Wage Dispersion, Over-Qualification, and Reder Competition

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The expansion of higher education in the Western countries has been accompanied by a marked widening of wage differentials and increasing over-qualification. While the increase in wage differentials has been attributed to skill-biased technological change that made advanced skills scarce, this explanation does not fit well with the observed increase in over-qualification which suggests that advanced skills are in excess supply. By "Reder-competition" I refer to the simultaneous adjustment of wage offers and hiring standards in response to changing labor market conditions. I present a simple model of Reder competition that gives sees wages driven by labor heterogeneity, rather than scarcity, and may give rise to a simultaneous increase in wage differentials and over-education.

Keywords: Hiring standards, employment criteria, selection wages, efficiency wages, mobility, skill-biased technological change, over-education, wage dispersion, Reder competition
Journal of Economic Literature Classification: J31, J63, D43

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Introduction

Over the recent decades, labor market researchers have noticed two trends which, if taken together, pose a challenge to conventional theorizing: Wage dispersion grew significantly, and over-qualification increased as well. I do not want to review these findings here, nor discuss the endemic data problems. My intention is to just stipulate these trends and focus on the implied theoretical issue.

While the joint occurrence of widening skill margins and over-qualification does not fit well with the standard framework of wage competition, it flows rather naturally from a more institutional view of labor market processes, which builds on Melvin Reder's (1955) analysis and will termed "Reder competition."[1]

The paper is organized as follows: Section 1 reviews some empirical findings concerning wage inequality and over-qualification. Section 2 introduces the concept of Reder competition. The subsequent Sections 3 to 4 present a very simple model of Reder competition in order to illustrate the concept. The model is used in the remaining Sections 5 to 11 to trace the joint occurrence of wage dispersion and over-qualification to factors such as labor heterogeneity, skill latitude, labor mobility, and non-labor costs. It is urged that the evidence cited for skill biased technical change can be interpreted to a great extent as evidence for an increasing importance of labor heterogeneity, "heterogeneity-biased technological change," so to speak. Such technological change would induce the observed joint trends in wage dispersion and over-education.

[1] I use the term "Reder competition" for lack of a better label. In view if Stigler's (1980) Law of Eponymy ("No scientific discovery is named after its original discoverer"), a non-eponymic label would be preferable, but maybe this is a case where Stigler's Law is refuted.
The argument presented in this paper is closely related to Skott's (2006) theory that explains the joint occurrence of over-qualification and inequality in terms of discipline efficiency wages. Let me add a slightly technical aside: While standard efficiency wage theory views excess supply in a labor market as stabilizing the wage level in that market for given product prices, the present note shows that such equilibration may be brought about by changes in the share of labor costs in total production costs, as induced by wage changes

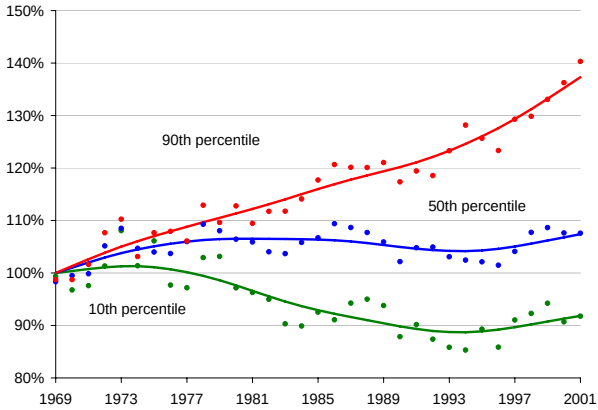


Figure 1: Wage dispersion in the US 1969-2001. (Data from Nikutowski (2006, 18)).

1 *Wage Dispersion and Over-Qualification*

In many western countries, a pronounced increase in wage dispersion has been observed: Wages in the lower tiers of the wage distribution rose considerably less than those in the upper rungs. This development is illustrated in Figures 1 (for the US) and 2 (for Germany). During the same time, an increase in "over-qualification" or "over-education" has been observed in many industrialized countries: An increasing number of workers hold jobs that require considerably less qualification than they have received. These trends are illustrated in Figures 3 (for the US) and 4 (for Germany).

It is to be noted that the both trends materialized simultaneously in a period when educational systems expanded dramatically, entailing a better skilled workforce. With unchanging labor demand, standard theory would have predicted wage inequality to diminish rather than increase. As a rationalization of this development, "skill biased technological change" has been invoked. In the words of Acemoglu (2002, 2): "The recent consensus is that technical change favors more skilled workers, replaces tasks previously performed by the unskilled, and exacerbates inequality." This explanation in

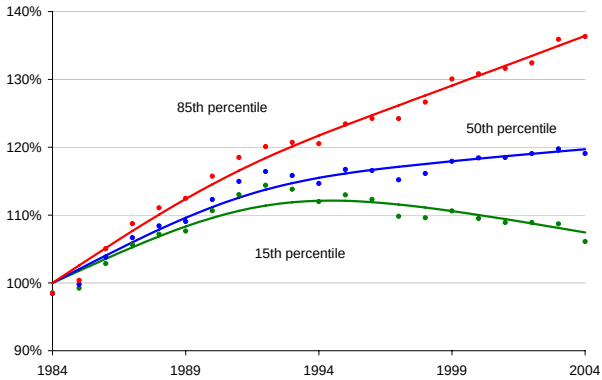


Figure 2: Wage dispersion in Germany 1984-2001. (Source: IAB, preliminary).

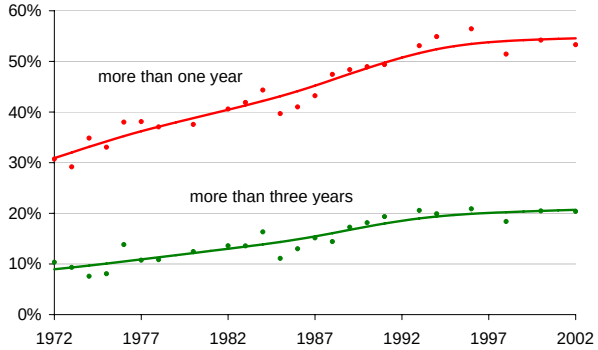
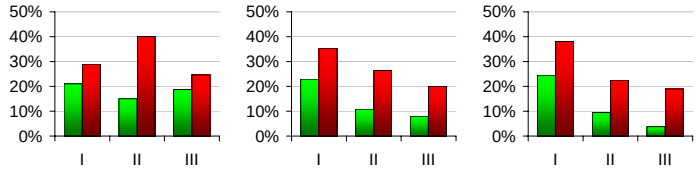


Figure 3: Over-qualification in the US. (Data from Vaisey (2006), based on "objective" indicators.)



(a) younger than 30 (b) between 30 and 49 (c) older than 50

Figure 4: Over-qualification male, 1979 (left column of each pair) and 1998/99 (right column of each pair) for different skill and age groups. (I: basic qualification, II: professional qualification, III: university qualification. Data from Laszlo (2002), based on employees' assessment.)

terms of increasing scarcity of advanced skills is not easily to reconcile, however, with "evidence that a substantial—and growing—number of American workers are overqualified for their jobs," and that "in 1979 one in four workers thought that they could be replaced by less qualified workers, twenty years later one in three workers held that opinion."[1] Seen from a conventional perspective, this would suggest an increasing oversupply, rather than a shortage of skills.[2] Another interpretation is possible, however, and will be outlined in the following sections.

2 *Reder Competition*

We consider labor markets that are characterized by the joint occurrence of the following features:

- Workers are heterogeneous.
- Jobs exhibit skill latitude

[1] Vaisey (2006, 855) and Laszlo (2002, 33, my translation), respectively. [2] Some researchers, such as Green *et al.* (2002) find no significantly rising trend in over-qualification, in spite of education inflation, yet with increasing shortage of advanced skills the conventional view would suggest a declining trend in over-qualification.

- Workers are imperfectly mobile.
- Firms pay job-specific wages.
- There is wage compression.

Workers are *heterogeneous* because they differ in many economically relevant attributes, like experience, trainability, skill, work attitudes, and preferences. If labor were homogeneous and previous work experience did not matter, any worker could easily be replaced by another one, and labor markets would be akin to spot markets, with firms hiring the services of workers for some days just as needed, rather than for prolonged periods, which is characteristic for modern labor markets. Without heterogeneity, we would observe neither long-term contracts, nor any screening of applicants, nor training, and perhaps not even firms as we know them. In contrast, modern labor markets are characterized by heterogeneity of labor.

We shall assume also that the jobs under discussion exhibit *skill latitude* in the sense that the productivity of a job depends on the skill of the worker doing this job, rather than being independent of the worker's performance as long as some minimum skill requirements are met. A job on a production line would exhibit little latitude, while the job of a sales representative would offer much skill latitude in the sense that different workers may work in such a job with quite different success. If there is skill latitude, labor heterogeneity matters, as different workers can do the same job, but cannot do it equally well.[1]

Further, workers are *imperfectly mobile* because they cannot move costlessly from one location to another, or are not willing to do so unless wage differentials are glaring. With perfect mobility, perfect sorting of workers would be conceivable, even in presence of labor heterogeneity and skill

[1] Smith (1904, v.i.178) drew already attention to the effect of technical progress on skill latitude when discussing the consequences of the introduction of firearms. He conjectured that technical progress would diminish skill latitude, whereas the position taken in this paper amounts to the thesis that technical progress enlarges skill latitude, more in line with Marshall (1920, iv.ix.9). But regardless of which thesis will ultimately turn out to be correct, it is of interest to analyze the effect of changes in skill latitude on wage formation. This note seeks to contribute to this question.

latitude, but this is not what we observe. Because there is imperfect mobility, heterogeneity and skill latitude are economically important.

Job-specific wages refer to wages that are fixed according to a wage-setting policy, rather than by individual bargaining. Examples for job-specific pay would be a pure time rate paid to all workers performing a certain job, or a piece rate, or a seniority system, or an incentive system like the *Taylor plan* or the *Halsey 50-50 plan.*[1]

Wage compression refers to the empirical regularity that firms, given their wage policies, prefer better workers to poorer workers for any given job. This implies that more productive workers are relatively underpaid, compared to less productive workers holding the same job.[2]

With labor heterogeneity and skill latitude, the same job can be performed by workers with different ability, albeit with different perfection, and any worker meeting some minimum requirements is, in principle, employable. Firms very obviously distinguish between "good" and "bad" employees. This is a clear indication that labor heterogeneity and skill latitude are actually encountered in most firms.

When looking for workers, firms face a heterogeneous labor supply. They prefer the best applicants and thus face a trade-off between the wage they offer and the quality of workers they can hire: The better the wage offer,

[1] For actual wage-setting practices, see any textbook on compensation, such as Milkovich and Newman (1999).

[2] Frazis and Loewenstein (2006, 3) find that "only 32 percent of differences in starting productivity are reflected in differences in starting wages," and that "productivity growth of 10 percent results in wage growth of only 2.9 per cent. See also Frank (1984), Bishop (1987), and Bewley (1999, 85). Further, the studies by Bishop and by Franzis and Loewenstein are merely concerned with the relationship between wages and "productivity" in a quite narrow sense: Employers have rated workers on a "productivity scale of zero to one hundred, where one hundred equals the maximum productivity any of your employees can attain and zero is absolutely no productivity." Wage compression, in their sense, refers to the wage ratios being below the productivity ratios, determined this way. Even if the authors would have found that there is no wage compression in their sense, there would be very substantial wage compression in the Marshallian sense, which is the relevant sense in our context. Marshall (1920, vi.iii.13) pointed this out as follows: "The corrected law then stands that the tendency of economic freedom and enterprise is generally to equalize efficiency-earnings in the same district: but where much expensive fixed capital is used, it would be to the advantage of the employer to raise the time-earnings of the more efficient workers more than in proportion to their efficiency."
The Appendix provides some further theoretical discussion relating to wage compression.

the more applicants will be available, and the more demanding can be the hiring standard implemented, entailing a more productive work force. The wage rate and the hiring standard must be conceived as determined simultaneously by the firms' optimizing against the trade-off between the wage level and the hiring standard.

In order to fix ideas, we may conceive two extreme forms of labor market clearing:

- *Wage competition:* For a given hiring standard, the market may be cleared by adjusting the wage rate
- *Job competition:* For a given wage rate, the labor market may be cleared by adjusting the hiring standard.

The view of wage competition–*viz.* treating labor markets in analogy to product markets–dominates contemporary labor market analysis. The other extreme, job competition, has been used by a minority of labor economists, following Lester Thurow (1975). Both views are incomplete. Labor markets characterized by skill latitude are best analyzed in terms of a combination of both extremes: Wages offers and hiring standards are determined simultaneously in response to market conditions. This is the type of labor market competition Reder (1955) has envisaged, and will be labeled accordingly:

- *Reder competition*: Labor markets are cleared by simultaneous adjustments of wages and hiring standards (and possibly other parameters).

Reder competition can not usefully be analyzed, however, by simply combining the views of wage competition and job competition, *viz.* by first treating the hiring standard as given and analyze wage formation, and then take wages as given and consider the adjustment of hiring standards. Such *ceteris paribus* treatment would fade out the interdependence of both mechanisms, and that wages are fixed in order to implement a hiring standard, and hiring

standards require a corresponding wage policy.[1] The following analysis focuses on the interdependence of hiring standards and wage setting.[2]

3 *Selection Wages*

In presence of labor heterogeneity in conjunction with skill latitude, different workers can perform a given job with different productivity while their pay does not reflect productivity differentials fully. This setting induces firms to offer wages in order to control the productivity of their work force. The market wages that arise from the interaction of firms engaging in this kind of wage setting are termed "selection wages." This section illustrates the idea in a simple case.[3]

To capture labor heterogeneity and skill latitude, we consider just two grades of labor, *prolific* and *mediocre.* Both types of workers, the mediocre and the prolific, can perform the task under consideration, but with different efficiency: The prolific workers are more productive. Firms can distinguish the types costlessly when they hire them. Further we assume that the alternative employment for both types of workers is such that individual productivity differences do not matter—think of a conveyor belt. Their wage in this standardized employment functions as a reservation wage (alternative wage) for the labor market under consideration. It is denoted by R.[4]

[1] See Schlicht (1985, Ch. 2) for a pertinent methodological discussion. [2] The interdependency between wages and hiring standards is also in voked more recently by Mortensen (1970). Note that Reder (1964) has augmented the wage/hiring standard trade-off described in Reder (1955) by adding a further parameter, the vacancy rate, to the analysis, but this line of argument is not pursued here and in the following for reasons of simplicity. [3] Selection wages are a variety of efficiency wages, see Schlicht (1978, 2005). They are closely akin to self-selection wages studied by Weiss (1980), but do not presuppose asymmetry of information. [4] This assumption can easily be relaxed in the sense that we may allow different reservation wages for both types of workers, as any equilibrium wage exceeding R will turn out to be independent of R.

To capture wage compression, we assume first that firms pay the same wage to mediocre and prolific workers.[5]

While firms prefer to employ only prolific workers, not enough of them are available to produce the output demanded. Hence firms have to hire also mediocre workers. Firms can, however, increase the number of applicants—and also in particular of prolific applicants—by offering a wage above the going market rate. This would enable them to increase the share of prolific workers in their work force and and enjoy higher productivity, but at the expense of higher labor costs.

We will assume here that all workers performing the job under consideration receive the same wage, regardless of their productivity. This captures, in the simplest form, the idea that wage differentials do not reflect productivity differentials fully—they don't reflect them at all. At the same time, the assumption captures the empirically relevant case of a wage without a performance component.[1]

Consider, thus, an industry composed of a number of identical firms that operate under free entry and produce a certain good. Firm size is fixed in the sense that each firm can employ just n workers, regardless of whether they are mediocre or prolific.

The prolific workers have productivity x, and the mediocre workers have productivity $y < x$. Denote by q the fraction of prolific workers and by the remainder $(1 - q)$ the fraction of mediocre workers in the work force. We shall refer to q as the *quality mix* of the workforce. As firms can assess the productivity of the applicants, they will hire all prolific workers who apply and fill the remaining job openings with mediocre applicants.[2]

Given the fraction of prolific workers q in the market with productivity

[5] Note that this not uncommon practice: In Bishop's (1987, S42) sample, 56 percent of the plant workers and 14 percent of the office workers received performance-unrelated pay. In the appendix it is shown that the effects that will be derived under the flat-pay assumption will remain valid for performance pay as long as wage compression obtains. [1] For some further observations, see the appendix on wage compression below. [2] As there is no continuum of different workers with different productivity, firms cannot impose a hiring standard in this extremely simple setting, but the fundamental selection wage mechanism still applies: By increasing the wage offer, firms can attain a higher productivity of their work force, as they attracting more prolific workers. For an analysis of the continuous case and the market determination of hiring standards, see Schlicht (2005).

x and the fraction of mediocre workers $(1-q)$ with productivity $y < x$, average productivity of the work force under consideration is

$$a = q \cdot x + (1-q) \cdot y. \tag{1}$$

The average productivity of a firm's work force may deviate from average market productivity a if the share of prolific workers in a firm differs from the market average. Denote the share of prolific workers enjoyed by the firm under consideration by ρ. The entailed productivity of the firm's work force is

$$\begin{aligned} \alpha &= \rho \cdot x + (1-\rho) \cdot y \\ &= \rho\,(x-y) + y. \end{aligned} \tag{2}$$

The share of prolific workers in the firm's workforce ρ will depend in turn on the wage offer w the firm makes, as compared to the going market wage rate W. If the firm pays above the market wage $(w > W)$, it will attract more prolific applicants and need hire only fewer mediocre workers. If the firm offers a wage below the market wage $(w < W)$, it will find fewer prolific applicants and has to hire more mediocre workers. This idea can be expressed by

$$\rho = q \cdot \left(1 + \mu \cdot \log\left(\frac{w}{W}\right)\right) \tag{3}$$

where the constant $1 > \mu > 0$ parametrizes *mobility*. It gives the elasticity of qualification for a typical firm in response to its wage offer:[1]

$$\mu = \left.\frac{\partial \rho}{\partial w} \cdot \frac{w}{\rho}\right|_{w=W}.$$

Equations (2) and (3) imply

$$\alpha = q \cdot \left(1 + \mu \cdot \log\left(\frac{w}{W}\right)\right) \cdot (x-y) + y. \tag{4}$$

[1] We exclude $\mu \geq 1$ because it would be always optimal to pay maximum wages in this case, and the selection effect would not apply in any interesting way. The formulation (3) is selected for reasons of simplicity of exposition. A more general formulation such as $\rho = q \cdot f\left(\frac{w}{W}\right)$ with $f(1) = 1$, $f' > 0$, and $f'' < 0$ would not change the argument or the results.

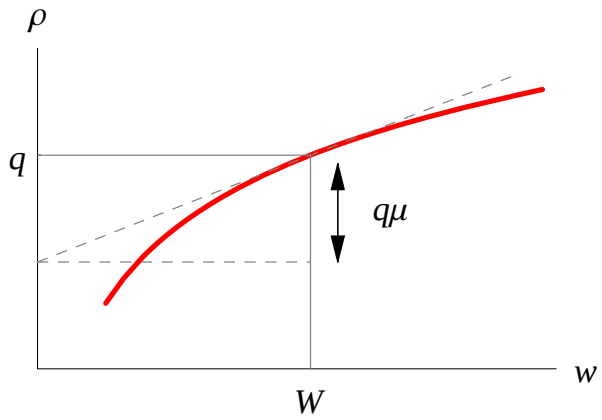


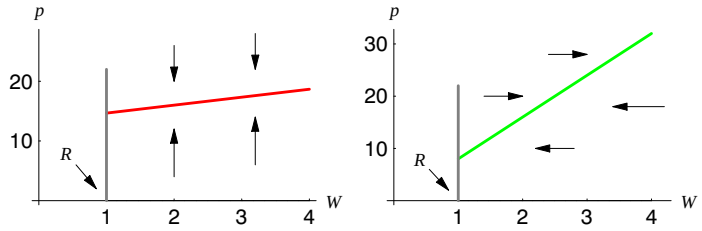
Figure 5: The share ρ of prolific workers in a typical firm as a function of the wage offer w. If the wage offer is equal to the market wage ($w = W$) , the share of prolific workers in the firm will be equal to the market share ($\rho = q$).

The industry is composed of a number of firms. Each firm has to invest in establishing a workshop for n workers. The capital outlays induce capital user costs (including normal profits) of C. With productivity α, a firm's production will be $\alpha \cdot n$. For a product price p, sales returns will be $p \cdot \alpha \cdot n$. With a wage rate w, the firm incurs labor costs $w \cdot n$. Further, it has to cover capital user costs C. The firm's profits will thus be equal to $\Pi = p \cdot \alpha \cdot n - w \cdot n - C$.[1]

For the subsequent argument it is convenient to express profits of the typical firm in per-capita terms. Denoting per-capita capital user costs by $c = \frac{1}{n}C$, these per-capita profits are given by

$$\pi \quad = \quad p \cdot \alpha - w - c$$

[1] For simplicity, other non-labor costs are neglected here. This simplification does not affect the argument nor the results. In order to take outlays for variable inputs into account, interpret p as the market price of the product *minus* the outlays for other factors of production per piece.



(a) zero profit (b) selection wage

Figure 6: The zero profit curve (a) gives all (W, p)-combinations where the zero-profit condition (6) is satisfied. The selection wage curve (b) gives all (W, p)-combinations where condition (9) is met.The parameters used are $x = 1,\ y = .5,\ q = .5,\ c = 10, \mu = .5$ and $R = 1$.
The parameters used are $x = 1,\ y = .5,\ q = .5,\ c = 10,$ $\mu = .5$ and $R = 1$.

$$= \quad p \cdot \left(q \cdot \left(1 + \mu \cdot \log\left(\frac{w}{W} \right) \right) \cdot (x - y) + y \right) - w - c. \qquad (5)$$

Consider now market equilibrium. As all firms are alike, all firms will pay the same wage rate w which can be identified with the market wage rate W. Equilibrium requires two things: First, per-capita profits must be zero. Otherwise there would be market entry or market exit, changing conditions of supply and demand. Second, it must be optimal for each firm to set its wage rate w equal to the market wage rate W. Else the market wage rate would change.

The zero-profit condition at $w = W$ is equivalent to

$$p = \frac{W + c}{q \cdot (x - y) + y}. \qquad (6)$$

This condition is depicted as the "zero profit" curve in Figure 6(a). Above that curve, there are positive profits that induce market entry and reduce the price level, below there will be losses and market exit, driving the product

price up.[1] As the minimum market wage is given by the reservation wage R, the zero profit curve is of relevance only for wage levels exceeding the reservation wage.

The conditions for a profit maximum with respect to w are

$$\frac{\partial \pi}{\partial w} = p \cdot q \cdot \mu \cdot (x - y) \frac{1}{w} - 1 = 0 \tag{7}$$

$$\frac{\partial^2 \pi}{\partial w^2} = -p \cdot q \cdot \mu \cdot (x - y) \frac{1}{w^2} < 0. \tag{8}$$

As the second-order condition (8) is always satisfied, the first-order condition (7) guarantees a profit maximum (if a maximum exists at all). At $w = W$, equation (7) implies

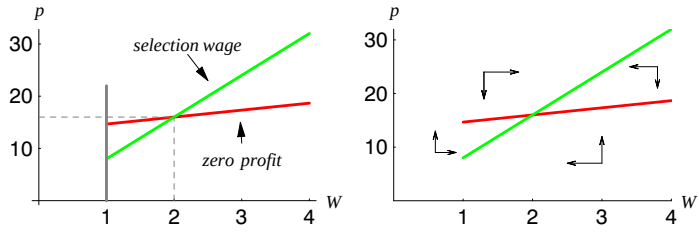
$$p = \frac{W}{q \cdot \mu \cdot (x - y)}. \tag{9}$$

We denote this equation as the "selection wage equation." Its graphical representation is termed the selection wage curve and is depicted in Figure 6(b). The selection wage curve gives, for any wage level W, that price level that makes it optimal for the individual firm to set its wage w just equal to to market wage W. Above this curve, the derivative $\frac{\partial \pi}{\partial w}$ in (7) is positive at $w = W$. The typical firm will therefore set its wage above the market wage ($w > W$). This will drive the market wage up. Below this curve, we will have $\frac{\partial \pi}{\partial w} < 0$ at $w = W$, and the typical firm will set $w < W$. This will drive the market wage down.[1]

The crossing of the two curves gives the equilibrium combination of the wage level and the product price. Algebraically equations (6) and (9) can be solved for the equilibrium market wage rate and the equilibrium price. The

[1] If there is market entry, this will not only increase production, but also employment. This increase comes about through the employment of mediocre workers (as all prolific workers are already employed). This will reduce q and thereby shift the zero-profit curve up. This effect would not affect our conclusions but is neglected here in order to keep the argument simple.

[1] The selection wage is a special case of what Stiglitz (1973, 290) hast termed an "efficiency wage." This modern usage of the term "efficiency wage" refers to the wage rate, set by the firm, that minimizes the Marshallian efficiency-wage.



(a) equilibrium (b) phase diagram

Figure 7: (a) Market equilibrium is obtained where the zero profit curve and the selection wage curve cross. The phase diagram (b) indicates stability. (Parameter values as in Figure 6. Equilibrium is at $W = 2$ and $p = 16$.)

equilibrium wage rate—which will be called the "selection wage"—is

$$\bar{W} = \frac{\mu q\,(x-y)}{q\,(x-y)\,(1-\mu)+y} \cdot c \tag{10}$$

and the corresponding equilibrium price is

$$\bar{p} = \frac{c}{q\,(x-y)\,(1-\mu)+y}. \tag{11}$$

The equilibrium will be feasible only if the equilibrium wage $\bar{W}$ exceeds the reservation wage R of the workers. Otherwise the firms have to maximize their profits (5) under the additional constraint $w \geq R$, and would set $w = R$, entailing a market wage level $W = R$ as would be expected with wage competition. The case of interest here (and where the wage competition mechanism is not applicable) relates to the reservation wage being the selection wage. If this is the case, changes in the reservation wage would not affect the equilibrium wage (which is the selection wage) and the equilibrium price level. This is an obvious deviation from the results that would be obtained from a model of wage competition.

4 Stability

The phase diagram given in Figure 7 indicates stability. Another way to see this is the following. Assume that the prevailing wage level W initially differs from the equilibrium wage level $\bar{W}$. By combining (6) and (7), we obtain the profit-maximizing wage level w for the typical firm as

$$w = \frac{\mu\,(x-y)\,q}{(x-y)\,q+y}\,(W+c)$$

which implies together with (6) and (10)

$$w - W = -\frac{(1-\mu)\,(x-y)\,q+y}{(x-y)\,q+y}\left(W-\bar{W}\right). \tag{12}$$

If the wage level is above the equilibrium wage level ($W > \bar{W}$), each firm will set its wage w below the market wage level W. This drives the market wage level down until the equilibrium wage level is reached. Conversely, for $W < \bar{W}$ the firms set $w > W$. This drives the wage level up to $\bar{W}$. This establishes stability of adjustment. The graph of equation (12) is depicted in Figure and the direction of adjustment is indicated.[1]

Further, the equilibrium would be unstable if the wage rate exceeded the marginal value product of a mediocre worker. If this were the case it would be profitable for any firm to leave all jobs unmanned that cannot be filled with prolific workers. This condition is $p \cdot x > W$. Together with (10) and (11) it can be equivalently stated as

$$x > \frac{\mu q}{1-\mu q} \qquad or \qquad \mu q < \frac{x}{1+x}. \tag{13}$$

If the productivity x of the mediocre workers is too low, it would not be worthwhile to employ them. If mobility is high, the equilibrium wage level

[1] A formal analysis would proceed as follows. Denote denote the zero profit curve by $p = a + bW$ and the selection wage curve by $p = c + dW$ with $a > c$ and $b < d$. The differential equation system $\dot{p} = \kappa\,(a + bW - p)$, $\dot{W} = \lambda\left(\frac{p-c}{d} - W\right)$ describes, for some positive speed parameters κ and λ, the adjustment described in the text. Its Jacobian $\begin{pmatrix} -\kappa & \kappa b \\ \frac{\lambda}{d} & -\lambda \end{pmatrix}$ has a negative trace and a positive determinant. This establishes stability.

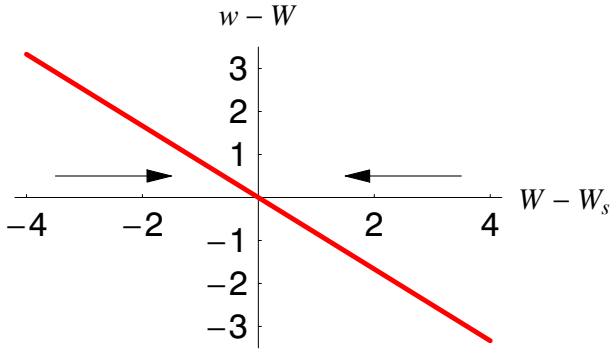


Figure 8: If the market wage W is above the equilibrium wage $\bar{W}$, the typical firm will set its wage offer w below the market wage W (point A). This drives the market wage down. Conversely, $W < \bar{W}$ induces $w > W$, and this drives the market wage up until equilibrium is reached and $w = W = \bar{W}$ obtains. (Parameters as in Figure 6.)

$\bar{W}$ would be high, and mediocre workers were too expensive to employ. The same would hold true if the ratio of prolific workers in the work force were too high.[1]

5 *Increasing Heterogeneity and Latitude*

Consider an increase of worker heterogeneity and skill latitude, in the sense that the productivity differential between prolific and mediocre workers increases while average labor productivity remains constant. We may formalize this by introducing a heterogeneity parameter h such that an increase in h increases the difference $(x - y)$ but leaves average productivity $qx + (1 - q)\, y$ unchanged. If we write the productivities x and y as functions of h, these

[1] Condition (13) is satisfied for the parameter values given in Figure 6. This establishes the possibility of such solutions.

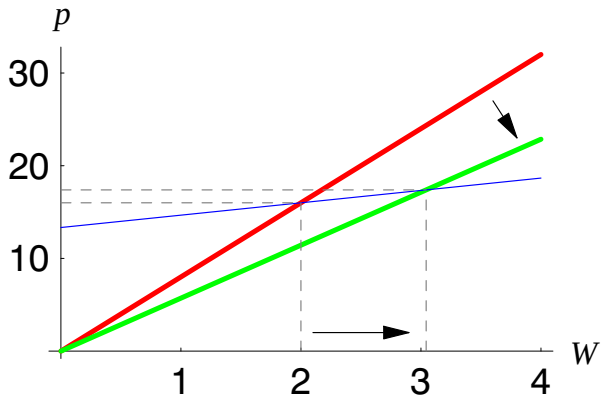


Figure 9: An increase in heterogeneity reduces the slope of the selection wage curve while leaving the zero-profit condition unaffected. As a result, the equilibrium wage level and the equilibrium price level increase. (Parameters as in Figure 6, with x increased from 1 to 1.1 and y decreased from .5 to .4. The equilibrium wage level increases from 2 to 3 and the equilibrium price increases from 16 to 17.4 .)

functions must satisfy $q \cdot x'(h) + (1-q) \cdot y'(h) = 0$ and we can stipulate

$$x' > 0, \; y' = -\frac{q}{1-q} x' < 0.$$

An increase in heterogeneity h means that the productivity of the prolific workers increases and the productivity of the mediocre workers decreases while average productivity remains unaffected.

As average productivity remains unaffected, the zero-profit constraint (6) is not changed. Yet increasing heterogeneity enlarges the difference $(x - y)$. This decreases the slope of the selection wage curve. As a consequence, the equilibrium wage rate and the equilibrium price level increase (Figure 9).

The intuition for this result is that the selection wage aspect of wage setting becomes more important if heterogeneity increases. This induces firms to raise the wage level. In the aggregate this raises costs and prices.

6 *Changes in the Quality Mix*

Another aspect of wage formation is captured by the proportion q of prolific workers in the workforce. Consider the effect of an increase in the number of prolific workers in the work force, *viz.* an increase in q. Such a change affects both the zero-profit line (6) and the selection wage curve (9). The zero-profit line will shift down, because an increase in the number of prolific workers increases productivity and reduces, for any given wage level, production costs per unit of output. At the same time, an increase in q will flatten the selection wage curve which would, by itself, induce a higher wage rate. The underlying mechanism is that, with an increase in the wage offer, a firm attracts more applicants. If the fraction of prolific workers amongst these applicants increases, a wage increase becomes even more effective as an instrument, as more prolific workers are around than can be attracted this way.

The joint outcome of both effects can be evaluated by again taking the appropriate derivatives of equations (10) and (11). We obtain

$$\frac{\partial \bar{W}}{\partial q} = \Theta^2 c\,(x-y)\,y\mu > 0 \tag{14}$$

$$\frac{\partial \bar{p}}{\partial q} = -\Theta^2 c\,((x-y)\,(1-\mu)) < 0 \tag{15}$$

with $\Theta = \frac{1}{(x-y)(1-\mu)+y}$. It can be seen that the selection wage effect pushes the wage level up, while the increased average productivity of labor abates costs and prices, overcompensating the cost increases brought about by the wage increase. Wages go up and prices go down. With the parameter values of Figure 6, an increase q from $q = .5$ to $q = .6$ increases the wage rate from $W = 2$ to $W = 2.3$ and decreases the price from $p = 16$ to $p = 15.4$.

7 *Trends in Heterogeneity and Latitude*

A closer look at the studies dealing with skill-biased technical change reveal that skill requirements have changed in all kinds of jobs, not just in the well-paying jobs. Autor *et al.* (2003, 1279, 1281) have noted: "The substitution

away from routine and toward nonroutine labor input was not primarily accounted for by educational upgrading; rather, task shifts are pervasive at all educational levels." In a similar vein, Spitz-Oener (2006, 237) has observed: "There has been a sharp increase in nonroutine cognitive tasks, such as doing research, planning, or selling, and a pronounced decline in manual and cognitive routine tasks, such as doubleentry bookkeeping and machine feeding. ... most of the task changes have occurred within occupations." This suggests an increase of skill latitude. At the same time, the expansion of the educational systems has increased the number of educated workers, and it can be expected that the enlarging of the pool of educated workers has increased heterogeneity.

By the above argument, the increases in latitude, heterogeneity, and the quality mix will make it more profitable for firms to increase their wage offers in order to attract the more productive workers. At the market level, this will lead to higher wages, making education even more attractive. The effect may be strengthened by an improved quality mix.

8 Education and Over-Qualification

Consider the case that the jobs under consideration require some previous training, irrespectively whether the worker is prolific or mediocre. The higher the wage rate W, the higher will be the supply of trained workers, both prolific and mediocre. Firms will preferentially hire the prolific workers and fill the remaining vacancies with mediocre workers. If more workers train than are needed to fill all vacancies, we have over-qualification.

Workers who consider training will face a lottery: They will turn out prolific or mediocre, with certain probabilities, but don't know their future type in advance. If a trained worker has turned out to be prolific, he will be hired at wage W with certainty, but, if mediocre, only with a certain probability that decreases with increasing over-education. With an increasing wage rate we would thus expect more training. This improves the quality mix. The improvement in the quality mix induces even higher wages and expanded training, along with increased over-qualification. In this sense, the joint occurrence of increasing wage inequality and over-education is

brought about by Reder competition. The view fits well with the empirical observation that the increase in inequality seems to have been caused "predominantly by increasing wage dispersion within industries, rather than between industries" (Wheeler, 2005, 375), while the standard view—that advanced skills became relatively scarce, while the demand for basic skills decreased—would not fit in this respect. The suggested interpretation in terms of increasing heterogeneity and skill latitude fits also well with the finding that the less able within an educational group do not find adequate employment and have to take jobs where their qualification is partially redundant (Green and McIntosh, 2002). Further, some authors have observed an increased wage premium from education and took this as "*prima facie* evidence against there being any over-investment in education" (Green *et al.*, 2002, 798). The above argument shows that such a conclusion may be doubted, as over-education may indeed be induced by increased wage premia for education.

9 *Wage Dispersion*

It has been shown so far that wage level W for the jobs under consideration increases if such factors as labor heterogeneity or job latitude increase. This implies that the wage differential $W - R$ increases, and in this sense we have an increase in wage dispersion for any given reservation wage R.

Yet the level of equilibrium selection wages W itself is determined *independently* of the reservation wage R —see equation (10) or Figure 7. The wage structure that emerges in an economy characterized by selection wages will be determined by the factors discussed so far: The importance of labor heterogeneity and skill latitude for the various jobs. We would expect, thus, that technological change that renders labor heterogeneity and skill latitude more important will increase all related wages, but we cannot predict the extent to which a particular rung in the wage distribution is affected by such changes. It could be the case, for instance, that the ratio of medium to low wages increases, stays constant, or decreases in response to such change, depending on the whether the selection effect becomes relatively more or less pronounced in one range, as compared to the other. Empiricqally, these

developments differ across countries. From Figures 1 and 2 it can be seen, for instance, that the ratio of medium wages to low wages in the US has remained constant beteen 1990 to 2000, while it increased substantially in Germany. It seems to be an advantage of the Reder view to allow for such differences, but it remains an open empirical question whether these differences between countries can actually be traced to differences in the factors that give rise to selection wages.

Further, the separation between reservation wages and selection wages becomes blurred if we consider not just one single labor market, but the entire spectrum of jobs. For any given job it remains true that the equilibrium wage will be the minimum of the selection wage and the reservation wage. Yet the reservation wage pertaining to a particular job—the wage paid for work in the next best alternative—may be determined as a selection wage in that alternative. Consider, as an example, a bus driver who is required to drive a bus according to a schedule. Any driver meeting the hiring standard will perform equally well in such a job. An alternative employment for the bus drivers could be to work as truck drivers, where less formal qualification is required. For truck drivers, skill differences would matter in the sense that, absent a strict schedule, drivers may differ in their ability to figure out appropriate routes, or clever sequences of delivery. If firms pay selection wages to truck drivers, these wages would function as reservation wages for bus drivers. An increase in skill latitude for truck drivers would then push up wages for bus drivers, although these wages are not selection wages. Hence the selection mechanism may affect wages indirectly, even in jobs without skill latitude.

10 Increasing Mobility

The selection wage mechanism that brings about wage dispersion and overqualification has been described here as propelled by increasing heterogeneity and skill latitude. Other processes may produce the same result, however. To illustrate such a further mechanism, consider an increase in labor mobility. A conventional preconception would be that increase in the mobility of the workers—in the sense of a greater responsiveness to wage

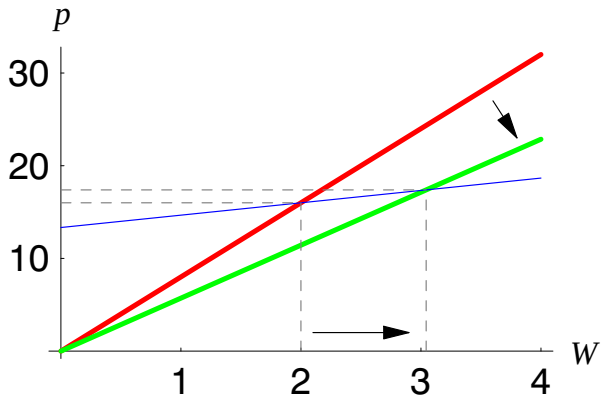


Figure 10: An increase in mobility reduces the slope of the selection wage curve while leaving the zero-profit condition unaffected. As a result, the equilibrium wage level and the equilibrium price level increase. (Parameters as in Figure 6, and μ increased from .5 to .7 The equilibrium wage level increases from 2to 3and the equilibrium prince increases from 16to 17.4 .)

differentials—will render the labor market "more competitive," thereby improving efficiency and decreasing production costs. This would lead in turn to reduced product prices. As will be seen presently, the outcome in the model discussed so far amounts to the opposite.[1]

Mobility is parametrized by μ. An increase in μ reduces the slope of the selection wage equation (9) in the (W, p) plane but leaves the zero-profit condition (6) unchanged. Hence both the wage level and the price level increase (Figure 10).

The intuition for this result is simple: With increased mobility, wage increases become more effective as a means for attracting prolific workers. This induces firms to raise their wages. For the industry as a whole, this

[1] See also Schlicht (1978, 346) for a similar argument in the context of turnover wages.

increases costs and therefore the price of the product. We obtain wage increases and price increases in response to an increase in mobility.

11 Fixed Non-Labor Costs

Still another mechanism leading to a similar outcome relates to an increase in fixed non-labor costs, such as capital costs.[1] An increase such costs can be captured by an increase in c. This shifts the zero-profit line (6) up and leaves the selection wage equation (9) unaffected. Hence both the equilibrium wage and the equilibrium price will move up (Figure 11).

The intuition is straightforward again: If more capital is used, the product price increases. More productive workers produce more with the same equipment, and any productivity advantage becomes more valuable. As a consequence, productivity differentials among workers become more important to the firm, and the firm will have an incentive to offer higher wages in order to attract more prolific workers. As all firms behave in this manner, the wage level is pushed up. The subsequent process is as described above for the case of labor heterogeneity: Education becomes more attractive, and over-qualification increases.

12 Conclusion

Reder competition emphasizes that firms offer wages to improve the quality of their work force. If a firm offers a higher wage, it has more applicants to select from, and will end up with better workers. Thus firms face a trade-off between wages and productivity. This induces them to set selection wages that balance the costs and benefits of offering higher wages.

[1] Variable non-labor costs are not relevant for the present argument. They can be easily introduced into the argument by re-interpreting the product price. Denote by m the variable costs occurring unit. From the point of view of the firm it is equivalent whether to obtain a price of p with variable cost of zero, or a price of $(p + m)$ with variable costs m. Hence substituting p by $(p - m)$ in all previous formulae would suffice to take care of such variable costs. All our results would therefore be maintained. A change in variable costs would simply lead to a corresponding change in the product price while leaving the wage level unaffected.

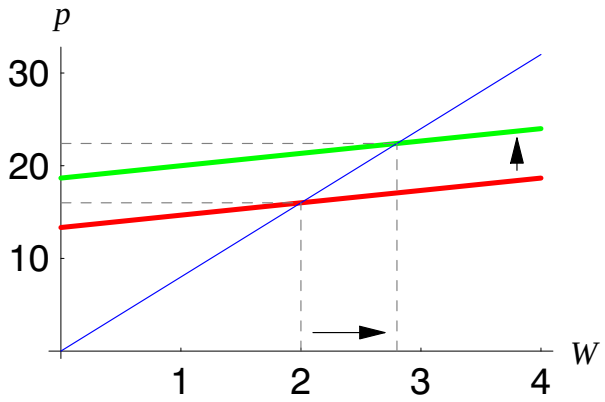


Figure 11: An increase in capital intensity raises the zero profit line while leaving the selection wage line unaffected. As a result, the equilibrium wage level and the equilibrium price level increase. (Parameters as in Figure 6, and c increased from 10 to 14 The equilibrium wage level increases from 2to 2.8, and the equilibrium prince increases from 16 to 22.4 .)

Factors that render differences between workers more important induce firms to place more emphasis on selection and to increase wages. Such factors are labor heterogeneity, skill latitude, or labor mobility. All these factors would give rise to the joint occurrence of inequality and over-qualification.

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Appendix

Performance Pay

The argument has been presented under the (empirically relevant) assumption of flat pay: All workers receive the same pay, regardless of performance. This makes the prolific workers more desirable and induces selection effects. It should be intuitively clear that similar results obtain in case of performance pay, as long as there is wage compression. If the additional profit obtainable from replacing a mediocre worker by a prolific one exceeds the addition wage payments, it will be worthwhile to attract the more productive workers. The purpose of the following remarks is to establish this formally for the case of pure performance pay, where firms set a piece rate that is applied to prolific and mediocre workers alike. (This is an extreme assumption. Empirically, wage compression seems to be somewhere between flat pay and pure performance pay.)

Denote wage payments for the prolific workers by w and wage payments for the mediocre workers by v. With a piece rate, the ratio of these wage payments would correspond to the ratio of the productivities x and y and we have $\frac{w}{v} = \frac{x}{y}$ implying $v = w\frac{y}{x}$. The profit equation (5) would read under this assumption

$$\pi \quad = \quad p \cdot (\rho x + (1-\rho)\, y) - \rho w - (1-\rho)\, v - c \tag{16}$$

$$= \quad \rho \cdot \left(p\left(x-y\right) + w\left(\frac{x}{y} - 1\right)\right) + py - w\frac{x}{y} - c \qquad (17)$$

Repeating the analysis of Section 3 with (5) replaced by (17) yields the equilibrium wage

$$\tilde{W} = \frac{\mu q x\left(x-y\right)}{\left(qx + \left(1-q\right)y\right)^2} \cdot c. \qquad (18)$$

As compared to the previous result (10) that has been derived under the flat pay assumption, the wage rate (17) emerging with performance pay reacts similar to parameter changes: Increases in mobility μ and the quality mix q increase the wage level. Further the wage level increases if the productivity difference $(x-y)$ increases while average productivity $qx + (1-q)\,y$ remains unaffected, *i.e.* if heterogeneity increases. Thus allowing for performance pay—even in the extreme form of a pure piece rate—yields results similar to those obtained under the flat pay assumption. Comparing the equilibrium wage rates (10) and (18) shows further that the equilibrium wage for the prolific workers obtainable under performance pay $\tilde{W}$ exceeds the equilibrium wage rate in the case of flat pay $\bar{W}$. It appears, thus, that *the introduction of performance pay increases wage dispersion.* Yet the selection wage effect is maintained, as the equilibrium wage for the mediocre workers, which is $\tilde{V} = \frac{y}{x}\tilde{W}$ is independent of the reservation wage R. If heterogeneity and skill latitude are sufficiently important, it will exceed the reservation wage, while wage competition would predict a mediocre wage $V = R$.

Wage Compression

Selection wages arise from wage compression. The assumption is essential for any model of selection wages. Wage compression is typically linked to psychological factors like fairness considerations, or to concerns about relative income positions among the workers. The purpose of the following remarks is to point out that we should expect wage compression to emerge even in absence of these psychological factors, simply as a consequence of limited mobility. I hasten to add that this argument does not imply that the psychological factors are less important than the more narrowly conceived

economic factors to be discussed presently. The psychological factors may well be dominant.

Consider market wage rates W and V for the two types of workers, the prolific and the mediocre. The prolific workers have productivity x and the mediocre workers have productivity $y < x$. Given any prolific wage W we ask now which mediocre wage would make a firm indifferent between hiring a prolific or a mediocre worker. This wage is the Marshallian efficiency wage for the mediocre workers, denoted by V_M.[1] It can be calculated as follows. With a product price p, the difference in value added between a prolific and a mediocre worker is $p\,(x - y)$. Hence the firm would be just indifferent between hiring a mediocre or a prolific worker if the wage for the mediocre worker is V_M and the condition

$$W - V_M = p\,(x - y) \tag{19}$$

is satisfied. Any wage structure with $(W, V) = (W, V_M)$ would exhibit zero wage compression as the firms would be indifferent between hiring a prolific or a mediocre worker.

Assume such a market equilibrium without wage compression. A firm may now consider deviating from market wages by setting different wages (w, v). It considers, in particular, to reduce the wage rate for the prolific workers below the market wage rate. If supply of the mediocre workers at the wage rate V_M is perfectly elastic (the assumption used in the body of the paper), it will always be worthwhile to do so, because a slight reduction of W will reduce the share of prolific workers somewhat, but these can be replaced by mediocre workers without affecting profits. (V_M is defined by this property.) The wage costs incurred for the remaining prolific workers will, however be reduced, and a reduction in the wage rate for the prolific workers w below the market rate W will increase profits. Hence the wage structure (W, V_M) cannot persist. Firms will drive down prolific wages, with the result that alternative offers for the prolific workers decline. Under the assumption of perfectly elastic mediocre supply, any stable wage structure must, therefore, exhibit wage compression.

[1] See Marshall (1920, vi,ii,9). Note that the Marshallian notion of an efficiency wage differs from the modern usage.

Yet the assumption of perfectly elastic mediocre supply is unnecessary restrictive. If the firm reduces prolific wages, it may be necessary to increase mediocre wages in order to attract some additional mediocre workers as replacements for prolific workers who are lost, because of the reduced wage offer. Take the simple case that supply elasticities of mediocre and prolific workers are identical, denoted again by μ. Supply of prolific workers ρ, as a share of the typical firm's total employment, is given by

$$\rho = q \cdot \left(1 + \mu \cdot \log\left(\frac{w}{W}\right)\right) \tag{20}$$

where q denotes again the quality mix prevailing in the market. This is identical to (3). Making a similar assumption for the supply of the mediocre workers σ amounts to

$$\sigma = (1-q) \cdot \left(1 + \mu \cdot \log\left(\frac{v}{V}\right)\right). \tag{21}$$

The typical firm's profits can be written as

$$\pi = \rho p x + \sigma p y - \rho w - \sigma v - c.$$

The firm will maximize this expression under the constraints (20) and (21) and under the further constraint that all jobs must be manned which reads $\rho + \sigma = 1$. This gives rise to the Lagrangian

$$\begin{aligned}\mathcal{L} \quad = \quad & q \cdot \left(1 + \mu \cdot \log\left(\frac{w}{W}\right)\right)(px - w) + \\ & + (1-q) \cdot \left(1 + \mu \cdot \log\left(\frac{v}{V}\right)\right)(py - v) - c + \\ & - \lambda \left(q \log\left(\frac{w}{W}\right) + (1-q)\log\left(\frac{v}{V}\right)\right)\end{aligned}$$

with the derivatives at

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial w} &= \frac{q}{w}\left((px - w)\,\mu - \lambda - w\right) \\ \frac{\partial \mathcal{L}}{\partial v} &= \frac{1-q}{v}\left((py - v)\,\mu - \lambda - v\right).\end{aligned}$$

Putting these derivatives to zero and assuming equilibrium with $(w, v) = (W, V)$ implies the wage differential

$$W - V = \mu \left(p \left(x - y \right) - \left(W - V \right) \right)$$

and hence

$$W - V = \frac{\mu}{1 + \mu} p \left(x - y \right).$$

This differential is smaller than the wage Marshallian differential (19) that defines the absence of wage compression. Hence even in case that all types of workers are equally mobile, wage compression would result.