How Monopsonistic and Monopolistic Competition Affects Wage Disparities?*

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Abstract

We develop a general equilibrium model in which firms employ different types of labor. Firms are endowed with market power that allows them to be price-makers and wage-setters. First, firms face upward sloping labor supplies because idiosyncratic non-pecuniary conditions interact with wages in workers' decisions to work for specific firms. Second, we pin down the existence of a double exploitation of labor whose intensity depends on the interaction between the product and labor markets. Third, the heterogeneity within each type of labor implies that the high-productive workers tend to be overpaid, whereas the low-productive workers would be underpaid. However, intensifying competition on the goods market shrinks the discrepancy between wages and workers' productivity. Last, we offer a theory of differential discrimination in which gender pay inequality varies with women's family status.

Keywords: worker heterogeneity; monopsonistic competition; monopolistic competition; wage dispersion

JEL Classification: D33, J31, J42, J71, L13

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1 Introduction

A substantial body of literature has documented the following facts: (i) the wage gap between skilled and unskilled workers has grown rapidly over the past 30 years; (ii) women are discriminated against in labor markets; (iii) gender discrimination shrinks as the product market becomes more competitive; and (iv) wage discrimination within the same group of workers occurs according to their familial or marital status. A variety of approaches, for example taste discrimination (Becker, 1957) or statistical discrimination (Arrow, 1973), have been developed to account for those facts, often employing partial equilibrium frameworks. As a consequence, the resulting explanations are scattered and lack unity. The main contribution of this paper is to provide a broader setup that explains, within a novel and tractable framework, the above-mentioned facts, while also shedding new light on the distribution of earnings. We believe that such an effort is warranted in order that policy actions against discrimination in the labor market may be designed.

We develop a general equilibrium model in which firms are endowed with market power in the product and labor markets. The central thesis of this paper is that blending imperfections in both the labor and product markets yields new and insightful results about the distribution of earnings across different types of production factors. In perfectly competitive markets, the wages-to-productivity ratio of each production factor is equal to one. Imperfect competition in just the product market lowers the value of the ratio but does not affect the equalization of the ratio across production factors. However, imperfect competition in the labor market not only changes the ratio but also affects the ratio differently across factors, even under free entry. Our model shows that, if the ratio decreases for one factor (e.g., labor, female workers, unskilled workers), it must increase for another factor (e.g., capital, male workers, skilled workers).

Although a comprehensive general equilibrium model involving strategic interactions in each of these two markets has been out of reach up to now, we are able to gain relevant insights by considering a large number of firms (formally, a continuum). Under these circumstances, a firm has market power but is negligible to the market. Regarding the product market, we consider two different settings that allow us to capture different market environments. In the first setting, the number of firms is exogenous and, consequently, market power generates a rent accruing to firms. In the second setting, the rent is eliminated by free entry on the product market.

We model the product market using a model in which (i) the markup is variable, (ii) preferences may differ across types of labor, and (iii) substitution between different types of labor is allowed. As for the labor market, we build on the growing evidence that firms face elastic labor supplies (Ashenfelter et al., 2010). To be precise, we assume that idiosyncratic non-monetary conditions interact with wages in workers' decisions to accept offers made by specific firms. In other words, different workers view jobs offered by different firms as bundles of attributes that provide the workers with more or less satisfaction. Since workers make mutually exclusive and indivisible job choices, discrete choice theory provides us with an appropriate tool to model the actual matching value between a worker and a firm. Specifically, we assume that heterogeneity differs between types of labor and is captured by the logit model within each type.

Our main findings may be summarized as follows. First, starting with an exogenous number of firms, we show that *a firm's labor supply curve is elastic when workers of a given type are heterogeneous*. Each worker having a most-preferred employer, firms may set a wage lower than workers' marginal product value while attracting their captive labor pool. Workers are paid below their marginal value product for a second reason. Since firms are price-makers on the product market, they evaluate workers' marginal productivity at the marginal revenue, which is lower than the market price. Hence, once it is recognized that both the product and labor markets operate under imperfect competition, the market delivers an outcome that involves a monetary transfer from the workers to the firms. It is worth stressing here that the intensity of this double exploitation of labor depends on the interaction between the product and labor markets. For example, the wage markdown increases when workers' preferences for pleasurable job attributes grow relative to workers' preference for consumption goods. However, a price drop on the product market weakens this effect by reducing firms' monopsonistic power on the labor market. How big are these effects? An elasticity of a firm's labor supply equal to 4 implies that on average workers accept a wage cut of 25 percent as a counterpart of the hedonic job attributes, while an elasticity of substitution across varieties equal to 7 in the case of CES preferences implies that their marginal productivity is evaluated at 86 percent of the market price.[1] In this event, the degree of exploitation of labor is far from being negligible.

Second, *the wage gap exceeds the productivity gap between any two different types of labor.* Indeed, workers' hedonic wages are equal to their actual wage plus the monetary evaluation of their jobs' positive attributes. As a consequence, the market works as if the more productive employees were more sensitive to wage differences than the less productive employees, even when they are equally heterogeneous. In other words, heterogeneity within each type of labor magnifies productivity differences between types. Note, however, that the premium paid to the more productive workers decreases when the product market becomes more competitive. In this sense, a more competitive product market lessens the divergence between wages and productivity.

Third, even when workers of different types have the same productivity, wage dispersion may still arise because those workers do not necessarily have the same degree of heterogeneity in their job preferences. In Denmark, for instance, Eriksson and Kristensen (2014) find that women value flexibility significantly more than do men, while in Spain, de la Rica et al. (2010) find that monopsonistic features, which could be related to women's lower labor mobility due to family responsibilities explain the gender wage gap. We also consider the fact that gender wage inequality is not uniform and varies between women with children and women without children (Polachek, 2014), and offer a theory of differential discrimination.[2] However, we will show that these results need to be qualified when preferences for goods differ strongly across types of labor. Therefore, ignoring differences in preferences for the final goods may lead to inaccurate conclusions in empirical studies of labor markets.

Fourth, when the number of firms is determined by free entry, income transfers from workers to firms disappear because profits are zero. Contrary to general belief, this does not eliminate discrimination among workers' types. Rather, monopsony power takes the concrete form of implicit transfers across different types of labor. Because the above-mentioned magnification of productiv-

[1] Manning (2003) and Ashenfelter et al. (2010) suggest that the labor supply elasticity ranges from 2 to 4, whereas Head and Mayer (2004) estimate the elasticity of substitution across varieties varies from 4.9 to 7.6. Using lower values for those elasticities would further increase the degree of exploitation of labor.

[2] This agrees with the fact that wage discrimination is more pronounced against heterosexual women than lesbians (Baert, 2014).

ity differences also holds under free entry, this effect expresses itself through an income transfer from the low-productive workers to the high-productive workers. To put it differently, *the high-skilled workers are overpaid, while the low-skilled workers are underpaid.* What is more, since the skilled tend to display a growing geographical mobility relative to the unskilled (Moretti, 2012; Diamond, 2015), this differential mobility is likely to be part of the explanation for the growing wage inequality between these two types of workers. More generally, we show that workers who attach less importance to the jobs' hedonic attributes gain at the expense of those for whom these attributes are more important. In the end, even when they share identical observable characteristics in every other aspect, a group of workers that values such attributes more than another will be discriminated against.

Finally, note that our model is versatile enough to shed light on two other important issues related to labor economics, namely the existence of an urban wage premium and the declining share of labor in the gross domestic product of developed countries.

Related literature. Kim (1989), Bhaskar and To (1999, 2003), Marimon and Zilibotti (1999), and Hamilton et al. (2000) build on Salop (1979) to model heterogeneous firms competing to attract heterogeneous workers. The introduction of strategic considerations in the labor market renders the analysis fairly complex, thus leading these authors to consider the product side as perfectly competitive. The majority of models that blend imperfections on the product and labor markets use a setting in which wages are bargained between workers and employers (Blanchard and Kiyotaki, 1987; Blanchard and Giavazzi, 2003). In Helpman et al. (2010), the labor market is characterized by search and matching frictions, which are modeled following the Diamond-Mortensen-Pissarides approach. However, unlike us, those various authors consider a single type of labor and, therefore, cannot analyze the distributional consequences of market imperfections on different types of labor due to as skill, gender and marital status.

The paper proceeds as follows. We present the model in Section 2. In Section 3, we characterize the equilibrium when the number of firms is exogenous, while the subsequent section considers the case of free entry. The last section summarizes our main policy implications and discusses possible extensions.

2 The model

We consider an economy endowed with one sector and Θ types of labor. A *type of labor* is formed by the workers who share the same observable characteristics, such as the educational level, age, gender, and ethnicity. There are L_θ workers of type $\theta = 1, ...\Theta$ and each worker is endowed with one unit of her type of labor. The total population is denoted by $L = \Sigma_\theta L_\theta$, while $\mathbf{L}$ denotes the vector $(L_1, ..., L_\Theta)$. There are two goods. The homogeneous good is unproduced (land) and its supply H is perfectly inelastic; it is used as the numéraire. Each worker is endowed with H/L units of this good. The differentiated good is produced and made available as a continuum of varieties of mass N; each variety is denoted by $i \in [0, N]$.

2.1 Workers

Workers are heterogeneous in their preferences for consumption goods and for jobs.

(i) **Consumption**. Workers of type $\theta = 1, ..., \Theta$ share the same strictly quasi-concave utility function:

$$U_\theta \left(h, u \left(x \left(i \right); i \in [0, N] \right) \right), \tag{1}$$

where h is the consumption of the numéraire and $x(i)$ the consumption of variety i. The subutility u is strictly quasi-concave and symmetric in the set of varieties, while the utility U_θ is θ-specific. In other words, workers endowed with different types of labor may have different attitudes toward consumption. For analytical simplicity, we assume that workers endowed with the same type of labor have the same preferences for goods.

In what follows, we will focus on symmetric equilibria. For this to happen, consumers of the same type must have the same income, which holds when profits are uniformly distributed across consumers. A θ-worker hired by firm i earns a nominal wage $w_\theta \left(i \right)$ and has a budget constraint given by

$$\int_0^N p\left(j\right) x\left(j\right) \mathrm{d}j + h = I_\theta\left(i\right) \equiv w_\theta\left(i\right) + \frac{H}{L} + \frac{1}{L} \int_0^N \pi\left(j\right) \mathrm{d}j,$$

where $\pi \left(j \right)$ is the profit made by firm j (see below for more details).

Individual preferences are such that the θ-workers aggregate demand for variety j decreases with $p(j)$ and increases with the sum of the θ-workers' incomes:

$$I_\theta \equiv \int_0^N I_\theta(i)\,\mathrm{d}i.$$

The total expenditure on the differentiated good is given by

$$E \equiv \int_0^N p(j)\,q(j)\,\mathrm{d}j,$$

where $q(j)$ is the market demand for variety j.

It will be convenient to illustrate our results in the widely used case of a Cobb-Douglas utility nesting a CES subutility:

$$\begin{aligned} U_\theta(h, M) &= \frac{M^{\mu_\theta} h^{1-\mu_\theta}}{(\mu_\theta)^{\mu_\theta}(1-\mu_\theta)^{1-\mu_\theta}} \qquad 0 < \mu_\theta < 1 \\ M &\equiv \left[\int_0^N (x(i))^{\frac{\sigma-1}{\sigma}}\,\mathrm{d}i\right]^{\frac{\sigma}{\sigma-1}} \qquad \sigma > 1. \end{aligned} \tag{2}$$

In this case, which we call **C-D-C**, the total expenditure on the differentiated good is given by

$$E = \sum_\theta \mu_\theta I_\theta, \tag{3}$$

while the aggregate demand for variety i is given by

$$q(i) = \left[\frac{p(i)}{P}\right]^{-\sigma} \frac{E}{P},$$

where

$$P \equiv \left[\int_0^N \left(p(j)^{-(\sigma-1)}\right)\mathrm{d}j\right]^{\frac{-1}{\sigma-1}}$$

is the CES price index of the differentiated good. In what follows, $\mathbf{P}_\theta \equiv P^{\mu_\theta} \cdot 1^{1-\mu_\theta}$ denotes the *general* price index faced by the θ-workers, which varies across types of labor because workers differ by the earning share they spend on the differentiated good.

(ii) **Jobs.** Workers sharing the same type are heterogeneous in their perception of the hedonic attributes associated with a particular firm/job or, equivalently, the importance of these attributes relative to their wages is worker-specific. Formally, this is modeled by assuming that the random indirect utility of a θ-worker employed in firm i is given by

$$\tilde{V}_\theta(i) \equiv V_\theta(i) + \varepsilon_\theta(i),$$

where $V_\theta(i)$ denotes the indirect utility the worker enjoys from consuming the homogeneous and differentiated goods and earning the wage $w_\theta(i)$ in firm i. In the **C-D-C** case, $V_\theta(i)$ boils down to the real income $V_\theta(i) = I_\theta(i) / \mathbf{P}_\theta$.

A workers' idiosyncratic taste for a job provided by firm i is given by the realization of the zero-mean random variable $\varepsilon_\theta(i)$, which is known to the worker but unobservable by the firms. A θ-worker chooses the firm that grants her with the highest random indirect utility $\tilde{V}_\theta(i)$ given by

$$\max_i \left[V_\theta(i) + \varepsilon_\theta(i)\right],$$

which depends on the wage $w_\theta(i)$ set by firm i and its hedonic attributes. Each θ-worker knows her own realization of $\varepsilon_\theta(i)$ for each firm i, but firm i knows only the distribution of $\varepsilon_\theta(i)$ for $\theta = 1, ..., m$. This implies that, even when the θ-workers who choose to work in firm i are paid the same wage, they value differently the hedonic attributes of this firm. As a consequence, the θ-workers hired by firm i enjoy different welfare levels.

For each type of labor θ, we follow the discrete choice theory of market competition and assume that the random variables $\varepsilon_\theta(i)$ are independently and identically distributed according to the Gumbel distribution across firms. This implies that the probability that θ-worker chooses to work in firm i is given by the *continuous logit* (Ben-Akiva et al., 1985; Dagsvik, 2002):

$$\mathbb{P}_\theta(i) = \frac{\exp \frac{V_\theta(i)}{\gamma_\theta}}{\int_0^N \exp \frac{V_\theta(j)}{\gamma_\theta} \mathrm{d}j}, \tag{4}$$

where γ_θ stands for the standard-deviation of the random variable $\varepsilon_\theta(i)$ (up to the numerical factor $\pi/\sqrt{6}$). We assume that γ_θ is small enough for all the expressions derived below to be positive.

In (4), γ_θ is an index that captures the heterogeneity of workers who react differently to the same wage schedule within the θ-type of labor. Therefore, γ_θ may be interpreted as an inverse measure of θ-workers' *mobility* across firms as a smaller γ_θ implies that a higher share of θ-workers is willing to change jobs in response to a wage cut. In accordance with models of discrete choice theory, firms know the density of $\varepsilon_\theta(i)$, thereby the value of γ_θ. However, they do not observe the individual realizations of $\varepsilon_\theta(i)$.

The value of γ_θ rises with the θ-workers' distance separating jobs in the space of hedonic attributes. It is, therefore, an index measuring the degree of job differentiation. Similarly, in the **C-D-C** case, the utility function (2) may be reinterpreted as a nested logit in which an individual, first, chooses which variety to buy and, then, how much of this variety to consume. In this case, $1/\sigma$ measures the heterogeneity of consumers' tastes or, equivalently, the distance separating varieties in the space of Lancasterian characteristics (Anderson et al., 1992). Each individual is then characterized by a *two-dimensional* heterogeneity associated with her consumption and job choices, each is used by firms to build their market power on the product and labor markets. Our main results may be reinterpreted by using this approach.

2.2 Firms

The differentiated good is produced under increasing returns and monopolistic competition. Each firm supplies a single variety and each variety is produced by a single firm. Consequently, a variety may be identified by its producer $i \in [0, N]$. Firm i hires $\ell_\theta(i) \geq 0$ workers of type $\theta = 1, ...\Theta$, and this firm's production function is given by a linear homogeneous function $F[\mathbf{l}(i)]$, where $\mathbf{l}(i) \equiv (\ell_1(i), ..., \ell_\Theta(i))$. The output of firm i is split between the fixed requirement f needed to undertake production and the quantity $q(i)$ offered to consumers:

$$q(i) + f = F[\mathbf{l}(i)]. \tag{5}$$

Note that the production function F is consistent with *any* pattern of substitutability between types of labor.

Each firm i chooses the wage $w_\theta(i)$ it pays to each type of labor θ and attracts

$$\ell_\theta(i) = L_\theta \mathbb{P}_\theta(i) \tag{6}$$

θ-workers. Therefore, $\ell_\theta(i)$ is the θ-labor supply function faced by firm i. Because each firm is negligible to the market, when choosing the salary $w_\theta(i)$ it will pay to the θ-workers, firm i treats accurately the denominator of (4) as a given, very much like firms view the price index of the product market as a parameter in the Dixit-Stiglitz model. In contrast, the numerator of (4) is affected by the choice of $w_\theta(i)$. Therefore, firms face *monopsonistic competition* on the labor market.

By choosing the wage $w_\theta(i)$ firm i determines its employment level $\ell_\theta(i) = L_\theta \mathbb{P}_\theta(i)$, which pins down the firm's output $q(i) = F[\mathbf{l}(i)] - f$. Through its inverse demand function, this in turn determines the price $p(i)$ at which firm i sells its variety. Hence, though firms operate on the product market as if there were monopolistic competition on this market, they cannot choose their prices $p(i)$ independently of their wages $w_\theta(i)$. However, the price at which firm i can sell its variety is endogenous and determined by the demand for its variety. As a consequence, the equilibrium wage is determined by the competitive conditions on the labor and product markets through the demands for varieties.

Firm i maximizes its profits given by

$$\pi(i) = p(i)\, q(i) - \sum_\theta w_\theta(i)\, \ell_\theta(i), \tag{7}$$

subject to the production function (5) and the inverse demand function obtained from (1). Formally, firm i's profit-maximizing wages solve the following profit-maximizing conditions:

$$\frac{d\pi(i)}{dw_\theta(i)} = p(i)\left[1 + \frac{\partial p(i)}{\partial q(i)}\frac{q(i)}{p(i)}\right] \cdot \frac{\partial q(i)}{\partial \ell_\theta(i)}\frac{\partial \ell_\theta(i)}{\partial w_\theta(i)} - \ell_\theta(i)\left[1 + \frac{\partial \ell_\theta(i)}{\partial w_\theta(i)}\frac{w_\theta(i)}{\ell_\theta(i)}\right] = 0.$$

This expression says that the equilibrium wage $w_\theta(i)$ set by firm i is such that the additional revenue earned by hiring θ-workers at a higher wage is equal to the increase in the wage bill borne by the firm. Note that the corresponding increase in marginal cost stems from the heterogeneity of the θ-workers while the marginal revenue differs from the market price because of firm i's market power on the product market.

3 Equilibrium under a given number of firms

3.1 Wage equation

Since firm i is negligible to the labor market, it accurately treats the denominator of (4) parametrically. Hence,

$$\frac{\mathrm{d}\ell_\theta\left(i\right)}{\mathrm{d}w_\theta\left(i\right)} = \frac{V_\theta'(i)}{\gamma_\theta}\ell_\theta\left(i\right), \tag{8}$$

where $V_\theta'(i)$ denotes the marginal indirect utility of a θ-worker employed by firm i. The expression (8) defines firm i's labor supply of θ-workers when firm i's chooses a wage equal to $w_\theta(i)$. It is the θ-workers' labor supply counterpart of consumers' demand for variety i, and its elasticity is given by

$$e_\theta(i) = \frac{V_\theta'(i)}{\gamma_\theta}w_\theta\left(i\right).$$

Thus, although the market supply of labor is perfectly inelastic, each firm faces a supply curve with a finite elasticity because the θ-workers are heterogeneous ($\gamma_\theta > 0$). Everything else being equal, *the more heterogeneous the θ-workers, the smaller the elasticity of the supply curve.* In contrast, the labor supply curve is infinitely elastic when θ-workers care only about their wage ($\gamma_\theta = 0$).

In the special case where preferences are given by (2), the elasticity of firm i's labor supply is

$$e_\theta(i) = \frac{w_\theta\left(i\right)}{\gamma_\theta \mathbf{P}_\theta},$$

which implies that the elasticity rises when the price index falls, e.g. through a higher elasticity of substitution σ. The intuition is easy to grasp. In choosing the employer that grants them with the highest random indirect utility $\tilde{V}_\theta(i) = V_\theta(i) + \varepsilon_\theta(i)$, workers face a trade-off between the consumption of goods (the value of $V_\theta(i)$) and the hedonic job attributes (the value of $\varepsilon_\theta(i)$). Recall that $V_\theta(i)$ increases with $w_\theta(i)$ and decreases with $\mathbf{P}_\theta$. Therefore, when θ-workers face a wage hike and/or a price drop, they put more weight on their consumption, whence their nominal wage, than on their job hedonic attributes. This increases the elasticity of the θ-labor supply schedule and weakens firms' monopsony power. Observe the same holds when the θ-workers become more homogeneous. In the limit, when workers are homogeneous ($\gamma_\theta = 0$), we fall back on the standard case of a perfectly elastic labor supply. This highlights the role of workers' heterogeneity for firms to face elastic labor supplies.

The following proposition is a summary.

Proposition 1. *A firm's labor supply gets more elastic as the product market becomes more competitive, the workers more homogeneous, or both.*

We now come to the wage determination. Using (8), we obtain the following wage equation:

$$w_\theta^*(i) = p(i)\left[1 - \left|\frac{q(i)}{p(i)}\frac{\partial p(i)}{\partial q(i)}\right|\right] \cdot F_\theta'(i) - \frac{\gamma_\theta}{V_\theta'(i)}, \tag{9}$$

where $F_\theta'(i)$ denotes the derivative of F (and thus of $q(i)$) with respect to $\ell_\theta(i)$. Note that $V_\theta'(i)$ depends wages and market prices, so that the wage equation is *not* additively separable in the effects of firms' market power and workers' heterogeneity. Furthermore, the equilibrium wage $w_\theta^*(i)$ depends on the type of labor's statistic γ_θ but are independent of the realization of $\varepsilon_\theta(i)$. However, although all θ-workers are paid the same wage, their utility level differ because the realizations of the random variables $\varepsilon_\theta(i)$ are different.

The wage equation (9) shows that workers are paid less than their marginal value product $p(i)F_\theta'(i)$ for two reasons. First, firms use their monopoly power on the product market to set a markup equal to $1/(1 + (q/p)(\partial p/\partial q)) > 1$ times the marginal cost. Therefore, the θ-workers' wage is evaluated at to the marginal value product times the inverse markup, that is, *wages are* *determined by the marginal revenue*, not by the market price. Econometric estimations undertaken by Anderson and van Wincoop (2004) show that the elasticity $-1/(q/p)(\partial p/\partial q)$ varies from 5 to 10, which suggests a first exploitation rate of about 10 to 20 percent of the marginal value product.

Second, since the θ-workers are heterogeneous in their preferences for employers, firms exercise their clout to pay these workers a wage smaller than the marginal revenue they generate. The wage drop is equal to $\gamma_\theta/V'_\theta(i)$ and, through the value of $V'_\theta(i)$, depends on the price level and the number of varieties. It follows from (4) that *a higher marginal indirect utility incentivizes workers to seek better paid jobs rather than better hedonic attributes*. Indeed, since lower prices increase the value of the marginal indirect utility, tougher competition on the product market reduces the negative effect that the heterogeneity of preferences for jobs exercises on wages. As noticed by Boal and Ransom (1997), Pigou (1924) used $1/e_\theta$, which is here equal to $(\gamma_\theta/V'_\theta)/w_\theta$, to measure labor exploitation. According to recent estimations the firm's labor supply elasticity would range from 2 to 4 (Manning, 2003; Ashenfelter et al., 2010), suggesting a second exploitation rate varying from 25 to 50 percent of the observed wage.

In sum, the exploitation of workers has *two* sources, while the degree of exploitation of labor seems far from being negligible. This 'double exploitation' of labor takes the form of an income transfer away from workers to firms, which stems from the product and labor market imperfections, as well as from the interaction between these various markets. It is worth stressing that the double exploitation is here the unintentional consequence of decisions made by a great number of firms and workers.

Thus far, the equilibrium price $p(i)$ is undetermined. Given the symmetry of our setting, we find it natural to focus on symmetric market outcomes:

$$\ell_\theta(i) = L_\theta/N \qquad q(i) = q \qquad p(i) = p.$$

Using (5) and $\ell_\theta(i) = L_\theta/N$, the equilibrium output

$$q^* \equiv F(L_1/N, ..., L_\Theta/N) - f$$

decreases with the number of firms but increases when the population of any type of labor rises.

As for the equilibrium price, it must be such that the value of production, $p\left(F\left(\mathbf{L}\right)-Nf\right)$, is equal to the total expenditure on the differentiated varieties, E:

$$p^{*}=\frac{E}{F\left(\mathbf{L}\right)-Nf}. \tag{10}$$

Regardless of the utility functions U_θ and u, the equilibrium price thus increases linearly with workers' total expenditure on the differentiated product, which itself depends on the income of all types of labor (see (3)). As for the total income of the θ-workers, it is equal to the sum of their wages, share of total profits and initial endowments of the homogeneous good:

$$I_\theta=L_\theta w_\theta^{*}+\frac{L_\theta}{L}\left(E-\sum_t w_t^{*}L_t\right)+\frac{L_\theta}{L}H.$$

Therefore, the income I_θ depends on workers' expenditure, which in turn varies with the income of all types of labor. Since I_θ is endogenous, the equilibrium price and wages are implicit functions of N. Although an explicit solution for w_θ^{*} seems to be out of reach, we will see that the above expressions are useful to better understand the interactions between the product and labor markets.

3.2 The equilibrium in the C-D-C case

The above expressions become easier to interpret in the **C-D-C** case, assuming further that workers are homogeneous in their taste for goods, $\mu_\theta=\mu$. In this case, the equilibrium price is given by

$$p^{*}=\frac{\mu}{1-\mu}\frac{H}{F\left(\mathbf{L}\right)-Nf}, \tag{11}$$

which is independent of σ and γ_θ. This expression shows that *a larger number of firms yields a higher market price*, a result that runs against the conventional wisdom, which states that entry leads to lower market prices. This may be explained as follows. A larger number of firms makes competition tougher on the product market, thus pushing the market price downward. However, when the labor force L remains constant, the entry of new firms reduces the employment and output of each firm $(F(\mathbf{L}/N) - f)$, which in turn fosters a higher price on the product market. What (11) shows is that the latter effect dominates the former when workers share the same preferences for goods. There is no reason to expect this result not to hold when workers have heterogeneous tastes for goods.

Wages are now explicitly given by

$$w_\theta^* = \frac{\sigma - 1}{\sigma} p^* F_\theta' - \gamma_\theta \mathbf{P}^*, \quad \text{where} \quad \mathbf{P}^* = N^{-\mu/(\sigma-1)} (p^*)^\mu. \tag{12}$$

This expression shows that the equilibrium wage of θ-workers depends on the product market for the following three reasons. First, wages depend on the market price p^*, which determines the marginal value product of labor $(p^* F_\theta')$. Second, $(\sigma - 1)/\sigma < 1$ represents firms' relative *markdown* generated by monopolistic competition on the product market. As observed by Robinson (1933), when there is imperfect competition on the product market, the equilibrium wage is smaller than the competitive wage, the markdown being given here by $(\sigma - 1)/\sigma < 1$. Even in the absence of imperfections on the labor market ($\gamma_\theta = 0$), imperfect competition on the product market translates into a wage smaller than the competitive wage because firms strives to produce less and, accordingly, hire fewer workers. Moreover, as the degree of firms' monopoly power on the product market rises, that is, σ falls, it follows from (11) and (12) that the equilibrium wage decreases. The argument is straightforward. Since firms further reduce their output, they hire fewer workers, thereby making competition on the labor market softer.

Third, θ-workers' hedonic job attributes are measured by $\gamma_\theta \mathbf{P}^*$, which depends on the price of the differentiated good and the income share μ spent on this good. This second markdown increases with the market price p^*. Indeed, a higher price reduces the marginal indirect utility of the differentiated good, and thus increases the relative value of the hedonic attributes. As a consequence, workers are willing to trade these attributes for a lower wage.

Consider now a positive shock on the market price p^*, such as a higher degree of product differentiation. This gives rise to the following two opposite effects. On the one hand, a higher market price has a direct positive impact on wage - see the first term of w_θ^*. On the other hand, this increases the price index, which raises the degree of labor exploitation - see the second term of w_θ^*. Differentiating (12) with respect to p^* shows that the former effect is stronger than the latter one: the equilibrium wages rise with the market price. In addition, an increase in f being equivalent to an hike in p^*, all workers earn a higher wage in industries where the degree of increasing returns is higher. Indeed, when f rises, the quantity produced for consumption gets smaller. This in turn allows firms to sell at a higher price, and thus to pay a higher wage.

Since we consider a general equilibrium setting in which the output and input markets are imperfectly competitive, it is hardly a shock that the interactions between the product and labor markets are complex. In particular, the equilibrium wage w_θ^* given by (12) is a fairly involved function of N. Nevertheless, we show in Appendix that, in the **C-D-C** case, *for each type of labor the equilibrium wage w_θ^* increases with the number of firms.* Indeed, a larger number of firms operating under increasing returns makes competition tougher on each labor market. Since the labor supply functions are perfectly inelastic, entry yields higher wages, and thus a higher marginal cost. Note the difference with standard models of monopolistic competition where marginal costs are constant, which holds when the input supply functions are perfectly elastic.

3.3 The wage structure

Consider now any two different types of labor, $\theta = k, l$. Then, we have:

$$w_k^* = \frac{F_k'}{F_l'}\left(w_l^* + \frac{\gamma_l}{V_l'}\right) - \frac{\gamma_k}{V_k'}. \tag{13}$$

When all workers are homogeneous ($\gamma_k = \gamma_l = 0$), we fall back on the well-known equality between the wage ratio w_k^*/w_l^* and the marginal productivity ratio F_k'/F_l'. By contrast, when workers are heterogeneous ($\gamma_k > 0$ and $\gamma_l > 0$), this equality ceases to hold. The relationship between the wage ratio and the marginal productivity ratio now depends on γ_θ and V_θ', which reflect the different attitudes of workers toward job attributes (γ_θ) and consumption goods (V_θ'). Hence, workers' heterogeneity suffices to break down the classical relationship between the productivity and wage ratios. In other words, workers' heterogeneity generates *direct interactions* between the labor and product markets through the parameters γ_θ/V'_θ, which has redistributional implications between types of labor. For example, the heterogeneity of type-l workers positively affects type-k workers when these ones are homogeneous ($\gamma_k = 0$ and $\gamma_l > 0$):

$$\frac{w_k^*}{F'_k} = \frac{w_l^*}{F'_l} + \frac{\gamma_l}{V'_l} > \frac{w_l^*}{F'_l}.$$

To further illustrate, we first consider the **C-D-C** setting in which workers share the same preferences for goods and for jobs ($\mu_k = \mu_l$ and $\gamma_k = \gamma_l = \gamma$), but differ in productivity ($F'_k > F'_l$). In this case, (13) becomes:

$$w_k^* = \frac{F'_k}{F'_l} w_l^* + \left(\frac{F'_k}{F'_l} - 1\right)\gamma \mathbf{P}^*,$$

which may be rewritten as follows:

$$\frac{w_k^*}{F'_k} - \frac{w_l^*}{F'_l} = \frac{F'_k - F'_l}{F'_k F'_l}\gamma \mathbf{P}^* > 0. \tag{14}$$

Since $F'_k > F'_l$, it must be that $w_k^*/F'_k > w_l^*/F'_l$. This implies the following proposition.

Proposition 2. *More workers' heterogeneity, a greater monopoly power on the product market, or both exacerbate the wage difference between the more and less productive types of labor.*

Intuitively, the relative value of hedonic job attributes is lower for the high-wage workers than for the low-wage workers, thus making the high-wage workers more sensitive to wage differences than the low-wage workers. This concurs with MacDonald and Reynolds (1994) who found substantial evidence that the wedge between the wage and the marginal value product is higher for a young baseball player than for an experienced player. More precisely, these authors showed that salary differences between first and second rank performers greatly exaggerate talent differences. It is worth stressing that the productivity level of workers reflects here their skill level as well as their relative scarcity. In the same spirit, since academics are likely to display fairly heterogeneous preferences in taste for jobs, universities will pay disproportionately high salaries to the super-stars, while underpaying the others.

Ever since Becker (1957), there is a wide consensus in economic theory that increasing competition tends to reduce wage discrimination. And indeed, (14) shows that wage discrimination between the two types of labor declines as the product market gets more competitive, that is, when the price index $\mathbf{P}^*$ falls. For example, Black and Strahan (2001) find that the gap between men's and women's wages shrunk after the deregulation of the banking sector in the US, but did not disappear. Indeed, the wage gap never vanishes as long as there is heterogeneity within types of labor ($\gamma > 0$). Therefore, a tough antitrust policy that intensifies competition on the product market shrinks the discrepancy between wages and workers' productivity. This is likely to be the best instrument that can be used to reduce wage distorsions, for the government must know what the competitive wages would be if it wants to correct those distortions by means of taxes or subsidies. Furthermore, wage discrimination should be stronger in small markets than in large markets because $\mathbf{P}^*$ is higher in the former than in the latter, a result that can be brought to the data. The proposition also implies that the premium paid to the more productive workers rises when competition on the product market is relaxed, perhaps through product differentiation.

We now consider the reverse case in which all workers have the same productivity ($F_k' = F_l'$) but different attitudes toward non-monetary job attributes ($\gamma_k < \gamma_l$). It is then readily verified that (13) is equivalent to

$$w_k^* - w_l^* = (\gamma_l - \gamma_k)\mathbf{P}^* > 0. \tag{15}$$

This expression highlights the main message of the paper by showing in a simple way how heterogeneity *within* each type of labor affects the distribution of earnings *between* types of labor. Since the expression (15) remains valid under free entry, that is, when firms' profits are zero, we may conclude that wage discrimination is not caused by the sole existence of a rent on the product market allocated by firms among different groups of workers. Rather, *heterogeneity is the cause and discrimination the consequence.* To be precise, wage discrimination reflects the heterogeneity of workers between groups of workers, while discrimination is exacerbated when profits are positive, the market becomes less competitive, or both.

4 The free-entry equilibrium

In this section, we assume that firms are free to enter and exit the market and study how this process affects the product and labor markets. Substituting (9) and (10) into (7), we obtain the zero-profit condition:

$$N\pi(i) = E - \sum_\theta w_\theta L_\theta = \frac{E}{F(\mathbf{L}) - Nf} \cdot \left(\left| \frac{q}{p} \frac{\partial p}{\partial q} \right| F(\mathbf{L}) - Nf \right) + \sum_\theta \frac{\gamma_\theta L_\theta}{V'_\theta} = 0.$$

Therefore, the equilibrium mass of firms is implicitly given by

$$N^* = \frac{F(\mathbf{L})}{f} \cdot \frac{\sum_\theta \frac{\gamma_\theta L_\theta}{V'_\theta} + E \cdot \left| \frac{q}{p} \frac{\partial p}{\partial q} \right|}{\sum_\theta \frac{\gamma_\theta L_\theta}{V'_\theta} + E}. \tag{16}$$

Inspecting (16) reveals that increasing firms' market power on both the product market (the demand elasticity $-(q/p)(\partial p/\partial q)$ becomes smaller) and the labor market (γ_θ increases) results in *a higher number of firms under free entry*, the reason being that competition is relaxed on both markets.

Using (16) allows one to show how entry affects the structure of prices and wages. First, substituting (16) into (10), we obtain the free-entry equilibrium price:

$$p^* = \frac{1}{1 - \left| \frac{q}{p} \frac{\partial p}{\partial q} \right|} \cdot \frac{E + \sum_\theta \frac{\gamma_\theta L_\theta}{V'_\theta}}{F(\mathbf{L})}, \tag{17}$$

which now depends on the whole range of heterogeneity indices γ_θ. This price encapsulates a 'double markup' expressed through firms' relative markup on the product market and the weighted sum of heterogeneity indices on the labor markets. These two effects reinforce each other.

As for the free-entry equilibrium wage of a θ-worker, it is still given by (9) where p^* is now given by (17):

$$w^*_\theta = \left(E + \sum_t \frac{\gamma_t L_t}{V'_t} \right) \cdot \frac{F'_\theta}{F(\mathbf{L})} - \frac{\gamma_\theta}{V'_\theta}. \tag{18}$$

The expressions (16), (17) and (18) highlights how the two sources of market imperfection interact to determine the equilibrium number of firms, price and wages.

When firms' monopoly power on the product market increases, e.g., varieties become more differentiated, wages are depressed as long as the number of firms is given. However, the entry of new firms provides workers with a wider range of job opportunities, which tends to push wages upward. As a result, the impact of entry on wages is a priori undetermined.

In order to better understand what is going on, let us consider the benchmark case of perfectly competitive labor markets ($\gamma_\theta = 0$ for all θ). The corresponding equilibrium price and wages are given by

$$\hat{p} = \frac{\hat{E}}{F(\mathbf{L})} \cdot \frac{1}{1 - \left|\frac{q}{p}\frac{\partial p}{\partial q}\right|} \qquad \hat{w}_\theta = \frac{\hat{E}}{F(\mathbf{L})} F'_\theta, \tag{19}$$

where $\hat{E}$is the total expenditure on the differentiated good at the monopolistically competitive equilibrium.

Comparing (18) and (19) reveals that the free-entry equilibrium wage w^*_θ exceeds the competitive wage $\hat{w}_\theta$ if and only if

$$\left(\frac{E - \hat{E}}{\sum_t \gamma_t L_t / V'_t} + 1\right) \cdot \frac{F'_\theta}{F(\mathbf{L})} > \frac{\gamma_\theta / V'_\theta}{\sum_t \gamma_t L_t / V'_t}. \tag{20}$$

Since V'_t varies with the price level and the mass of varieties, which both depend on E, and thus on wages, we are unable to determine under which conditions (20) holds. However, when consumers share the same CES preferences, things become much easier to interpret because all workers spend the same share of their earnings on the differentiated good, which makes the distribution of their earnings irrelevant for the determination of consumers' expenditures E.

Specifically, we have

$$\frac{E - \hat{E}}{\mathbf{P} \sum_t \gamma_t L_t} = 0 \quad \text{ if } \mu_\theta = \mu,$$

so that (20) becomes

$$\frac{F'_\theta}{F(\mathbf{L})} > \frac{\gamma_\theta}{\sum_t \gamma_t L_t}. \tag{21}$$

Note that the two ratios are comparable as both numerators are θ-specific, while the denominators refer to two aggregates. The inequality (21) says that the θ-workers earn a wage exceeding their competitive wage when the ratio of their marginal productivity to the average production of labor exceeds the ratio of their heterogeneity index to the average index. In particular, *workers with lower heterogeneity indices benefit from the presence of equally productive workers who have higher heterogeneity* as they extract more than their competitive wage. To be precise, there exists a cutoff value of θ at which the above inequality is reversed, for otherwise we would have

$$1 = \frac{\sum_\theta F'_\theta L_\theta}{F(\mathbf{L})} > \frac{\sum_\theta \gamma_\theta L_\theta}{\sum_t \gamma_t L_t} = 1.$$

Therefore, the workers whose type exceeds the cutoff are paid more than their competitive wage, whereas those who have a lower type are paid less than their competitive wage. Furthermore, when workers also differ in preferences (μ_θ), these gaps widen when monopsonistic competition on the labor markets redistributes workers' earnings towards those who spend more on the differentiated product, the reason being that the total expenditure E increases and, eventually, becomes higher than $\hat{E}$.

Thus, contrary to the conventional wisdom, we have:

Proposition 3. *Free entry and zero profit do not wash out the between-type redistributional effects of workers' heterogeneity.*

An increase in γ_θ gives rise to two opposite effects. First, it increases firms' monopsony power over the θ-workers, which allows the incumbent firms to pay them lower wages. Second, the incumbents make higher profits, which invites entry; this shifts upward the demand for labor, and thus push wages upward. As shown by differentiating (18) with respect to γ_θ, the former effect dominates the latter so that the θ-workers receive a lower pay. In contrast, an increase in γ_θ is always beneficial to all the other groups of workers because only the entry effect is at work. For example, observing a negative correlation between seniority and salary of university professors, Ransom (1993) argues along the same lines that "[i]ndividuals with high moving costs receive lower salary offers and have higher seniority than individuals with low moving costs." In the same vein, in a society where women would value hedonic job attributes more than men, such as time flexibility and home proximity, *women having the same productivity as men would earn lower wages.*

What is more, the degree of gender discrimination varies with women's marital and family status, an empirical fact detailed by Polachek (2014). If married women with children value more hedonic job attributes than single women, our approach offers a theory of *differential discrimination*: discriminated workers belonging to the same group need not be equally discriminated.

Last, we show how our model can be used to shed new light on two issues that generate hot debates in the literature. First, workers living in small cities operate in markets having a small number N of potential employers, which means that workers must incur the costs of moving to another place if they want to earn higher wages. However, changing place typically involves various kinds of sunk costs, which makes workers stickier. In contrast, workers living in larger cities do not have to change place to face a large array of potential employers because N is higher. This makes them more prone to change jobs. Consequently, workers having the same individual characteristics will earn higher wages in larger cities than in smaller cities because *firms have less monopsony power in thicker labor markets than in thinner ones* (Manning, 2010). Even though it is well documented that the urban wage premium primarily stems from the presence of agglomeration economies at the city level (Rosenthal and Strange, 2004; Combes et al., 2012), we expect this effect to be exacerbated by a lower degree of monopsony power on a large urban labor market, especially for the skilled workers and industries that are disproportionally represented in large cities. Note that this does not contradict Baum-Snow and Pavan (2013) who find a positive correlation between city size and wage disparities across industries. Indeed, larger cities accommodate a wider range of industries and more types of workers who need not face the same equally-broad set of job opportunities.

Second, according to the OECD (2012), the median labor share dropped from 66.1 percent in the early 1990s to 61.7 percent in the late 2000s.[3] Reinterpreting the input vector $\mathbf{l}(i)$ as the amounts of capital and labor needed to produce $q(i) + f$ units of the final good, our results provide a new

[3] Jayadev (2007) finds a robust negative correlation between the degree of openness and the labor share in developed countries.

perspective on the distribution of rents between employers and workers, which supplements those envisioned in the literature (Blanchard and Giavazzi, 2003). Although it is commonly assumed in the literature that workers are perfectly mobile across locations, this assumption is at odd with the empirical evidence. For example, using the British Household Panel Survey that involves $32,380$ individuals from 1991 to 2009, Bosquet and Overman (2015) observe that 43.7 percent of the workers always worked in the same area where they were born. Under these circumstances, our analysis implies that *capital-owners capture a higher rent when workers have a low geographical mobility, whereas sticky workers are hurt when capital-owners seek the highest rate of return at the global level.* Hence, the international integration of capital markets would raise the rent accruing to capital as workers remain confined to local or regional labor markets. Conversely, when capital is locked in specific locations, such as the heavy or oil extraction industry, mobile workers exhibit a lower degree of heterogeneity than capital-owners, thus allowing the former to secure earnings that exceeds their competitive wages.

Since the above argument holds true for any two production factors, we have the next proposition.

Proposition 4. *Assume there is monopolistic competition on the product market and monopsonistic competition on the input markets. If there are two inputs, the input with the higher mobility across firms extracts more than its competitive earning, whereas the input with the lower mobility gains less.*

5 Concluding remarks

The analysis developed in this paper has several important implications. First of all, a group of workers showing a high degree of attachment to specific job attributes is discriminated against compared to a group of workers who put a low weight on non-pecuniary characteristics. For example, in a society dominated by male chauvinist behaviors, women will earn less than men even when they both have the same productivity. Second, preference heterogeneity tends to exacerbate wage inequalities among workers' types. Last, institutions such as minimum wage rules or unions that push wages up more for lesser than higher skilled men (Card et al., 2004) reduce wage dispersion not only by raising the wage of the low-paid workers but also by indirectly decreasing those of the high-paid workers. A progressive income tax should play a similar role by making the high-paid workers less sensitive to gross wages.

Models of monopolistic competition has been extensively used in many economic fields. The tractability of our model, which combines monopsonistic competition and monopolistic competition, should permit its application to a wide range of issues. Except for imperfect competition, labor markets are frictionless–no queueing, unemployment, search costs. As a first extension, it seems natural to investigate how workers' search costs affect the labor market outcome. By analogy with what arises on the product market when consumers incur search costs, we may expect the following scenario to hold. First, the greater the workers' heterogeneity, the more workers search. This intensified search activity reduces firms' monopsony power and increases wages. However, when firms have acquired a better knowledge of workers' heterogeneity, wages fall for the reasons discussed in this paper. This extension can then be grafted onto a setting in which a worker faces a positive probability of not to being hired by the firm she chooses. This should allow one to develop a new theory of unemployment based on imperfectly competitive markets.

Empirical evidence shows that firms differ in productivity. In this case, it is natural to expect the more productive firms to have higher sales, which requires a larger workforce. Being more productive, these firms can afford to pay higher wages to attract the additional workers they need. Since the high-productive workers value relatively more their wages than the other jobs' attributes, the more productive firms will enjoy a more productive labor force, thus magnifying their initial technological advantage through a positive assortative matching à la Sattinger (1993).

A word, in closing. We do not consider the approach developed in this paper as an alternative to other theories explaining the distribution of earnings. On the contrary, we see it as a "prediction-augmenting" theory that can be grafted onto others. Heterogeneity is pervasive in the real world and there is no apparent reason why labor markets should be immune.

Appendix

Proof of $dw_\theta^*/dN > 0$ in the C-D-C case.

Plugging (11) into (12) and differentiating the resulting expression with respect to N yields

$$\frac{dw_\theta^*}{dN} = \mu \frac{f(\sigma-1)^2 HN + [H\mu(\sigma-1) - w_\theta^*(1-\mu)\sigma(L-Nf)](L-Nf\sigma)}{\sigma(\sigma-1)(1-\mu)N(L-Nf)^2}.$$

It follows from (12) that

$$0 < w_\theta^* < \frac{\mu}{1-\mu}\frac{H}{L-Nf}\frac{\sigma-1}{\sigma}. \tag{A.1}$$

Assume, first, that $L - Nf\sigma > 0$. In this case, dw_θ^*/dN decreases with w_θ^*. Given (A.1), it is then readily verified that

$$\frac{dw_\theta^*}{dN} > \frac{\mu}{1-\mu}\frac{H}{(L-Nf)^2}\frac{\sigma-1}{\sigma}f > 0.$$

We now assume that $L - Nf\sigma < 0$. Therefore, dw_θ^*/dN increases with w_θ^*. Using (A.1), we thus obtain:

$$\frac{dw_\theta^*}{dN} > \mu H \frac{\mu(L-Nf) + Nf(1-\mu)(\sigma-1)}{\sigma N(1-\mu)(L-Nf)^2} > 0.$$

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