamma)\left(1-\rho^2\right)\frac{\beta_u^2}{2}. \tag{2.21}$$

State 3: In State 3, both occupations are perceived as equally sensitive to ability, $\beta_f - \rho\beta_u = 0$. Ability will thus not matter for occupational choice. This last case is relevant only when abilities are positively correlated. Occupational choice depends only the relative wage and on the risk premium. The individual sticks to the family occupation if

$$\ln\left(\frac{W_f}{W_u}\right) \geq (1-\gamma)\left(1-\rho^2\right)\frac{\beta_u^2}{2}. \tag{2.22}$$

The individual will require a lower/higher wage in the family occupation to convince him to stay, depending on the coefficient of relative risk aversion. If the individual is very risk averse, $\gamma > 1$, the individual demands a risk premium in order to choose the unfamiliar occupation. If the individual is less risk averse, $\gamma < 0$, the individual demands a premium in order to stay in the family occupation.

Figure 3.1: State 1



The more risk averse the individual, i.e. the higher is γ, the lower is the premium the individual asks in order to stay in the family occupation. When γ exceeds one, the premium is negative. The higher is β_u the higher are the potential gains of opting for the uncertain occupation and, thus, the higher the premium demanded in order to stay in the family occupation, provided that the coefficient for relative risk aversion does not exceed one. If γ exceeds one, the risk premium is negative since the individual is so risk averse that the negative impact on expected value of risk out weighs the positive effect of higher expected earnings in the uncertain occupation. Increasing β_u, further increases the risk, and thus makes the negative premium larger in size. The more closely correlated the two abilities the smaller the absolute size of the premium, since closer correlation implies that there is less uncertainty.

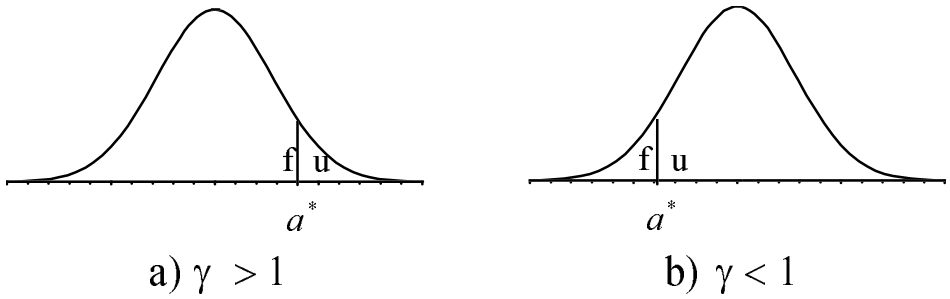
3. Implications for talent allocation and earnings patterns

3.1. The allocation of talent

The allocation of talent of individuals with the same family background, but different attitudes toward risk when the States 1 and 2 prevail are depicted in Figures 3.1 and 3.2 respectively. The figures are based on the assumption that ability is not correlated across generations, i.e. the distribution of ability is independent of family background. For simplicity it has also been assumed that the wage rate is the same in both occupations although it may be more realistic to assume that wage rates are higher in more ability sensitive occupations.

Figure 3.1a depicts a situation where risk aversion is strong and the family

Figure 3.2: State 2



occupation is perceived to be more ability sensitive. This implies that the risk factor, ξ, is negative, i.e. the individual needs compensation in order to opt for the uncertain alternative. A majority will thus stick to the family occupation. Only those who have very low aptitude for the family occupation will have higher expected utility in the unfamiliar occupation. The reason for this is that the prospects in the family occupation are so poor that the chance of having higher ability in the unfamiliar occupation will make it worthwhile to take the chance.

Figure 3.1b shows the situation where individuals are only moderately risk averse and the family occupation is perceived to be more ability sensitive. In this case the risk factor, ξ,is positive and when the wage is the same in both occupations, most people will find it worthwhile to venture into the unfamiliar occupation. Only those who are very good at their family occupation will stick to it since their chances of doing even better in the unfamiliar occupation are so small.

Figure 3.2a depicts a situation with strong risk aversion and higher perceived ability sensitivity in the unfamiliar occupation. Most people will stick to the safe family occupation. Only those who think they will have very high ability in the unfamiliar occupation (remember State 2 can only prevail when ability correlation is positive) will dare to opt for the unfamiliar occupation where they will get higher returns to their talent.

Figure 3.2b shows a situation where risk aversion is moderate and ability sensitivity is higher in the unfamiliar occupation. Because there is much to gain by opting for the unfamiliar occupation, most people will try their luck. Only for those who have very low ability in the family occupation will the risk of having equally low or even worse ability in the unfamiliar occupation be so high that

they rather stick to the safe family occupation.

If the assumption of equal wage rates in both occupations is relaxed the picture gets more complex. It can be argued that occupations where ability matters more will also have higher wage rate. In the context of the model this means that, $\beta_f \gtrless \beta_u$ would imply that $W_f \gtrless W_u$. The diagram in Figure 2.1 illustrates three situations. If $\beta_f > \beta_u$, the region marked A, the wage in the family occupation exceeds the wage in the unfamiliar occupation and the individual is in State 1. When $\beta_f < \beta_u$, and $\beta_f > \rho\beta_u$, the region marked B, the wage in the unfamiliar occupation exceeds the wage in the family occupation, but the same State prevails. In the region marked C, $\beta_f < \beta_u$, the wage in the unfamiliar occupation exceeds the wage in the family occupation and the individual is in state 2.

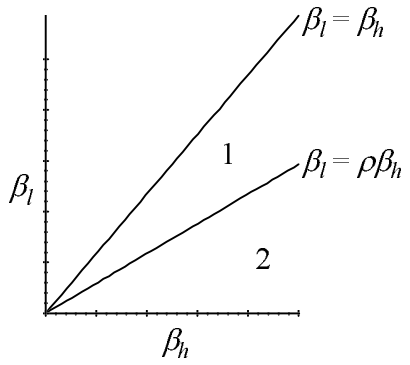
In A, the talent allocation in Figure 3.1a will not be altered qualitatively. An even greater majority will, however, opt for the family occupation. With moderate risk aversion, the higher wage in the family occupation compensates for the premium asked in order to stay in the family occupation. If the wage in the family occupation is high enough the cut off ability in Figure 3.1b may be pushed so much to the left that a majority decides to opt for the family occupation. In B, the talent allocations in Figure 3.1 will be affected in the opposite way. With strong risk aversion, a high enough wage in the unfamiliar occupation will convince a majority to opt for the unfamiliar occupation (i.e. make the cut off ability positive). With moderate risk aversion, even fewer will stick to the family occupation if the wage in the unfamiliar occupation exceeds the wage in the family occupation.

In C, a high enough wage in the unfamiliar occupation will convince a majority to opt for the unfamiliar occupation, even if risk aversion is strong. The cut off ability will thus become negative in Figure 3.2a. The allocation illustrated in Figure 3.2b would however not change qualitatively.

3.2. Implications for earnings patterns

In this section we shall analyze the effects of talent allocation on the earnings patterns within occupations. In order to do so we will need to consider the occupational choices of individuals with different family background. It will thus no longer be convenient to discuss occupations in terms of family and unfamiliar occupation. Instead we shall call the occupations h (high) and l (low), where $\beta_h \geq \beta_l$. We will assume, for simplicity, that the wage rates are equal in both occupations. Depending on the ability sensitivity of the two occupations and on

Figure 3.3: Situations



1: Both h-people and l-people are in State 1.
2: h-people are in State 1 and l-people are in State 2.

the correlation between abilities, the individuals with family background in the respective occupations will be in States 1 or 2. We will refer to people with family background in the high return occupation h, as h-people and people with family background in the low return occupation l, as l-people.

We need to consider two types of situations depending on which states prevail. These are illustrated in Figure 3.3 for positive ability correlations. When ability correlation is negative, individuals are in State 1 regardless of family background. As shown above, the allocation of talent depends crucially on the degree of risk aversion. We will focus on the case where both types of people are either strongly risk averse or moderately risk averse.

3.2.1. Situation 1: Occupations are similar: horizontal mobility

When the occupations are relatively similar in terms of return to ability and in terms of the nature of ability required (ability correlation is positive), the mobility that takes place can be thought of as horizontal mobility.

When the return to ability is fairly similar in the two occupations (or when ability correlation is negative) strong risk aversion implies that in both occupations will those few who are newcomers be those who were very poor at their family occupations. With positive ability correlation, this means that newcomers into

Figure 3.4: Horizontal mobility: strong risk aversion

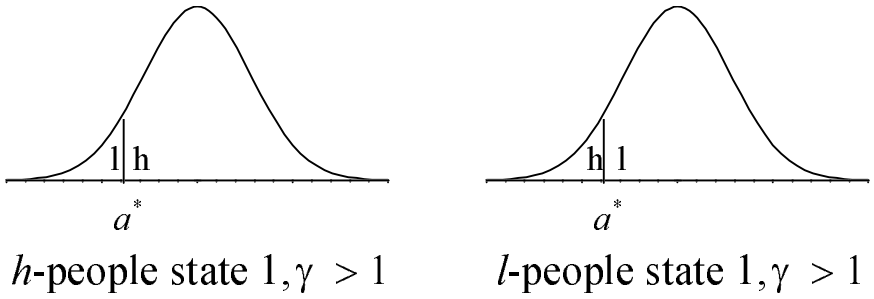
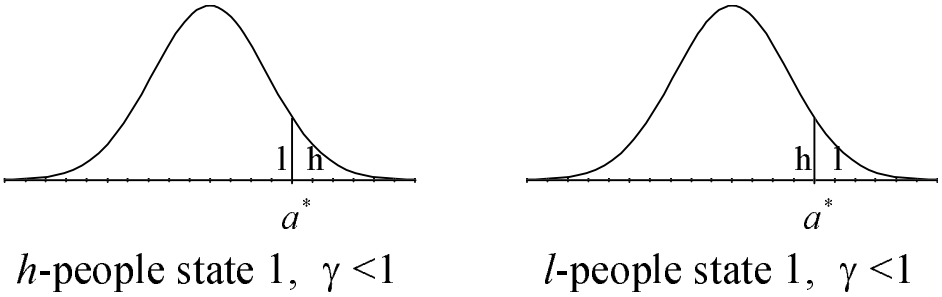


Figure 3.5: Horizontal mobility: moderate risk aversion



an occupation will on average earn less than those with a background in the occupation. If ability correlation is negative, the new comers on average earn more.

When return to ability is fairly similar (or ability correlation is negative) and risk aversion is moderate. Mobility will be high. However, the same kind of earnings pattern as with strong risk aversion will prevail.

3.2.2. Situation 2: Occupations are different: vertical mobility

When the return to ability is sufficiently much higher in one occupation than in the other we call the mobility that takes place vertical mobility. Here we assume occupation h is more ability sensitive than occupation l.

When risk aversion is strong, the few l-people who venture upward into occu-

Figure 3.6: Vertical mobility: strong risk aversion

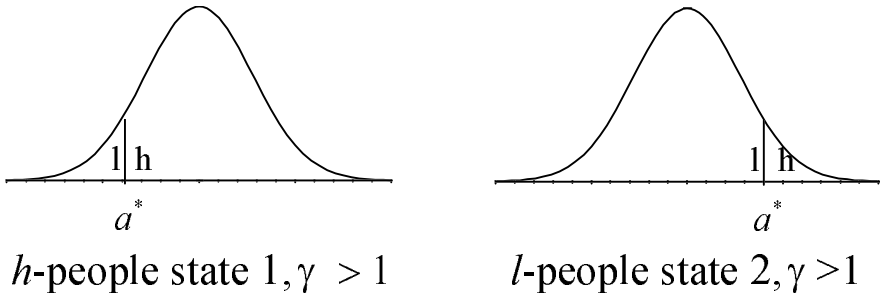
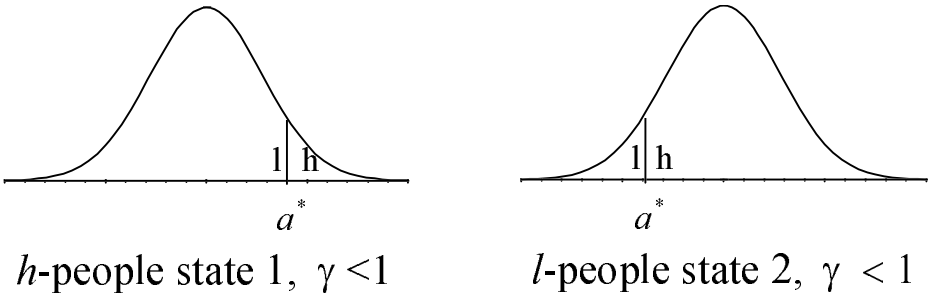


Figure 3.7: Vertical mobility: moderate risk aversion



pation h will be very able and thus earn more on average than the h-people who stayed in their family occupation. The rare few h-people who choose occupation l will be low ability people and they will therefore earn less than the l-people who choose to stay in occupation l.

When the return to ability is sufficiently much higher in occupation h than in occupation l, and when risk aversion is moderate, the majority of the l-people will venture into occupation h and only the most brilliant of the h-people will stay in their family occupation. The result is that the h-people who choose to stay in their family occupation will on average earn more than the newcomers. In occupation l only the least able of the l-people will remain. The large group of h-people who opt for occupation l will thus on average earn more than the l-people who stay in their family occupation.

So far we have assumed that people have the same degree of risk aversion

regardless of family background. If instead we assume that people from well to do background, i.e. from high wage, ability sensitive background are moderately risk averse while people from low ability sensitive background are strongly risk averse, the pattern of vertical mobility and earnings is altered. Depending on how much higher (if at all) the wage rate is in the ability sensitive occupation, people would tend to be more or less mobile. The larger the wage difference, the lower the mobility of the high sensitivity background people and the higher the mobility of the low sensitivity background people. Whether newcomers or those with family background in the occupation will earn the most on average also depends on the wage difference and on the degrees of risk aversion.

4. Mobility, earnings patterns and changes in the incentive structure

This section analyses how mobility and earnings patterns of people from different background are affected by policies that change the incentive structure. Although the model has not so far allowed for government policy or institutional changes, we will interpret parameter changes in terms of increased or reduced wage compression resulting from more or less solidarity wage policy[10] and introduce a more or less progressive redistributive welfare system. A reduction in the sensitivity of earnings to ability, β, in an occupation will be regarded as an effect of increased solidarity wage policy since it implies a change in the direction of "equal job equal pay", regardless of productivity. Increasing the progressiveness of the redistributive system is defined as a simultaneous proportional reduction of sensitivity of earnings to ability in both occupations in combination with a reduction in wage rates leading toward equalization of wage rates.

The effects on mobility and earnings patterns of changes in the incentive structure will depend on where the economy starts out. We will compare effects of more or less solidarity wage policy and more or less progressive redistributive in the following situations:

1 wages are equal, return to ability is similar.

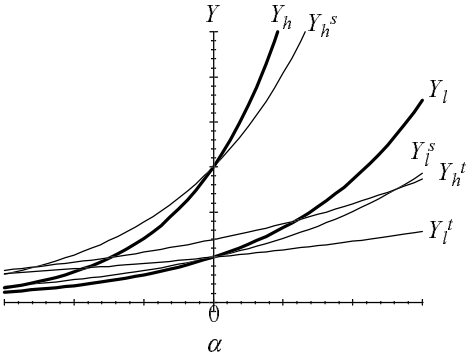
2 wages are equal, return to ability different.

3 wage is higher in high return occupation, returns to ability are different.

We continue to refer to the occupations as h (high) and l (low), where $\beta_h > \beta_l$

[10] See e.g. Edin and Holmlund (1993) for a critical discussion of solidarity wage policy as the cause behind Swedish wage compression.

Figure 4.1: Earnings as a function of ability



Y_i =Earnings in occupation *i*, Y_i^s = Earnings in occupation *i* under solidarity wage policy, Y_i^t = Earnings in occupation *i* with redistributive welfare system, *h*=high return occupation, *l*=low return occupation.

The results in this section are based on an analysis of the comparative statics of cut-off ability of people with h and l background with respect to β_h and β_l. Reducing the β in an occupation represents an introduction of more solidarity wage policy into the occupation. We will also experiment with a progressive redistributive system in the whole economy by assuming that the disposable earnings function in occupation i takes the following form

$$Y_i^d = Y_i^{1-t}, \quad 0 \leq t < 1, \tag{4.1}$$

and the average tax rate τ

$$\tau = 1 - \frac{Y_i^d}{Y_i} = 1 - Y_i^{-t}, \tag{4.2}$$

is increasing in earnings. The larger is t, the more progressive the tax system. Figure 4.1 illustrates the experiments to be analyzed.

If we introduce taxation into the model, we can derive cut off ability:

$$a_i^* \equiv \left(\frac{\ln\left(\frac{W_j}{W_i}\right) + (1-t)\left(1-\rho^2\right)(1-\gamma)\frac{\beta_j^2}{2}}{(\beta_i - \rho\beta_j)} \right). \tag{4.3}$$

The derivatives with respect to the incentive structure parameters are:

$$\frac{\partial a_i^*}{\partial \beta_i} = -\frac{\ln\left(\frac{W_j}{W_i}\right) + (1-t)(1-\rho^2)(1-\gamma)\frac{\beta_j^2}{2}}{(\beta_i - \rho\beta_j)^2}, \tag{4.4}$$

$$\frac{\partial a_i^*}{\partial \beta_j} = \frac{(1-t)(1-\rho^2)(1-\gamma)\beta_j}{(\beta_i - \rho\beta_j)} + \rho\frac{\ln\left(\frac{W_j}{W_i}\right) + (1-t)(1-\rho^2)(1-\gamma)\frac{\beta_j^2}{2}}{(\beta_i - \rho\beta_j)^2}, \tag{4.5}$$

$$\frac{\partial a_i^*}{\partial t} = -\frac{(1-\rho^2)(1-\gamma)\frac{\beta_j^2}{2}}{(\beta_i - \rho\beta_j)}. \tag{4.6a}$$

The effects on occupational choices of solidarity wage policy depend both on the attitude toward risk and on the ability of the individual. In general, disregarding uncertainty, a reduction in the sensitivity of earnings to ability makes an occupation more attractive to an individual with negative ability and less attractive to an individual with above zero ability. Uncertainty about ability will, however, affect the individual's reaction to changes in the sensitivity of earnings ability in the unfamiliar occupation. The ability level at which the individual finds that a reduction in ability sensitivity makes the unfamiliar occupation more or less attractive may thus differ from zero. If risk aversion is strong a reduction in ability sensitivity of the unfamiliar occupation will make that occupation more attractive also for moderately positive abilities because the reduction in return to expected ability is compensated for by the reduction in risk. If risk aversion is moderate, however, a reduction in ability sensitivity of the unfamiliar occupation makes that occupation less attractive for individuals with moderately negative ability because the reduction in risk does not compensate for the substantial loss in terms of expected earnings. In other words, the effect of solidarity wage policies on the mobility of people with different background will thus depend on the position of the cut off abilities. The position of the cut off abilities is, as we have seen, in turn determined by the degree of risk aversion, the relative wages and the difference in perceived sensitivity to ability.

A general feature is that for given parameter values, the cut-off abilities associated with equality of wage rates between occupations define the maximum mobility of $h-$people and the minimum mobility of $l-$people, given the assumption that $W_h \geq W_l$.

4.1. Introducing solidarity wage policy in the low return occupation.

Strong risk aversion With strong risk aversion, solidarity wage policy in the low return occupation will increase the mobility of the h-people since the marginal h-individual, who has low ability for the h-occupation, will find the low return occupation more attractive due to the reduction in uncertainty.

If the return to ability is sufficiently similar in both occupations, both h- and l-people will regard their family occupations as the most ability sensitive. Strong risk aversion then implies that only the least able of the l-people choose the unfamiliar occupation unless the wage is very much higher in the other occupation.[11] The marginal l-individual will thus have below zero ability and a reduction in the ability sensitivity of the l-occupation will, therefore, make that occupation more attractive. Hence, mobility declines even further. Within each occupation, average earnings will initially tend to be higher for those with family background in the occupation. Solidarity wage policy in the low return occupation will make average earnings of people from different background more equal in the l-occupation, but more unequal in the h-occupation.

If, on the other hand, the occupations are sufficiently different so that people of both backgrounds agree that the h-occupation is more ability sensitive, the most able of the l-people will opt for the h-occupation. The cut-off ability will be positive (and hence, mobility low) provided that the wage in the h-occupation is not sufficiently high. With positive cut-off ability, the marginal individual will find the l-occupation less attractive if its ability sensitivity decreases and mobility will therefore increase. With a negative cut-off ability (and high mobility) mobility will decrease. In this case, l-people will initially earn more on average than h-people in both occupations. Unless wages are very different (in which case effects are unclear because average earnings increase for all groups), background differences in average earnings will become smaller in both occupations.

Moderate risk aversion With moderate risk aversion the mobility of the h-people will be high because only the most able of the h-people will choose to stay in their family occupation unless the h-wage is very high. Solidarity wage policy in the l-occupation will thus make the l-occupation less attractive and reduce mobility of the h-people. If the wage is sufficiently much higher in the h-occupation, cut-off ability will, however, be so low that reduced ability sensitivity in the l-occupation makes it attractive to leave the family occupation.

[11] and this is perhaps not so likely if the occupations are very similar.

In a situation when the occupations are relatively similar, a minority, and only the most able of the l-people will choose to stay in their family occupation when risk aversion is moderate. The marginal individual will thus find that reduced ability sensitivity in the family occupation makes it less attractive and mobility will, therefore, increase as a result of solidarity wage policy in the l-occupation. When returns to ability are similar, the between background comparison of average earnings favor those who have stayed in their family occupation also in the case with moderate risk aversion. Solidarity wage policy in the low return occupation will, however, reduce between group earnings differences in the h-occupation and enhance differences in the l-occupation when wages are not too different. If wage differences are large, effects are unclear because average earnings increase for all groups.

If, however, the occupations are different and the l-people agree that the h-occupation is the more ability sensitive, it will still be the case that a majority opts for the h-occupation, but now those who choose to stay in the family occupation are the least able. Because cut-off ability is negative the marginal individual will benefit from a reduction in ability sensitivity and mobility will, therefore, decrease. If occupations are sufficiently different and risk aversion is moderate, average earnings in both occupations will be higher for h-people than for l-people. Solidarity wage policy in the low return occupation will tend to reduce between group earnings differences unless wages are very different in which case the effects are unclear, again because average earnings increase for all groups.

4.2. Introducing solidarity wage policy in the high return occupation.

Strong risk aversion When risk aversion is strong, a majority of the h-people will stick to their family occupation and cut off ability will thus be negative. This implies that reducing the sensitivity to ability in the h-occupation makes it more attractive to the marginal h-individual. Mobility therefore decreases.

If the occupations are similar so that the l-people perceive their family occupation to be the more ability intensive, the most able of the l-people will choose to stay in their family occupation. Unless the wage is sufficiently much higher in the h-occupation, the cut off ability will be low enough to make the marginal l-individual find the h-occupation more attractive as a result of reduced sensitivity to ability in that occupation. Hence, with strong risk aversion, mobility will increase. If, however, the wage is sufficiently high in the h-occupation,[12] mobility

[12] This may not be likely given that the occupations are similar.

will decrease because the rare few who choose to stay in the l-occupation are so able that they will not benefit from reduced ability intensity. As mentioned above, when occupations are similar, average earnings in an occupation are higher for people who have stayed in the family occupation. Solidarity wage policy in the high return occupation will make between group earnings differences larger in the l-occupation and smaller in the h-occupation.

In the case when occupations are different enough to make people of both background agree that the h-occupation is more ability sensitive, the most able of the l-people will choose the h-occupation. If the ability sensitivity is sufficiently much higher in the h-occupation while the h-wage is only moderately higher than the l-wage, the mobility of the l-people will decrease as a result of reduced ability sensitivity in the h-occupation, otherwise mobility will increase. If occupations are different, average earnings decline irrespective of background and occupational choice. The effect on between group earnings differences is thus unclear. If, however, the ability sensitivity is very much higher in the h-occupation while wages are not too different, between group earnings differences will increase.

Moderate risk aversion Turning to a situation when risk aversion is moderate we find that the mobility of the h-people will depend on how much the h-wage exceeds the l-wage. When wages are the same or when h-wage is moderately higher, the cut-off ability is positive and, hence, reducing the ability sensitivity in the family occupation will make the h-people more mobile. If the h-wage is sufficiently high, cut-off ability is negative and mobility will decrease since the reduced ability sensitivity makes the h-occupation more attractive to the marginal h-individual.

When the occupations are fairly similar, a minority and the most able of the l-people will chose the low return occupation. Cut-off ability is positive and, hence, a reduction in the ability sensitivity of the h-occupation will reduce mobility of the l-people. Solidarity wage policy in the h-occupation will make average earnings differences across people from different background smaller in the l-occupation and larger in the h-occupation unless wages are very different.[13]

If occupations are different enough for people of both backgrounds to view the h-occupation as the more ability intensive, a majority and the most able of the l-people will choose the h-occupation. As in the situation with strong risk aversion, mobility of the l-people will increase as a result of reduced ability sensitivity in

[13] In which case average earnings decrease regardless of background and occupational choice.

the h-occupation.[14] When people of both backgrounds regard the h-occupation as the more ability intensive and when wages are similar h-people will earn more on average in both occupations than l-people. If wages are not too different (and the difference in ability sensitivity not too large), solidarity wage policy in the h-occupation will enhance background differences in average earnings. If wages are sufficiently different, average earnings decrease for all groups.

4.3. Increasing the progressiveness of the tax system

Raising t has the same effect on mobility whether the returns to ability are similar or not. There will be a reduction of mobility of both l- and h-people who are moderately risk averse while strongly risk averse people will become more mobile, regardless of background. Regardless of attitude toward risk, background related earnings differences in both occupation will be reduced provided that the occupations are different enough. If the occupations are similar average earnings increase for all groups if risk aversion is strong and decrease for all groups if risk aversion is moderate. Thus, when occupations are similar, effects on average earnings of people from different background are not clear.

4.4. Demand and supply effects on talent allocation and mobility

So far we have not at all considered equilibrium effects of supply and demand for workers in the different occupations. If we assume a well functioning labor market where wages are set such that the labor market clears, the analysis is fairly straight forward. First, we should consider a situation where there for some reason, technological change, migration or other, is a shift in the supply or demand for one occupation. If such a shift leads to an increase or decrease in the relative wage in an occupation, people will, regardless of background, to a larger extent choose the occupation with the increased relative wage. People of different background will, however, not react equally much. The reason being that the effects on cut off abilities differ, as well as do the initial cut off abilities. Second, if markets are to clear, the type of policies discussed in the previous section which affect the total number of people choosing an occupation will also affect wage rates.

To give an example of what would happen in the case of a positive demand shift in one occupation or in the case of a policy shifting people out of an occupation,

[14] This is the case unless the ability sensitivity is sufficiently much higher in the h-occupation while the h-wage is only moderatly higher than the l-wage.

consider the following. If the wage in occupation j increases as a result of a increased demand for people in occupation j (or as a result of a policy that had shifted people out of occupation j), cut off abilities of both j and i-people will be affected.[15]

Increasing w_j always make j-people less mobile and i-people more mobile. Depending on the initial cut off abilities, average earnings of people of different background will become more or less different.

5. Conclusions and Discussion

We have analyzed the role of family background for occupational choice and the implications for intergenerational mobility of changes in the incentive structure. Our analysis sheds light on the recent Swedish debate about the importance of economic incentives for educational and occupational choices of children from different social background. The results show that policy makers interested in equality of opportunity, need to carefully consider the incentive effects of redistributive policies. We show that even if occupational choices are free in the sense that human capital investments are costless, uncertainty about ability to make it in an unfamiliar occupation is enough to make family background influence talent allocation and earnings. Therefore, equality of outcome in the parent generation or free education do not guarantee that there will be equality of opportunity in the young generation.

We can further conclude that there is no simple answer to the question posed in the title of this paper: Does wage equality nail the cobbler to his last? Thus, our analysis provides no whole hearted support for increased wage dispersion as a means to increase the efficiency of the talent allocation through improved mobility. Whether there is a trade off between redistributive policies and intergenerational mobility depends on a number of factors.

In general, we find that upward mobility increases with the size of the wage gap between occupations, regardless of risk aversion. Total mobility, however, depends on the degree of risk aversion. Total mobility is higher if wage differences are large between different occupations than if wages are equal when risk aversion is strong, but if risk aversion is moderate, total mobility is highest when the wage gap between occupations is small.

[15] The derivatives of the cut off abilities are respectively: $\frac{\partial \alpha_j}{\partial w_j} = \frac{1}{-w_j(\beta_j - \rho\beta_i)} \gtrless 0$ if $\beta_j - \rho\beta_i \lesseqgtr 0$ and $\frac{\partial \alpha_i}{\partial w_j} = \frac{1}{w_j(\beta_i - \rho\beta_j)} \gtrless 0$ if $\beta_i - \rho\beta_j \gtrless 0$.

In the analysis of the effects of redistribution, we looked at two forms of solidarity wage policy, a) wage compression in the low returns to ability occupation and b) wage compression in the high returns to ability occupation. We also analyzed the effects of a welfare system which redistributes both within and across occupations at the same time.

We find that wage compression in the low returns to ability occupation leads to increases in upward as well as total mobility provided that risk aversion is strong and wage rates are not too different. The reason for this is that wage compression in the low return occupation makes the low return occupation less attractive to the marginal individual with family background in the low return occupation because their ability is above average. Wage compression thus reduces their productivity in the low return occupation. If the marginal individual with background in the high returns to ability occupation has below average ability, wage compression in the low return occupation makes it more attractive to be mobile.

If risk aversion is moderate, compressing earnings in the low return occupation always reduces upward mobility. It is also the case that total mobility is reduced provided wage rates are similar. The reason for this reduced mobility is that when the marginal individual has below average ability, as is the case for people with low returns to ability background and moderate risk aversion, a compression of wages in the low returns to ability occupation makes it more attractive to stick to the low returns to ability occupation. When the marginal individual with background in the high returns to ability occupation has above average ability, wage compression in the low returns to ability occupation will make it more attractive to stick to the high returns to ability occupation.

A compression of wages in the high return occupation increases upward mobility regardless of risk aversion if occupations differ sufficiently in terms of wage rates. The reason for this is that due the large wage difference also below average ability people choose the high return occupation. A reduction in ability sensitivity will therefore make the high return occupation more attractive to the marginal individual. If, however, wage rates are similar and ability sensitivities differ a lot, upward mobility will decline if wages in the high returns to ability occupation are compressed. This result implies that an increase in the sensitivity of earnings to ability in an occupation which is already very ability sensitive and in which earnings are mediocre for the mediocre talent, will attract upward mobility into the occupation. The effects on total mobility of wage compression in the high return occupation are, in general, ambiguous.

The effects on mobility of a redistributive welfare system are more straight forward. If risk aversion is moderate, people become less mobile with the introduction of a redistributive welfare system because there will be less to gain by taking chances and hoping for high ability to work in the unfamiliar occupation. If risk aversion is strong, people become more mobile since the welfare system acts as an insurance against bad outcomes if the unfamiliar occupation is chosen.

In summary, the results in this paper imply that increased wage dispersion between occupations is positive for upward mobility, although not necessarily for total mobility. Increased wage dispersion within occupations, on the other hand, does not necessarily increase upward mobility. Increased wage dispersion within the high return occupations will result in less upward mobility, except into extreme return occupations like golf or tennis. Increased wage dispersion in the low return occupation, will however, act as a push effect on people and increase upward mobility if people are moderately risk averse or if they are strongly risk averse and the wage in the high return occupation is sufficiently much higher than in the low return occupation.

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6.

The expected value in the unfamiliar occupation is:

$$E\left[V_u\right] = \frac{1}{1-\gamma}\int_{-\infty}^{\infty}(w_u A_u^{\beta_u})^{1-\gamma} f(a_u \mid a_f) da_u. \tag{0.7}$$

Given the utility function and the conditional distribution function we have

$$E\left[V_u\right] = \frac{{W_u}^{1-\gamma}}{(1-\gamma)\sqrt{2\pi(1-\rho^2)}}\int_{-\infty}^{\infty}(A_u^{\beta_u})^{1-\gamma}\exp\left\{-\frac{1}{2(1-\rho^2)}(a_u-\rho a_f)^2\right\} da_u. \tag{0.8}$$

Because $(A_u^{\beta_u})^{1-\gamma} = \exp\left\{(1-\gamma)\beta_u a_u\right\}$ we can write the integral:

$$I = \int_{-\infty}^{\infty}\exp\left\{\frac{2(1-\rho^2)(1-\gamma)\beta_u a_u - (a_u-\rho a_f)^2}{2(1-\rho^2)}\right\} da_u. \tag{0.9}$$

separating out terms which do not contain the integrand we can write the integral

$$I = \int_{-\infty}^{\infty}\exp\left\{\frac{-(\rho a_f)^2}{2(1-\rho^2)}\right\}\exp\left\{\frac{-a_u^2 + 2[(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f]a_u}{2(1-\rho^2)}\right\} da_u. \tag{0.10}$$

We can complete the square in the second exponent by multiplying and dividing by

$\exp\left\{\frac{-[(1-\rho^2)(1-\gamma)\beta_{u1+}\rho a_f]^2}{2(1-\rho^2)}\right\}$ in the second and first exponent respectively:

$$\begin{aligned} I \;=\; & \int_{-\infty}^{\infty}\exp\left\{\frac{[(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f]^2 - (\rho a_f)^2}{2(1-\rho^2)}\right\} \\ & \exp\left\{\frac{-a_u^2 + 2[(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f] - [(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f]^2}{2(1-\rho^2)}\right\} da_u, \end{aligned} \tag{0.11}$$

which we can simplify to:

$$I = \int_{-\infty}^{\infty} \exp\left\{\frac{[(1-\rho^2)(1-\gamma)\beta_u]^2 + 2(\rho a_f)(1-\rho^2)(1-\gamma)\beta_u}{2(1-\rho^2)}\right\} \quad (0.12)$$
$$\exp\left\{\frac{-(a_u + [(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f])^2}{2(1-\rho^2)}\right\}.$$

Moving the first exponent out of the integral gives us:

$$E[V_u] = \gamma\frac{{W_u}^{1-\gamma}}{(1-\gamma)}\exp\left\{(1-\rho^2)(1-\gamma)^2\frac{\beta_u^2}{2} + \rho a_f(1-\gamma)\beta_u\right\} \quad (0.13)$$
$$\frac{1}{\sqrt{2\pi(1-\rho^2)}}\int_{-\infty}^{\infty}\exp\left\{\frac{-(a_u + [(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f])^2}{2(1-\rho^2)}\right\}da_u.$$

We can now use the fact that $\frac{1}{\sqrt{2\pi(1-\rho^2)}}\int_{-\infty}^{\infty}\exp\left\{\frac{-(a_u+[(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f])^2}{2(1-\rho^2)}\right\}da_u$ is the integral of a normal distribution with mean $[(1-\rho^2)(1-\gamma)\beta_{u+}\rho a_f]$ and variance $(1-\rho^2)$. The integral from -∞ to ∞ of a normal distribution is always equal to one. This gives us:

$$E[V_u] = \frac{{W_u}^{1-\gamma}}{(1-\gamma)}\exp\left\{(1-\rho^2)(1-\gamma)^2\frac{\beta_u^2}{2} + \rho a_f(1-\gamma)\beta_u\right\}, \quad (0.14)$$

which we can rewrite as:

$$E[U_u] = \frac{1}{(1-\gamma)}\left(W_u A_f^{\beta_u\rho}e^{\frac{\beta_u^2}{2}(1-\rho^2)(1-\gamma)}\right)^{1-\gamma}. \quad (0.15)$$