

Emami Namini, Julian; Chisik, Richard

Conference Paper

International Trade and Labor Market Discrimination

Beiträge zur Jahrestagung des Vereins für Socialpolitik 2015: Ökonomische Entwicklung - Theorie und Politik - Session: Trade, Labor, and Inequality, No. A05-V2

Provided in Cooperation with:

Verein für Socialpolitik / German Economic Association

Suggested Citation: Emami Namini, Julian; Chisik, Richard (2015) : International Trade and Labor Market Discrimination, Beiträge zur Jahrestagung des Vereins für Socialpolitik 2015: Ökonomische Entwicklung - Theorie und Politik - Session: Trade, Labor, and Inequality, No. A05-V2, ZBW - Deutsche Zentralbibliothek für Wirtschaftswissenschaften, Leibniz-Informationszentrum Wirtschaft

This Version is available at:

<https://hdl.handle.net/10419/113074>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

International Trade and Labor Market Discrimination

Richard Chisik* and Julian Emami Namini†

February 24, 2015

Abstract

We embed a competitive search model with labor market discrimination into a two-sector two-country framework in order to analyze the relationship between international trade and labor market discrimination. Discrimination reduces the matching probability, and output, in the skilled-labor differentiated-product sector so that the country with more discriminatory firms has a comparative advantage in the simple sector. As countries alter their production mix in accordance with their comparative advantage, trade liberalization can then reinforce the negative effect of discrimination on development in the more discriminatory country and reduce its effect in the country with fewer discriminatory firms. Similarly, the relative profit difference between non-discriminatory and discriminatory firms will increase in the less discriminatory country and shrink in the more discriminatory one. In this way trade can further reduce discrimination in a country where it is less prevalent and increase it where it is more prevalent.

JELClassification: F16, F66, J71

Keywords: Discrimination, Nepotism, International Trade, Competitive Search

*Department of Economics, JOR-211, Ryerson University, Toronto, ON, M5B 2K3. E-mail: rchisik@arts.ryerson.edu. Phone: +1-416-979-5000 Ext. 4620.

†Erasmus School of Economics, Erasmus University Rotterdam, P.O. Box 1738, 3000DR Rotterdam, the Netherlands. E-mail: emaminamini@ese.eur.nl. Phone: +31-10-408-1399.

1 Introduction

In Gary Becker's (1957) seminal work on labor market discrimination he suggested that discrimination is costly to the firms that practice it. In a similar way that a discriminator has to pay for his taste to exclude certain groups, a nepotist will incur a cost when he excludes non-relatives.¹ If practicing discrimination (or nepotism) reduces the relative productivity of a firm within a country, then it seems possible that a country where discrimination or nepotism is more prevalent may have lower relative productivity in sectors where exclusion is more costly. In this paper we analyze this question to determine if some forms of labor market discrimination can be a source of comparative advantage. We then return to Becker's original idea and ask whether the pro-competitive effects of international trade can mitigate discrimination.

The effect of discrimination on aggregate productivity and growth has received recent attention. For example, Hsieh et al. (2013), show that between fifteen and twenty percent of the growth in US output per worker between 1960 and 2008 can be explained by allowing blacks and white women into skilled occupations in which they were formerly very poorly represented. The negative effect of the gender wage gap on growth has also been demonstrated by Galor and Weil (1996), Lagerlöf (2003), Esteve-Volart (2009), and Teignier and Cuberes (2014).² The effect of nepotism on economic performance in southern European countries has been studied by Bloom and Van Reenen (2007). We depart from these previous studies by considering the effect of discrimination on the pattern of trade as well as the converse effect of trade liberalization on discrimination.

We take as given that some forms of labor market discrimination and nepotism exist and ask how does this discrimination affect the structure of the economy.³ A very nice overview of the literature

¹In fact, Bloom and Van Reenen (2007) show that much of the long tail of very-poorly managed firms can be explained by primogeniture.

²An interesting anecdotal example is provided by India. It is a democracy that does not suffer from a natural resource curse and has a large well-educated English-speaking population, but that still suffers from very low labor productivity. A partial explanation may be found in the fact that twenty-five percent of India's population belongs to the scheduled (formerly backward) castes and tribes (i.e. the untouchables) and over thirteen percent of India's population is Muslim. Thus, more than thirty-eight percent of India's population has historically suffered restricted access to the Indian formal labor market.

³As Gary Becker noted about his (1957) book "For several years it had no visible impact on anything. Most economists did not think racial discrimination was economics, and sociologists and psychologists generally did not believe I was contributing to their fields," as quoted in Murphy (2014). The eventual realization that discrimination is an important topic for economists is echoed in the words of Kevin Murphy (2014), "Now the impact is clear. Not only is racial discrimination viewed as a subject about which economics has something useful to say, but economists are among the top academics in any field researching the topic."

on discrimination is provided by Lang and Lehman (2012), who discuss an overwhelming number of papers that cannot reject the empirical evidence on labor-market discrimination. Fang and Moro (2010) contains a review of many additional theoretical papers on discrimination that are not covered in Lang and Lehman (2012).

To this end, we embed a directed (competitive) search model into a general equilibrium framework. There are two sectors in the economy: a simple sector that uses only labor and a sector where each firm produces a differentiated product using labor and a manager. Firms in this second sector can only produce if they successfully hire a manager. In order to locate a manager, firms post a payment for the manager and the skilled workers decide where to apply (unskilled workers cannot become managers). Any skilled worker who does not find a match as a manager can work with the unskilled workers as labor in either sector. There are profits in the restricted entry differentiated product sector (as long as the firm successfully hires a manager) and part of these profits are payment to the manager. The remainder of the profits are shared equally by all agents.

Our modeling of discrimination in a competitive search model follows Lang et al (2005).⁴ All firms prefer to hire a manager of a certain label. That is, productivity of either label of skilled worker is the same, but every firm has a very slight preference for an *A*-label over a *B*-label manager. Labels may refer to differences in skin color, eye color, gender, religion, caste, ancestral origin, native language, regional accent, or familial connections. This preference only matters if skilled workers of both labels apply to the same firm. In that case a firm would always hire an *A*-label manager and they would hire a *B*-label only if no *A*-labels apply. This firm preference implies that in equilibrium no *B*-labels will apply to a firm that attracts *A*-labels and vice-versa. Hence, there will be two posted payments in equilibrium: a higher one by firms that attract *A*-labels and a lower one by those that attract *B*-labels. Because the two groups are divided, both posted payments will be lower than in the label-blind equilibrium (i.e. in the equilibrium without discrimination). Furthermore, because the posted payments are different, the number of firms posting each payment will

⁴Although several of our results are similar to theirs we present all results and propositions without referring the reader to their paper for two reasons. First, intimate familiarity with their model is necessary in order for the reader to understand our extensions of it to general equilibrium, international trade, and the introduction of some non-discriminatory firms. Second, we provide some additional figures that further explain the workings of their model.

be different.⁵ There will then be an asymmetric arrival rate at the two groups of firms and, therefore, the overall arrival rate of potential managers at firms will be lower than in the label-blind equilibrium. Hence, the matching rate will be lower in the discriminatory equilibrium.

The lower match success rate implies fewer varieties of the aggregate differentiated product and a higher relative autarky price of this product for a country in a discriminatory equilibrium. Hence, when liberalizing trade with a label-blind country, the discriminating country will be a net exporter of the simple good that does not require a manager or a skilled worker. It is through the induced distortion in the matching process that discrimination inhibits development of the differentiated product sector and generates comparative advantage in the simple sector. The country in a label-blind equilibrium will have more varieties per agent and, therefore, realized profits of a successful firm (i.e. of a firm that has found a manager) will drop when the discriminatory country liberalizes trade. Output per successful firm, output for the entire differentiated product sector, and the payment to each hired manager will also fall in the discriminatory country as a result of trade liberalization.

In order to consider the effect of trade on discrimination we introduce a second type of firm. These additional firms are label-blind and it is common knowledge that they do not discriminate. Because they are known to not show hiring preference to either label of manager, they can offer a higher payment to *B*-label managers than can the existing discriminatory firms. This higher payment by a discriminatory firm would attract *A*-labels because they would be hired with certainty, however, they would only be hired with an equal probability by the non-discriminatory firms. The presence of these non-discriminatory firms partially mitigates the discrimination induced matching inefficiencies in the resulting equilibrium. In addition, these firms have higher expected profits than the discriminatory firms because they have a higher matching probability.⁶

Finally, we consider trade between two countries that differ in their percentage share of non-discriminatory firms in the firm distribution. Our previous result on comparative advantage

⁵As a result of the lower payment and, therefore, more profit per successful match, more firms will post a payment to attract a *B*-label manager than those that post to attract an *A*-label manager.

⁶If entry were costless, then these firms would come to dominate the market which would substantiate Becker's (1957) hypothesis. Alternatively, if firms had to pay an entry cost and firms had differing entry costs, then non-discriminatory firms could enter for a higher entry cost, but they would not take over the market. As our focus is on how trade affects each type of firm, we limit their numbers and instead analyze how the relative profits of discriminatory and non-discriminatory firms are effected by trade.

translates to this extended version of our model. In particular, the country with relatively more discriminatory firms will have a comparative advantage in the simple sector. For the country with more label-blind firms, output per successful firm, output of the differentiated product sector, the realized profit of a successful firm, and the payment to each manager will all increase when liberalizing trade and the opposite will happen in the country with more discriminatory firms. Because the expected profits of a label-blind firm are greater than those of a discriminatory firm, they will see a bigger change as a result of opening to trade. In particular, because of their higher match probability, any change in realized firm profit has a magnified effect on their expected profit. Label-blind firms will, therefore, increase their expected profits by more than the discriminatory firms in the country with less discrimination, and they will decrease by more in the country with more. Hence, trade will help ameliorate discrimination in the country where it is less prevalent and enhance it in the country where it is worse.

Our paper is related to several distinct strands of the literature.

We contribute to the research mentioned above that relates discrimination (or nepotism) to growth by considering their effect on the pattern of trade and the converse effect of trade on discrimination. Starting with Black (1995) and Rosen (1997, 2003), economists have analyzed discrimination as the equilibrium of a model with random search. Recognizing that firms may want to strategically post a payment, Lang et al. (2005) analyze discrimination as the equilibrium of a competitive search framework. We extend this literature by adding some additional non-discriminatory firms to the framework of Lang et al. (2005), embedding it into a two-sector general equilibrium environment, and allowing for international trade. Finally, our paper is related to the broad literature on international trade with labor market frictions, such as Davidson et al. (1999), Davidson et al. (2008), Helpman and Itskhoki (2010), Helpman et al. (2010), Ranjan (2013), and Grossman et al. (2013). We extend this literature in two ways. First, we analyze a competitive instead of a random search framework. Second, we analyze discrimination as a source of comparative advantage.

In the next section we describe our framework. In the third section we consider the working of the model without discrimination. Discrimination is introduced in the fourth section and comparisons are made in the fifth section. International trade is considered in the sixth section. In the seventh section we introduce some non-discriminatory firms and we analyze trade in this

extended framework in the eighth section. Our conclusions are contained in the ninth section.

2 Economic environment

There are two countries: home and foreign. Foreign variables are denoted with an (*). In each country there are two sectors. The numeraire sector produces perfectly substitutable goods with a constant returns to scale technology using only labor. The monopolistically competitive sector produces differentiated goods using labor and a manager. Upper tier preferences over goods from the two sectors can be represented by a Cobb-Douglas utility function:

$$U(C_M, C_0) = C_M^\alpha C_0^{1-\alpha}. \quad (1)$$

Preferences over the manufactured goods in the monopolistically competitive sector can be represented by a constant elasticity of substitution sub-utility function:

$$C_M = \left(\sum_{z=0}^{\infty} c_z \frac{\sigma-1}{\sigma} \right)^{\frac{\sigma}{\sigma-1}}, \quad (2)$$

where the elasticity of substitution between varieties is σ and $\sigma > 1$. Therefore, none of these varieties is essential to consumption. Although preferences are defined over a potentially infinite number of varieties, only a finite number will be available to consume. Agents derive labor income from working as either labor, or if they are skilled and successfully locate a match, as a manager. In addition, all agents are equal owners of each of the firms and they equally share any firm profits (which may exist in the restricted entry monopolistically competitive sector). Each firm producing in the monopolistically competitive sector has the same technology:

$$\ell_z = \begin{cases} q_z + f & \text{if } m_z = 1 \\ \xi q_z & \text{if } m_z = 0 \end{cases}, \quad (3)$$

where ℓ_z is the amount of labor used in producing good z , q_z is the quantity of good z , m_z is a manager for the firm producing good z , f denotes the fixed input requirement, and ξ is an

arbitrary large constant that makes production unfeasible if firm z is not successful in hiring a manager, i.e. if $m_z = 0$. We use the convention that the fixed cost of production, f , is paid in terms of labor.

The technology for producing the numeraire good is $\ell_0 = q_0$, and the labor supply of each country, $L = L^*$, is assumed to be large enough so that there is positive numeraire production in each country and the wage of unskilled workers in either sector is, therefore, equal to the price of the numeraire good which is one.

We will be interested in the composition of firms in the monopolistically competitive sector (rather than the number of firms). Therefore, the number of potentially active firms in the monopolistically competitive sector, $N = N^*$, is taken as exogenous. As a result of search frictions only a fraction M of the N (M^* of the N^*) firms will be successful in hiring a manager and producing.⁷ Still, the size of the economy is large enough so that the number of operating manufacturing firms is large and, therefore, the effect of each manufacturing firm's output on the price and quantity of other firms is negligible.

For each home firm that successfully hires a manager, the product market is described by monopolistic competition. As shown by Dixit and Stiglitz (1977), the set of purchased manufactured goods can be considered as a composite good C_M with corresponding aggregate price

$$P_M = \left(\sum_{z \in M} p_z^{1-\sigma} \right)^{\frac{1}{1-\sigma}}. \quad (4)$$

Consumer maximization of the first stage utility function yields the following demand functions:

$$C_M = \frac{\alpha I}{P_M}; \quad C_0 = \frac{(1-\alpha)I}{P_0}. \quad (5)$$

Consumer maximization of the sub-utility function yields demand for each variety as

$$c_z = C_M \left(\frac{p_z}{P_M} \right)^{-\sigma} = \frac{\alpha I}{M p_z} \quad (6)$$

Each manufacturing firm chooses output to maximize profits, taking the output of other firms

⁷Although $N = N^*$, it is not necessarily the case that $M = M^*$.

and the aggregate price index and C_M as given. This leads to the following pricing rule: $p_z = \frac{\sigma}{\sigma-1}$.

Hence,

$$c_z = \frac{\alpha I}{M \frac{\sigma}{\sigma-1}}, \quad (7)$$

and the gross profits of operating each firm is given by:

$$\pi_z = r_z - l_z = p_z q_z - q_z - f = p_z q_z - q_z p_z \frac{\sigma-1}{\sigma} - f = \frac{r_z}{\sigma} - f, \quad (8)$$

where $r_z = C_M P_M^\sigma \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}$.

Agents in each country are either skilled or unskilled. Unskilled ones work either in the numeraire sector or as laborers in the manufacturing sector. Skilled workers can work as a manager if they are offered a managerial job and they can also work as unskilled labor if their managerial search is unsuccessful.

In addition to their skills (skilled versus unskilled), agents differ by their label $k \in \{A, B\}$. Labels may refer to differences in skin color, eye color, gender, religion, caste, ancestral origin, native language, regional accent, or familial connections. This label is also perfectly observable and it is common knowledge that productivity does not depend on the label. The number of skilled workers in each country with each label is a Poisson random variable $\tilde{\Lambda}_k$ whose mean is $\Lambda_k = E(\tilde{\Lambda}_k)$. The total number of skilled workers in each country is identical: $\tilde{\Lambda} = \tilde{\Lambda}^*$. Although the mean of this random variable is common knowledge its realization is not observed by the firms or the other agents.⁸

Despite the identical productivity for skilled workers, firms in the home country may prefer to hire an A -label manager. In particular, the disutility for a home firm that hires a B -label manager is δ , where δ is a vanishingly small amount. Hence, preferences of home country firms are lexicographic: if skilled managers of each label apply to the same job with the same posted bonus, then the firm will hire the A -label worker. We use the term “bonus” for the payment to managers in order to differentiate it from the payment to labor, which is the wage. A B -label manager will be

⁸This assumption ensures that each firm considers the number of skilled applicants that it receives as a Poisson random variable and not binomial even for a finite number of skilled applicants. If the number of skilled applicants were large as is commonly assumed in the literature, then we could rely on the usually employed limiting result. As we assume that the number of skilled agents is small compared to the total labor supply, we make the additional assumption.

hired by a home firm only if there are no A -label skilled applicants at the posted bonus. Finally we denote the percent of B -label skilled workers in the home country as β so that the number of A -label skilled workers is $(1 - \beta)\tilde{\Lambda}$. Firms have no preferences over the label of unskilled workers. The percent of B -label skilled workers in foreign is irrelevant because foreign firms have no preference over the label of their managers.

The timing and information structure of the model is as follows. We write the case of the home country. The foreign country is similar. The number of potentially active monopolistically competitive firms, N , and the labels are common knowledge. First, each of the N firms posts a bonus, b_z , for a manager. Second, skilled workers observe the vector of posted bonuses, $\mathbf{b} = \{b_z\}$, and decide where to apply. Skilled workers can only apply once and to only one firm.⁹ Formally, from the perspective of firms a worker's action at this stage is a collection of probabilities that they will apply to firm z , denoted as $a_z(\mathbf{b})$. From the perspective of firms, workers play mixed strategies. The skilled worker's strategy is restricted to those that assign equal probability to all firm's offering the same bonus. Hence, the workers' strategies satisfy anonymity. Third, the M firms that have an applicant are successful and will produce and sell their goods in the market. Unsuccessful firms will not produce. Unmatched skilled workers and all unskilled workers will work as wage laborers in the manufacturing or numeraire sector.

Firm z 's strategy consists of posting a bonus and choosing output. Each agent's strategy is a vector of application probabilities $\mathbf{a}(\mathbf{b}) = \{a_z(\mathbf{b})\}$. If all skilled workers with the same label use the same strategy, then the number of workers of each label applying to firm z will also have a Poisson distribution whose mean is given by:

$$\lambda_{zk} = a_z(\mathbf{b})\Lambda_k. \quad (9)$$

3 Closed economy without discrimination

We start with the case of no discrimination and with a closed economy, therefore, we can suppress the subscript k in this section. We will denote equilibrium values with a hat “ $\hat{}$ ” and row or

⁹As long as there is some cost to additional applications, allowing skilled workers to apply to more than one firm would not have any effect in a qualitative sense on our results.

column vectors by bold face letters. A manufacturing firm will only be able to produce if it hires a manager. This occurs if and only if it receives at least one applicant. The probability it receives at least one applicant is

$$1 - Pr(\lambda_z = 0) = 1 - e^{-\lambda_z}, \quad (10)$$

where we have made use of the Poisson distribution.¹⁰ Then the expected profit net of payment to a manager is:

$$E(\pi_z^{net}) = (1 - e^{-\lambda_z})(\pi_z - b_z), \quad (11)$$

where b_z denotes the bonus to the manager. The equilibrium level of b_z , which maximizes $E(\pi_z^{net})$, will be derived below.

We now consider a skilled worker's decision. The probability that applicant $i + 1$ is hired at a firm z is the product of the probability that there are i other applicants to a firm, which is $\frac{e^{-\lambda_z} \lambda_z^i}{i!}$, times the probability that the $(i + 1)$ th applicant is the chosen one. This product is $\frac{1}{i+1} \frac{e^{-\lambda_z} \lambda_z^i}{i!}$ (notice that a worker does not have any information about how many potential managers already applied). Summing over all possible values of i yields the probability (from the perspective of an applicant) that an additional applicant is hired at a single firm z :

$$Pr(\text{hired}) = h(\lambda_z) = \sum_{i=0}^{\infty} \frac{1}{i+1} \frac{e^{-\lambda_z} \lambda_z^i}{i!} = \frac{e^{-\lambda_z}}{\lambda_z} \sum_{i=0}^{\infty} \frac{\lambda_z^{i+1}}{(i+1)!} = \frac{1 - e^{-\lambda_z}}{\lambda_z}. \quad (12)$$

Let V_z be the expected bonus that a prospective manager receives if he or she applies to a firm z . Then, $V_z = b_z h(\lambda_z)$. Since a skilled worker will only apply with positive probability at the firm(s) which offer(s) the highest bonus, the equilibrium expected bonus for a skilled worker is $\hat{V} = \max_z \{V_z\}$.¹¹ Hence, in equilibrium: $V_z = \hat{V}$ if $b_z \geq \hat{V}$ and $V_z = b_z$ if $b_z < \hat{V}$ and $\lambda_z > 0$ for $b_z \geq \hat{V}$ and $\lambda_z = 0$ for $b_z < \hat{V}$.

Thus, for $b_z \geq V$ we have $\lambda_z = h^{-1}\left(\frac{\hat{V}}{b_z}\right)$.¹² Then, for any firm choosing $b_z \geq \hat{V}$ the expected

¹⁰The probability that there are i applicants is $\frac{e^{-\lambda_z} \lambda_z^i}{i!}$.

¹¹Note that the prospective manager's strategy is a mixed strategy and they only apply to one firm but each firm treats it as a probability that they apply to all offering the same wage – given the assumed anonymity of the skilled workers' strategy.

¹²Although in equilibrium all firms offer the same bonus, we have not imposed the equilibrium condition at this point. An identical V could result for different b s across firms if a different number of skilled workers applies to each firm.

number of applicants is λ_z . Hence, in equilibrium, the expected number of applicants to all firms is:

$$\sum_{z=1}^N \lambda_z = \sum_{z|b_z \geq V} h^{-1} \left(\frac{\hat{V}}{b_z} \right) = \Lambda. \quad (13)$$

Note that h is strictly decreasing in λ_z . Therefore, h^{-1} is strictly decreasing in V and the number of terms in the summand are weakly decreasing in V . Hence, there exists a unique solution \hat{V} to the above equation.

We now consider a sub-game perfect monopolistically competitive equilibrium (SPMCE), which is characterized as follows:

1. Each firm chooses p_z to maximize π_z , given the assumption that C_M, P_M are not sensitive to a firm's own price.
2. Each agent chooses C_0 and the amount c_z consumed of each variety of C_M to maximize utility subject to the budget constraint and under the assumption that prices are invariant to the agent's own choices.
3. Each firm's \hat{b}_z is a best response to $\hat{\mathbf{b}}$ and to $\hat{\mathbf{a}}$, given the assumption that $V(\mathbf{b})$ is not sensitive to a firm's own bonus offer.
4. Each skilled worker's $\hat{a}(\mathbf{b})$ is a best response to $\hat{\mathbf{b}}$ and to $\hat{\mathbf{a}}(\hat{\mathbf{b}})$ of all other workers.
5. Relative supply of the $\hat{M} + 1$ goods equals relative demand for the $\hat{M} + 1$ goods and the labor market clears.

In solving for market clearing, note that since all manufacturing firms charge an identical price in equilibrium, they all sell the same amount of their variety. Thus, we must also have: $\frac{Q_0}{q} = M \frac{\sigma}{\sigma-1} \frac{1-\alpha}{\alpha}$. Labor market clearing implies that $L - \Lambda h(\lambda) = L - M$ workers work as unskilled workers, and $\sum_{j=1}^M (q + f)$ of these unskilled workers work in the monopolistically competitive sector. Hence, $C_0 = L - \Lambda h(\lambda) - \sum_{j=1}^M (q + f) = L - M(1 + q + f)$. The total number of skilled workers is Λ , therefore, the number of skilled workers who work as unskilled is $\Lambda - M = \Lambda [1 - h(\lambda)]$. The condition that relative supply equals relative demand therefore becomes: $\frac{L - M(1 + q + f)}{q} = M \frac{\sigma}{\sigma-1} \frac{1-\alpha}{\alpha}$.

The key to solving for the SPMCE is analyzing the interaction between the monopolistically competitive firms and their skilled applicants. The following proposition establishes this relationship.

Proposition 1. *There exists a unique symmetric SPMCE in which: (i) all firms offer an identical bonus $\hat{b} = \frac{\hat{V}(\hat{\mathbf{b}})}{h(\hat{\lambda})}$ and all workers adopt the same mixed application strategy in which the application probability at a single firm is given by $\hat{a} = a_z(\hat{\mathbf{b}})$; (ii) $\hat{b}_z = \frac{\hat{\pi}_z \hat{\lambda}}{e^{\hat{\lambda}} - 1}$; (iii) $\hat{V} = \hat{b}h(\hat{\lambda}) = \hat{\pi}e^{-\hat{\lambda}}$; and (iv) $E(\hat{\pi}^{net}) = [1 - (1 + \hat{\lambda})e^{-\hat{\lambda}}] \hat{\pi}$.*

Proof. First, we know from $V_z = b_z h(\lambda)$ that, in equilibrium, $b_z = \frac{V_z}{h(\lambda_z)}$. Thus, we can rewrite the expected profit net of payment to a manager as follows: $E(\pi_z^{net}) = (1 - e^{-\lambda_z}) \left(\pi_z - \frac{V}{h(\lambda_z)} \right) = (1 - e^{-\lambda_z}) \pi_z - \lambda_z V$ since $h(\lambda_z) = \frac{1 - e^{-\lambda_z}}{\lambda_z}$.

The value of λ_z which maximizes $E(\pi_z^{net})$ results from the following necessary first order condition: $\frac{\partial E(\pi_z^{net})}{\partial \lambda_z} = -\hat{V}(\hat{\mathbf{b}}) + \pi_z e^{-\lambda_z} = 0$, which can be solved for $\hat{\lambda}_z = \ln\left(\frac{\pi_z}{\hat{V}(\hat{\mathbf{b}})}\right)$. This latter equation can be transformed to $e^{\hat{\lambda}} = \frac{\hat{\pi}}{\hat{V}(\hat{\mathbf{b}})}$ or $\hat{V}(\hat{\mathbf{b}}) = \frac{\hat{\pi}}{e^{\hat{\lambda}}}$. Considering that $\hat{V}(\hat{\mathbf{b}}) = \hat{b}h(\hat{\lambda})$, we can thus derive $\hat{b} = \frac{\hat{\pi}}{h(\hat{\lambda})e^{\hat{\lambda}}} = \frac{\hat{\pi}e^{-\hat{\lambda}}}{1 - e^{-\hat{\lambda}}} \hat{\lambda} = \frac{\hat{\pi}\hat{\lambda}}{e^{\hat{\lambda}} - 1}$. As a consequence, we can rewrite the expected profits of a firm z , net of payments to a manager, as $E(\hat{\pi}^{net}) = (1 - e^{-\hat{\lambda}}) \hat{\pi} - \hat{\lambda} \hat{\pi} e^{-\hat{\lambda}} = [1 - (1 + \hat{\lambda})e^{-\hat{\lambda}}] \hat{\pi}$.

In equilibrium, potential managers apply at all firms with an identical probability. Therefore, we have $\hat{\lambda} = \frac{\Lambda}{N}$. Thus, we can solve for M : $M = \Lambda \frac{1 - e^{-\hat{\lambda}}}{\hat{\lambda}}$.

Second, we can solve the condition that supply of the numeraire good relative to supply of a single variety should equal demand for the numeraire good relative to demand for a single variety, for q : $q = \alpha \frac{\sigma - 1}{\sigma - \alpha} \left[\frac{L}{M} - (1 + f) \right] = \alpha \frac{\sigma - 1}{\sigma - \alpha} \left[\frac{L}{\Lambda \frac{1 - e^{-\hat{\lambda}}}{\hat{\lambda}}} - (1 + f) \right]$.

Third, once we know q , we can solve for the profits $\hat{\pi}$ of a single firm: $\hat{\pi} = \frac{q}{\sigma - 1} - f$.

Fourth, once we know $\hat{\pi}$, we can solve for \hat{b} and \hat{V} . Once $\hat{\lambda}$, \hat{V} , \hat{b} and M are known, we can solve for the aggregate price index P_M , income I and consumption of the two (aggregate) goods C_0 and C_M . □

Although income does not affect the autarky outcome, it will be important in describing the international trade equilibrium. The $L - \Lambda$ unskilled workers each receive a wage of one. The Λ skilled workers have an expected return of $\hat{V} + \left(1 - \frac{M}{\Lambda}\right)$, where $\frac{M}{\Lambda}$ is the probability of a successful match. The profits of the M successful firms, $\hat{\pi} - \hat{b}$, are shared equally by all agents and in equilibrium

$\hat{V} = \frac{M\hat{b}}{\Lambda}$. Hence, total income is $I = L - \Lambda + \left[\hat{V} + \left(1 - \frac{M}{\Lambda}\right) \right] \Lambda + M(\hat{\pi} - \hat{b}) = L + M(\hat{\pi} - 1)$, which we state as Lemma 2 below.

Lemma 2. *National income is $L + M(\hat{\pi} - 1)$.*

4 Closed economy with discrimination

We now consider two labels of workers, A and B . All firms have a disutility δ when employing B workers: $E(U_{Az}) = E(\pi_z^{net})$ and $E(U_{Bz}) = E(\pi_z^{net}) - \delta$, where U_{Az} and U_{Bz} denote the utility of a firm z employing an A -label or a B -label manager, respectively, and δ is vanishingly small. Hence, firms' preferences are essentially lexicographic. They prefer to have a match, and given a match, they prefer an A -label manager.

Firms can only post a single wage and skilled workers can apply at most to only one firm. The skilled workers' strategies again satisfy anonymity.

The case for A -label workers is the same as in the previous section. Of course, the measure of all workers combined is greater than the measure of A -label workers, therefore, the bonuses and also the expected number of applicants may change in this two-label case.

For B -label skilled workers, they would be hired with equal probability if and only if no A -labels apply. The probability that no A -labels apply is: $1 - \sum_{i=1}^{\infty} \frac{e^{-\lambda_A} \lambda_A^i}{i!} = e^{-\lambda_A}$. Hence, the probability that an additional B -applicant is hired is: $h(\lambda_A, \lambda_B) = e^{-\lambda_A} h(\lambda_B) = e^{-\lambda_A} \frac{1 - e^{-\lambda_B}}{\lambda_B}$.

The expected bonus for a B -worker applying to a firm z is: $V_{Bz} = h(\lambda_{Az}, \lambda_{Bz}) b_{Bz}$. The expected equilibrium bonus is $\hat{V}_B = \max_z \{h(\lambda_{Az}, \lambda_{Bz}) b_{Bz}\}$.

As it is the case for A -label skilled workers, no B -worker will apply to a firm which offers $b_{Bz} \leq \hat{V}_B(\hat{\mathbf{b}})$. Furthermore, there exists a $\bar{b}(\mathbf{b})$ such that for all $b > \bar{b}(\mathbf{b})$ too many A -label workers would apply and, therefore, no B -label worker would expect to be hired and no B -label worker would apply. Hence, $\lambda_{Bz} = 0$ for $b_z \leq \hat{V}_B(\mathbf{b})$, $\lambda_{Bz} = 0$ for $b_z \geq \bar{b}(\mathbf{b})$ and $\lambda_{Bz} > 0$ only for $\hat{V}_B(\mathbf{b}) < b_z < \bar{b}(\mathbf{b})$.

We now consider the firms' optimal bonus choice. If a firm z attracts both A -label and B -label

applicants, the firm's expected net profit is:

$$E(U_z) = E(U_{Az}) + E(U_{Bz}) = (1 - e^{-\lambda_A}) (\pi_z - b_z) + e^{-\lambda_A} (1 - e^{-\lambda_B}) (\pi_z (1 - \delta) - b_z). \quad (14)$$

The firm's optimal choice of bonus satisfies $\frac{\partial E(U_z)}{\partial b_z} = 0$, i.e.:

$$e^{-\lambda_A} - 1 + \frac{\pi_z - 2b_z + (1 - e^{-\lambda_B}) \pi_z (1 - \delta) + e^{-\lambda_B} b_z}{e^{\lambda_A}} \frac{\partial \lambda_A}{\partial b_z} + \frac{e^{-\lambda_B} - 1}{e^{\lambda_A}} + \frac{(\pi_z (1 - \delta) - b_z)}{e^{\lambda_A} e^{\lambda_B}} \frac{\partial \lambda_B}{\partial b_z} = 0. \quad (15)$$

If $\delta \rightarrow 0$, then:

$$\frac{\partial E(U_z)}{\partial b_z} \rightarrow \frac{\partial E(\pi_z^{net})}{\partial b_z} = e^{-\lambda_A} e^{-\lambda_B} - 1 + e^{-\lambda_B} e^{-\lambda_B} (\pi_z - b_z) \left(\frac{\partial \lambda_A}{\partial b_z} + \frac{\partial \lambda_B}{\partial b_z} \right). \quad (16)$$

Hence, if $\frac{\partial \lambda_A}{\partial b_z} + \frac{\partial \lambda_B}{\partial b_z} < 0$, then $\frac{\partial E(\pi_z^{net})}{\partial b_z} < 0$. In this case a firm choosing a bonus that is large enough to attract A - and B -label workers would want to lower the offered bonus and then only attract B -label workers. Notice that the condition $\frac{\partial \lambda_A}{\partial b_z} + \frac{\partial \lambda_B}{\partial b_z} < 0$ says that an increase in the offered bonus would decrease the number of B -label applicants by more than it would increase the number of A -label applicants. Hence, a reduction in the bonus would increase the number of B -level applicants by more than it would decrease the number of A -label applicants and no firm would ever choose a bonus that attracts both labels of potential managers.

Rewriting the term for the expected market bonus leads to: $\hat{V}_B(\mathbf{b}) = b_z e^{-\hat{\lambda}_A} h(\hat{\lambda}_B) = b_z e^{-\hat{\lambda}_A} \frac{1 - e^{-\hat{\lambda}_B}}{\hat{\lambda}_B}$ and $\hat{V}_A(\mathbf{b}) = b_z h(\hat{\lambda}_A) = b_z \frac{1 - e^{-\hat{\lambda}_A}}{\hat{\lambda}_A}$. In the appendix we show that totally differentiating these two equations with respect to the (common) bonus and holding the aggregates constant yields that $\frac{\partial \lambda_A}{\partial b_z} + \frac{\partial \lambda_B}{\partial b_z} < 0$.

If no B -label workers apply, then:

$$\frac{\partial E(U_{Az})}{\partial b_z} = (e^{-\lambda_A} - 1) + (\pi_z - b_z) e^{-\lambda_A} \frac{\partial \lambda_A}{\partial b_z} = 0. \quad (17)$$

If no A -label workers apply, then:

$$\frac{\partial E(U_{Bz})}{\partial b_z} = (e^{-\lambda_B} - 1) + e^{-\lambda_B} [\pi_z (1 - \delta) - b_z] \frac{\partial \lambda_B}{\partial b_z} = 0. \quad (18)$$

We have now established the following:

Proposition 3. *In any SPMCE firms separate so that a firm chooses a bonus that will attract only A-label workers or only B-label workers, but not both.*

Denote by N_A and N_B the numbers of A- and B-label attracting firms and note that in equilibrium the expected net profit at each firm must be the same. Note also that $\lambda_A = \frac{\Lambda_A}{N_A}$ and $\lambda_B = \frac{\Lambda_B}{N_B}$ are the expected numbers of applicants to firms in each group. We can now derive the equilibrium bonuses, expected profits and expected income for each type of firm and label of worker. Denote π_D as the realized profit in an equilibrium with discrimination and $b_A(b_B)$ as a bonus offer that only attracts A-label (B-label) skilled workers. This leads us to proposition 4.

Proposition 4. *In any SPMCE with discrimination and $\delta \rightarrow 0$ we have: (i) $\hat{b}_A = \frac{\hat{\pi}_A \hat{\lambda}_A}{e^{\hat{\lambda}_A} - 1}$, $\hat{V}_A(\hat{\mathbf{b}}) = \pi_D e^{-\hat{\lambda}_A}$ and $E(\pi_A^{net}) = [1 - (1 + \hat{\lambda}_A) e^{-\hat{\lambda}_A}] \pi_D$; (ii) $\hat{b}_B = \hat{V}_A(\hat{\mathbf{b}})$, $\hat{V}_B(\hat{\mathbf{b}}) = \pi_D e^{-\hat{\lambda}_A} \frac{1 - e^{-\hat{\lambda}_B}}{\hat{\lambda}_B}$ and $E(\pi_B^{net}) = (1 - e^{-\hat{\lambda}_B}) (1 - e^{-\hat{\lambda}_A}) \pi_D$.*

Proof. The proof for part (i) is the same as that for proposition 1. For part (ii) note that for the firms that attract B-label applicants we must have $b_B \leq \hat{V}_A(\mathbf{b})$ because A-label workers will apply if $b_B > \hat{V}_A(\mathbf{b})$. If $b_B \leq \hat{V}_A(\mathbf{b})$ then only B-label workers will apply, but for δ sufficiently small firms would want to increase the offered wage to maximize the chance of filling the vacancy. Hence, $\hat{b}_B = \hat{V}_A(\hat{\mathbf{b}})$. Then, $\hat{V}_B(\hat{\mathbf{b}}) = \hat{V}_A(\hat{\mathbf{b}}) h(\hat{\lambda}_B) = \hat{V}_A(\hat{\mathbf{b}}) \frac{1 - e^{-\hat{\lambda}_B}}{\hat{\lambda}_B} = \frac{1 - e^{-\hat{\lambda}_B}}{\hat{\lambda}_B} \pi_D e^{-\hat{\lambda}_A}$ and $E(\pi_B^{net}) = (1 - e^{-\hat{\lambda}_B}) [\pi_D - \hat{V}_A(\hat{\mathbf{b}})] = (1 - e^{-\hat{\lambda}_B}) (1 - e^{-\hat{\lambda}_A}) \pi_D$. \square

We now define $\bar{\lambda} = \frac{\Lambda_A + \Lambda_B}{N} = \frac{\Lambda}{N}$ as the expected total number of skilled workers to firms. Similarly, $\beta = \frac{\Lambda_B}{\Lambda_A + \Lambda_B} = \frac{\Lambda_B N}{\Lambda}$ is the ratio of the expected number of skilled B-label workers to total skilled workers. We can then state:

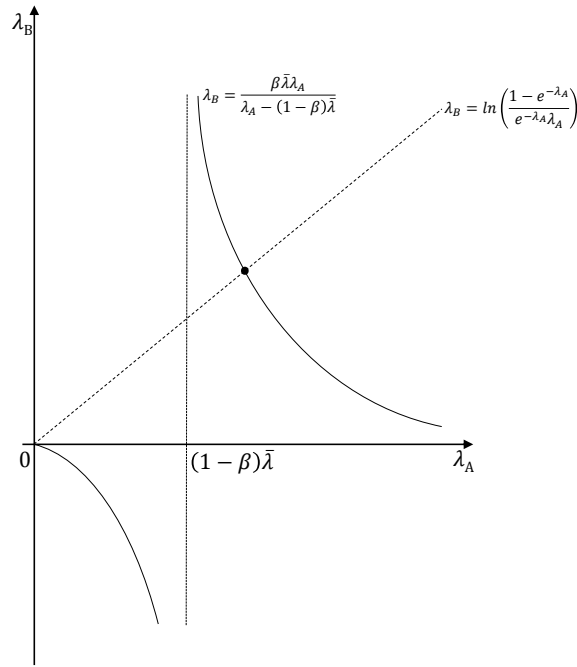
Proposition 5. *If workers' strategies satisfy anonymity and if $\delta \rightarrow 0$, then $\hat{b}_B, \hat{b}_A, \hat{a}_A(\hat{\mathbf{b}}), \hat{a}_B(\hat{\mathbf{b}}), \pi_D, \hat{V}_A, \hat{V}_B, \hat{\lambda}_A$ and $\hat{\lambda}_B$ uniquely define a SPMCE of this competitive search wage posting game with discrimination. In the unique SPMCE, $E(\pi_A^{net}) = E(\pi_B^{net})$ and $\hat{\lambda}_A$ and $\hat{\lambda}_B$ are uniquely defined as the solution to: (i) $\hat{\lambda}_B = \frac{\beta \bar{\lambda} \hat{\lambda}_A}{\hat{\lambda}_A - (1 - \beta) \bar{\lambda}}$ and (ii) $\hat{\lambda}_B = \ln\left(\frac{1 - e^{-\hat{\lambda}_A}}{e^{-\hat{\lambda}_A} \hat{\lambda}_A}\right)$.*

Proof. Using $\beta = \frac{\Lambda_B}{\Lambda_B + \Lambda_A}$ and $\bar{\lambda} = \frac{\Lambda_A + \Lambda_B}{N}$, we can write: $\lambda_B = \frac{\Lambda_B}{N_B} = \beta \frac{\bar{\lambda} N}{N_B} = \beta \frac{\bar{\lambda} N}{N_B} \frac{\lambda_A}{\lambda_A} = \frac{\beta \bar{\lambda} \lambda_A}{\frac{\lambda_A N_B}{N}}$, which we can further transform to: $\lambda_B = \frac{\beta \bar{\lambda} \lambda_A}{\frac{\lambda_A (N - N_A)}{N}} = \frac{\beta \bar{\lambda} \lambda_A}{\lambda_A - \frac{\lambda_A N_A}{N}} = \frac{\beta \bar{\lambda} \lambda_A}{\lambda_A - \frac{\lambda_A}{N}}$. From $E(\pi_A^{net}) = E(\pi_B^{net})$ it follows that $1 - (1 + \lambda_A) e^{-\lambda_A} = (1 - e^{-\lambda_B}) (1 - e^{-\lambda_A})$, which we can transform to $e^{-\lambda_B} (1 - e^{-\lambda_A}) = \lambda_A e^{-\lambda_A}$ and further to $\lambda_B = \ln\left(\frac{1 - e^{-\lambda_A}}{\lambda_A e^{-\lambda_A}}\right)$.

From equation (i) we have $\frac{\partial \lambda_B}{\partial \lambda_A} = -\frac{\beta(1-\beta)\bar{\lambda}^2}{[\lambda_A - (1-\beta)\bar{\lambda}]^2}$, which is negative and defined as long as $\lambda_A \neq (1 - \beta) \bar{\lambda}$. Concerning the shape of the curve described by equation (i), we determine $\frac{\partial^2 \lambda_B}{(\partial \lambda_A)^2} = \frac{2\beta\bar{\lambda}^2(1-\beta)}{[\lambda_A - (1-\beta)\bar{\lambda}]^3}$. Hence, $\frac{\partial^2 \lambda_B}{(\partial \lambda_A)^2} > 0$ if $\lambda_A > (1 - \beta) \bar{\lambda}$ and $\frac{\partial^2 \lambda_B}{(\partial \lambda_A)^2} < 0$ if $\lambda_A < (1 - \beta) \bar{\lambda}$. Second, considering equation (ii), we can derive the following: $\frac{\partial \lambda_B}{\partial \lambda_A} = \frac{\lambda_A - 1 + e^{-\lambda_A}}{(1 - e^{-\lambda_A}) \lambda_A} > 0$. Finally note, that equation (ii) is positive for all values of $\lambda_A \geq 0$ and equation (i) is positive for $\lambda_A > (1 - \beta) \bar{\lambda}$. Hence, there is a unique solution for $\hat{\lambda}_A, \hat{\lambda}_B$ where both are greater than zero. The rest of the equilibrium values are then uniquely defined from this solution. \square

The essence of the proof of proposition 5 and the determination of $\hat{\lambda}_A$ and $\hat{\lambda}_B$ can be seen with the help of the following figure 1:

Figure 1: Determination of $\hat{\lambda}_A$ and $\hat{\lambda}_B$



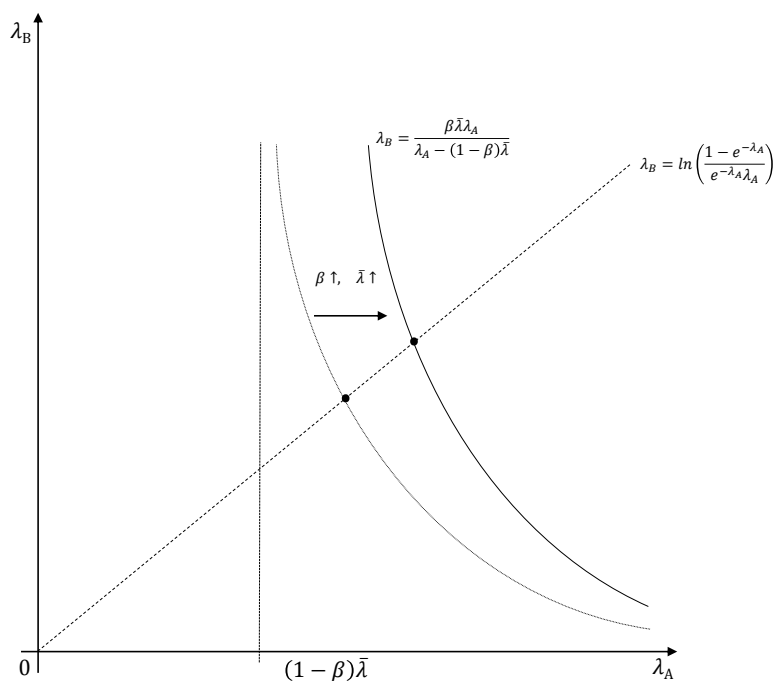
From the results of proposition 5 we can derive the following proposition.

Proposition 6. *In the unique SPMCE of the competitive search discriminatory wage posting game: (i) $\hat{\lambda}_B < \bar{\lambda} < \hat{\lambda}_A$, (ii) both $\hat{\lambda}_A$ and $\hat{\lambda}_B$ are increasing in β and $\bar{\lambda}$.*

Proof. Result (i) follows from $\hat{\lambda}_B = \ln\left(\frac{1-e^{-\lambda_A}}{e^{-\lambda_A}\lambda_A}\right)$, which can be transformed to $\hat{\lambda}_B - \hat{\lambda}_A = \ln\left(\frac{1-e^{-\lambda_A}}{\lambda_A}\right) = \ln(h(\lambda_A)) < 0$. Thus, $\hat{\lambda}_B = \frac{\Lambda_B}{N_B} < \frac{\Lambda_B + \Lambda_A}{N_B + N_A} = \bar{\lambda} < \frac{\Lambda_A}{N_A} = \hat{\lambda}_A$. Result (ii) follows from $\hat{\lambda}_B = \frac{B\bar{\lambda}\lambda_A}{(1+B)\lambda_A - \bar{\lambda}}$, which generates $\frac{\partial \hat{\lambda}_B}{\partial \bar{\lambda}} > 0$ and $\frac{\partial \hat{\lambda}_B}{\partial \beta} > 0$. \square

The second result of proposition 6 is illustrated in figure 2. The first result is important because it allows us to compare the discriminatory and non-discriminatory equilibrium. In particular, in the non-discriminatory equilibrium the unique value of λ is given by $\bar{\lambda}$.

Figure 2: Comparative statics of the autarkic equilibrium with discrimination



5 Comparing equilibria

We define the average vacancy rate in the discriminatory equilibrium as:

$$\Psi = \frac{N_A}{N} e^{-\lambda_A} + \frac{N_B}{N} e^{-\lambda_B} = \eta e^{-\frac{\Lambda_A}{\eta N}} + (1 - \eta) e^{-\frac{\Lambda_B}{(1-\eta)N}}, \quad (19)$$

with $\eta \equiv \frac{N_A}{N}$. Thus, $\Psi = \Psi(\eta)$. We now show that $\Psi(\eta)$ is strictly convex in η , that $\Psi(\eta)$ attains its minimum at $\eta_{min} = \frac{\Lambda_A}{\Lambda_A + \Lambda_B}$ and that $\Psi(\eta_{min}) = e^{-\frac{\Lambda_A + \Lambda_B}{N}} = e^{-\hat{\lambda}} = e^{-\hat{\lambda}}$, which is the vacancy rate in the non-discriminatory equilibrium. The partial derivative of Ψ with respect to η results as: $\frac{\partial \Psi}{\partial \eta} = e^{-\frac{\Lambda_A}{\eta N}} \left(1 + \frac{\Lambda_A}{N_A}\right) + e^{-\frac{\Lambda_B}{(1-\eta)N}} \left(1 + \frac{\Lambda_B}{N_B}\right)$. Note that $\frac{\partial \Psi}{\partial \eta} = 0$ if $\eta = \frac{\Lambda_A}{\Lambda_A + \Lambda_B}$. To demonstrate that Ψ reaches its minimum at $\eta = \frac{\Lambda_A}{\Lambda_A + \Lambda_B}$, we have to show that $\frac{\partial^2 \Psi}{(\partial \eta)^2}$ is positive: $\frac{\partial^2 \Psi}{(\partial \eta)^2} = e^{-\frac{\Lambda_A}{\eta N}} \lambda_A^2 \frac{N}{N_A} + e^{-\frac{\Lambda_B}{(1-\eta)N}} \lambda_B^2 \frac{N}{N_B} > 0$. Substitution yields that $\Psi(\eta_{min}) = e^{-\frac{\Lambda_A + \Lambda_B}{N}}$, which equals the vacancy rate in the non-discriminatory case since $\frac{\Lambda_A + \Lambda_B}{N} = \hat{\lambda}$. Hence, we have

Proposition 7. *The number of vacancies is larger in the discriminatory equilibrium.*

Proposition 7 is an important result because it will allow us to show that there is relatively less production of the monopolistically competitive good and more of the numeraire good in a discriminatory equilibrium. We then use that result to derive the pattern of comparative advantage. Before we consider international trade we compare expected profits, bonuses, and expected income in the discriminatory and non-discriminatory equilibrium. We begin by analyzing national income in the discriminatory equilibrium.

The $L - \Lambda$ unskilled workers each receive a wage of one. The Λ_k skilled workers have an expected return of $\hat{V}_k + \left(1 - \frac{M_k}{\Lambda_k}\right)$, where $\frac{M_k}{\Lambda_k}$ is the probability of a successful match for a k -label agent. The profits of the M_k successful firms, $\pi_D - \hat{b}_k$, are shared equally by all agents and in equilibrium $\hat{V}_k = \frac{M_k \hat{b}_k}{\Lambda_k}$. Note that $\Lambda_A + \Lambda_B = \Lambda$. We write $M_D = M_A + M_B$ and from proposition 7 we know that $M_D < M$. Hence, total income is $I = L - \Lambda + \left[\hat{V}_A + \left(1 - \frac{M_A}{\Lambda_A}\right)\right] \Lambda_A + \left[\hat{V}_B + \left(1 - \frac{M_B}{\Lambda_B}\right)\right] \Lambda_B + M_A (\pi_D - \hat{b}_A) + M_B (\pi_D - \hat{b}_B) = L + (M_A + M_B) (\pi_D - 1)$, which we state as Lemma 8 below.

Lemma 8. *National income is $L + M_D (\pi_D - 1)$.*

Using lemmas 2 and 8, and denoting with a subscript t the type of equilibrium we are considering we can rewrite the profit of a successful firm as follows:

$$\pi_t = \frac{r_{Zt}}{\sigma} - f = \frac{\alpha I_t}{M_t \sigma} - f = \frac{\alpha(L + M_t(\pi_t - 1))}{M_t \sigma} - f \Rightarrow \pi_{Zt} = \frac{\alpha}{\sigma - \alpha} \left(\frac{L}{M_t} - 1 \right) - \frac{\sigma f}{\sigma - \alpha}. \quad (20)$$

Now from proposition 7 we know that $M_D < M$, therefore, the profit of a successful firm is higher in the discriminatory equilibrium: $\pi_D > \pi$. This result is intuitive: if there are less successful firms, then there is less competition and the profits of each producing firm is greater. In comparing expected profits in the discriminatory and non-discriminatory equilibrium note that $E(\pi_A^{net}) = E(\pi_B^{net})$ in equilibrium. Hence, we only need to compare $E(\pi_A^{net}) = [1 - (1 + \lambda_A) e^{-\lambda_A}] \pi_D$ in the discriminatory case to $E(\hat{\pi}_z^{net}) = [1 - (1 + \bar{\lambda}) e^{-\bar{\lambda}}] \pi$ from the non-discriminatory case. Now, $1 - (1 + \lambda) e^{-\lambda}$ is increasing in λ and from proposition 6 we know that $\lambda_A > \bar{\lambda}$. Hence, given that $\pi_D > \pi$ we know that the expected profits as well as the profits of a successful firm are larger in a discriminatory equilibrium. Finally we consider the output of each successful firm. From equation (20) and lemmas (2) and (8) we have that national income is given by:

$$I_t = \frac{\sigma}{\sigma - \alpha} [L - (1 + f) M_t]. \quad (21)$$

National income is also larger in a discriminatory equilibrium. This result arises because fewer successful matches implies that there are fewer fixed cost expenditures. If we then substitute income into the demand for each variety from equation (6) we have:

$$q_z = c_z = \frac{\alpha I}{M \frac{\sigma}{\sigma-1} \frac{1}{\phi}} = \frac{(\sigma - 1) \alpha \phi}{\sigma - \alpha} \left[\frac{L}{M_t} - (1 + f) \right]. \quad (22)$$

Hence, output of each variety is larger in the discriminatory equilibrium. We summarize these results in proposition 9.

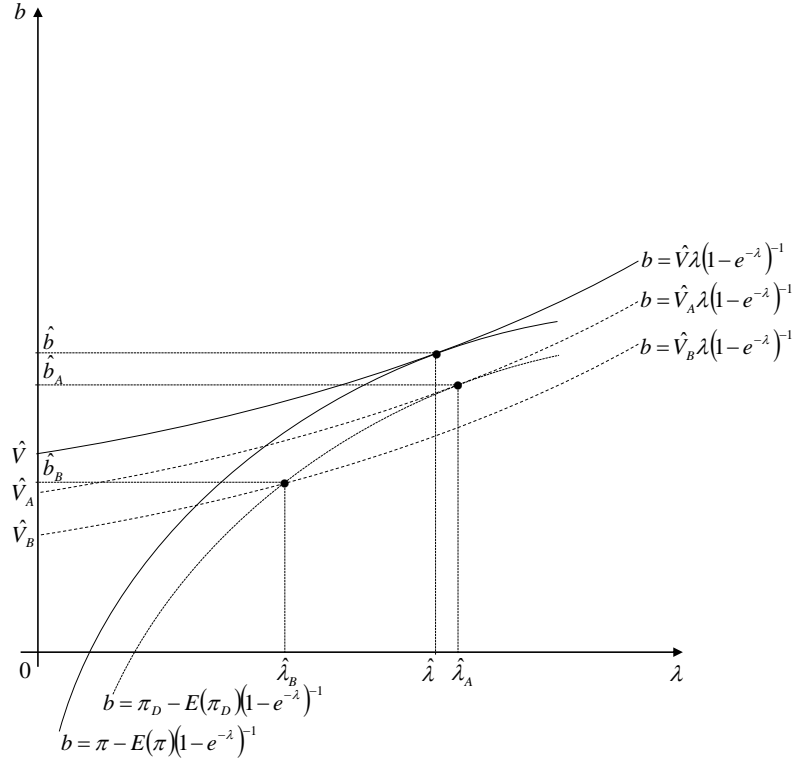
Proposition 9. *Expected and realized firm profits, and output of each variety, are larger in the discriminatory equilibrium.*

The overall effect on workers is not as easy to disentangle. The change in λ produces two opposing effects on skilled workers. First, note that B -label workers have a lower bonus and expected income than A -label workers. Their bonus is lower because $\hat{b}_B = \hat{V}_A(\hat{\mathbf{b}}) = h(\hat{\lambda}_A) \hat{b}_A$ and $h(\hat{\lambda}_A) <$

1. Their expected income is lower since $\hat{V}_B(\hat{\mathbf{b}}) = h(\hat{\lambda}_B)\hat{b}_B = h(\hat{\lambda}_B)\hat{V}_A(\hat{\mathbf{b}}) < \hat{V}_A(\hat{\mathbf{b}})$. With respect to A-label workers, note that holding π_z constant, \hat{b}_A and $\hat{V}_A(\hat{\mathbf{b}})$ are both decreasing in λ . Hence, given that $\hat{\lambda}_A > \bar{\lambda}$, if π_z does not change, then the bonuses and expected incomes of skilled workers would be lower in the discriminatory equilibrium. Of course, given that there are less successful firms, the profit of each successful firm would be higher in the discriminatory equilibrium and part of this profit would be passed on to the manager in their bonus.

In figure 3 we see a depiction of the discriminatory and non-discriminatory equilibria (for the case when the realized firm profit does not rise enough to increase the expected bonus of the skilled workers). The topmost tangency between the firm's iso-profit and the skilled workers indifference curve indicates the non-discriminatory equilibrium at $(\hat{\lambda}, \hat{b})$. In the discriminatory equilibrium the firm has higher profits and this is reflected by movement to an iso-profit that lies to the southeast of the non-discriminatory equilibrium iso-profit. In the resulting discriminatory equilibrium the A-label skilled workers are on a lower indifference curve, with a lower bonus a lower probability of finding a match (a larger λ). The B-label skilled workers are on an even lower indifference curve with a much lower bonus but a greater probability of successfully finding a match. The firm's profit is the same whether or not they post a bonus to attract A- or B-label managers. We will return to this figure in a later section when we introduce the possibility of a small number of additional non-discriminatory firms.

Figure 3: The equilibrium with and without discrimination



6 Trade liberalization

We now consider international trade. In order to analyze the pattern of trade we begin by deriving the autarky prices for the home economy, which is in a discriminatory equilibrium, and the foreign economy which is in a label-blind equilibrium. Given that $L = L^*$, $N = N^*$, and $\tilde{\Lambda} = \tilde{\Lambda}^*$, we know from proposition 7 that the vacancy rate is higher in the home country. Hence, production of the monopolistically competitive good is lower in the home country. Given that the vacancy rate is higher, and $L = L^*$, the production of the numeraire good must be larger in the home country. From equations (4) through (7) we can then write the relative autarky prices in the home and foreign countries as:

$$\frac{P_M}{P_0} = \frac{\alpha}{1 - \alpha} \frac{C_0}{C_M} = \frac{M^{\frac{1}{1-\sigma}} p_z}{1} > \frac{(M^*)^{\frac{1}{1-\sigma}} p_z}{1} = \left(\frac{P_M}{P_0} \right)^* . \quad (23)$$

We have now established the following result.

Proposition 10. *The country in the discriminatory equilibrium has a comparative disadvantage in the manufacturing sector.*

We now consider how trade affects the home and foreign countries. As its manufacturing output falls below the foreign country's manufacturing output, the relative size of the home country's numeraire sector can grow. In addition, the total number of available varieties increases.¹³ This produces two counteracting effects: first, the price index P_M , and a firm's profits, are both decreasing in the number of available varieties; second, a firm's profits are increasing in the market size. In the case where the countries are symmetric, these two effects cancel out: $\pi^{autarky} = \frac{r_z}{\sigma} - f = \frac{\alpha}{\sigma - \alpha} \left(\frac{L}{M_t} - 1 \right) - \frac{\sigma f}{\sigma - \alpha} = \frac{\alpha}{\sigma - \alpha} \left(\frac{2L}{2M_t} - 1 \right) - \frac{\sigma f}{\sigma - \alpha} = \pi^{trade}$.

In the case in which countries are asymmetric because the home country is in a discriminatory equilibrium we have that for home country firms:

$$\pi^{trade} = \frac{\alpha}{\sigma - \alpha} \left(\frac{2L}{M_D + M} - 1 \right) - \frac{\sigma f}{\sigma - \alpha} < \frac{\alpha}{\sigma - \alpha} \left(\frac{L}{M_D} - 1 \right) - \frac{\sigma f}{\sigma - \alpha} = \pi^{autarky} \quad (24)$$

because $M_D < M$. Finally we consider output of each firm. Comparing output in trade and autarky we have:

$$q_z^{trade} = \frac{(\sigma - 1) \alpha \phi}{\sigma - \alpha} \left(\frac{2L}{M_D + M} - (1 + f) \right) < \frac{(\sigma - 1) \alpha \phi}{\sigma - \alpha} \left(\frac{L}{M_D} - (1 + f) \right) = q_z^{autarky}. \quad (25)$$

The output of the monopolistically competitive sector is $M_D q_z$ and is, therefore, also lower in trade than in autarky. We have now established the following proposition.

Proposition 11. *When moving from autarky to free trade, the output per firm, of the manufacturing sector, and the realized and expected firm profits all fall in the discriminatory country and the output of the numeraire sector increases. The opposite results occur in the label-blind country.*

Finally, we use our results for firm profits to note the effect of trade liberalization on skilled workers of both labels. From proposition 4 we have that the bonuses and expected incomes of both

¹³If firms had to pay an entry cost, then the number of varieties produced in each country would be reduced.

labels of skilled workers are increasing in realized firm profits and they are increasing faster for A-label workers.

Proposition 12. *In moving from autarky to the free trade equilibrium bonuses and expected income of skilled workers decrease in the discriminatory country and increase in the label-blind country. The change is larger for A-label than for B-label skilled workers.*

7 Co-existence of discriminating and non-discriminating firms in autarky

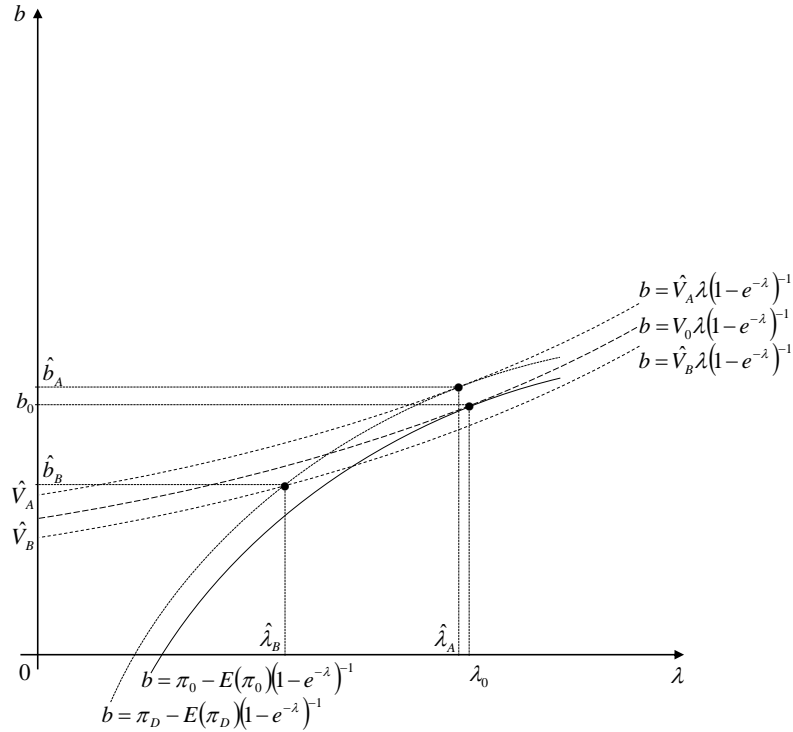
We now consider the case whereby a small number of non-discriminating firms $N_0 < \min \{ \beta \tilde{\Lambda}, (1 - \beta) \tilde{\Lambda} \}$ are also in the market. For these firms the label is irrelevant. Hence, when faced with both an A-label and a B-label managerial applicant each applicant is hired with equal probability. Note that the small number of non-discriminating firms, N_0 , precludes them from employing all of the workers of either label.

We begin by analyzing the choice of posted bonus (and, therefore, the matching and arrival rate) by the N_0 firms. First, note that any offered bonus that attracts only A-label applicants cannot generate higher profits than that of the existing discriminating firms. This is because when attracting only A-label applicants b_A is profit maximizing. Second, note that any posted bonus that attracts both A-label and B-label applicants must leave both labels of applicants indifferent between the non-discriminating and the discriminating firms in equilibrium. For the A-label applicant this implies $\hat{V}_0 = \hat{V}_{A0} = \pi_{z0} e^{-\lambda_{A0}}$, where λ_{A0} is the ratio of A-label applicants that apply to firms posting b_{A0} in the equilibrium with some non-discriminating firms. If some of the A-label applicants apply to the non-discriminating firms, then $\lambda_{A0} < \lambda_A$. For the B-label applicants this indifference implies $\hat{V}_0 = \hat{V}_{B0} = \pi_{z0} \frac{1 - e^{-\lambda_{B0}}}{\lambda_{B0}} e^{-\lambda_{A0}}$, where λ_{B0} reflects that some of the B-label applicants might apply to the non-discriminating firms. Putting these two equalities together implies that $\pi_{z0} e^{-\lambda_{A0}} = \pi_{z0} \frac{1 - e^{-\lambda_{B0}}}{\lambda_{B0}} e^{-\lambda_{A0}}$ or $1 = \frac{1 - e^{-\lambda_{B0}}}{\lambda_{B0}}$, which is impossible given that $1 - e^{-\lambda_{B0}} < \lambda_{B0}$ for any $\lambda_{B0} \in (0, \infty)$. We state this result as the following lemma:

Lemma 13. *In any equilibrium where a small number, N_0 , of non-discriminatory firms co-exist with discriminating firms, the non-discriminatory firms offer a bonus b_0 , which attracts only B-label applicants.*

We now show that the non-discriminating firms choose a $b_0 > b_B$ and, therefore, some of the B -label applicants now apply to N_0 -firms. In equilibrium the expected bonus is the same whether or not they apply to the N_{B0} discriminatory or N_0 non-discriminatory firms. In addition, we show that the profit of the non-discriminatory firms is strictly larger than that of the discriminatory firms. Before moving to the formal propositions we develop the intuition for the next two propositions in figures 3-5. In figure 3 we illustrate the equilibrium without non-discriminatory firms. We see there that the low bonus offered to the B -label applicants generates “too many” firms posting that low bonus in the attempt to attract a B -label worker.¹⁴ Hence, the inefficiency illustrated in figure 3 suggests that a firm that is known not to discriminate can post a bonus (and a corresponding hiring probability) that would attract B and not A -label applicants. A discriminating firm could not post such a bonus (and expect only B -label applicants) because it is known that they would show priority to A -label applicants. This bonus is shown in figure 4.

Figure 4: The potential for non-discriminatory firms

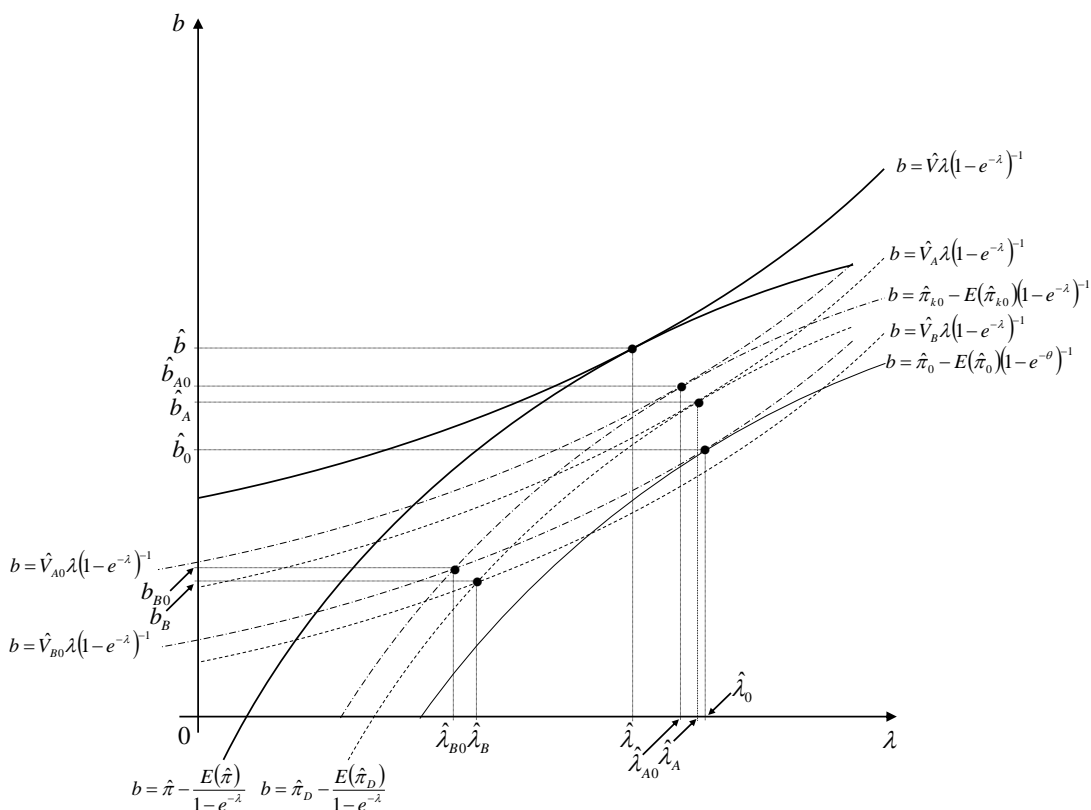


¹⁴ $\lambda_B < \lambda_A$ implies $\frac{\beta\Lambda}{N_B} < \frac{(1-\beta)\Lambda}{N_A}$ or $\frac{\beta}{1-\beta} < \frac{N_B}{N_A}$, therefore, we say “too many” firms post for B -labels.

In figure 4, at b_0 the B -label applicant is on a higher indifference curve and the non-discriminatory firms have larger profits than the discriminatory ones. We see there that the b_{B0} bonus offered by the discriminating firms to the B -label workers must increase as well. Of course, figure 4 does not depict the new equilibrium. In response to the higher bonus required to attract the B -label applicants (and the resulting fewer applicants at the discriminatory B -label firms) some discriminatory firms switch from attracting B -label applicants to attracting A -label applicants.

The new equilibrium is depicted in figure 5. We see there that the profits for discriminatory firms decrease and the expected payment of both labels of applicants increases. Not only does the bonus offered to both labels of applicants increase, but the applicant to vacancy ratio decreases for both types of discriminatory firms.

Figure 5: The autarky equilibrium with co-existence of discriminating and non-discriminating firms



Before developing these results formally it will be useful to introduce the following notation. De-

note Λ_0 as the expected number of B -label workers who apply at the non-discriminating firms and $\Lambda_{B0} = \Lambda_B - \Lambda_0$ as the remaining expected number of B -labels who apply at discriminatory firms. All A -label skilled workers continue to apply only at discriminatory firms and their expected number remains Λ_A in the new equilibrium with some non-discriminatory firms. The remaining discriminatory firms that post b_{B0} are denoted N_{B0} and the resulting number of firms that post b_{A0} is N_{A0} . We then have $\lambda_0 = \frac{\Lambda_0}{N_0}$, $\lambda_{B0} = \frac{\Lambda_{B0}}{N_{B0}}$, $\lambda_{A0} = \frac{\Lambda_A}{N_{A0}}$, $\beta_0 = \frac{\Lambda_{B0}}{\Lambda_A + \Lambda_{B0}}$ and $\bar{\lambda}_0 = \frac{\Lambda_A + \Lambda_{B0}}{N_{A0} + N_{B0}}$. We now consider the actions of the non-discriminatory firms.

Proposition 14. *In any equilibrium with N discriminatory firms and $N_0 < \min \{ \beta \bar{\Lambda}, (1 - \beta) \bar{\Lambda} \}$ non-discriminatory firms, the non-discriminatory firms all post the same bonus, $b_0 > b_B$, attract only B -label applicants, and earn larger expected profits than the discriminatory firms.*

Proof. First note that the discriminatory firms that attract B -label applicants maximize expected profit subject to the constraint that the bonus for B -labels is no larger than the expected payoff of A -label skilled workers. This constraint arises because an A -label applicant would always be hired instead of a B -label at any discriminatory firm. A non-discriminatory firm does not face this constraint and because the derivative of expected profits with respect to the bonus is positive at $b_B = \hat{V}_A(\mathbf{b}) < b_A$ the non-discriminatory firms can increase profits by offering a higher bonus to B -label applicants. Now from lemma 13 we know that in any such equilibrium the non-discriminatory firms will post bonuses that attract only B -label applicants and because these N_0 firms are identical and cannot coordinate their actions we have that they all choose the same b_0 . \square

We now show that there is a unique equilibrium with the coexistence of discriminatory and non-discriminatory firms.

Proposition 15. *If there are $N_0 < \min \{ \beta \bar{\Lambda}, (1 - \beta) \bar{\Lambda} \}$ non-discriminating firms and N discriminating firms, then there exists a unique equilibrium whereby all non-discriminatory firms all post the same bonus $b_0 > b_B$ and attract only B -label applicants. In this equilibrium $\lambda_{B0} < \lambda_B$, $\lambda_{A0} < \lambda_A$, $\lambda_0 > \lambda_{B0}$, and $E(\pi_0^{net}) > E(\pi_B^{net}) > E(\pi_{B0}^{net})$.*

Proof. The equilibrium is defined by the following equations. First, all B -label agents must be

indifferent between applying to a non-discriminatory and a discriminatory firm:

$$\hat{V}_0 = b_0 \frac{1 - e^{-\lambda_0}}{\lambda_0} = \frac{1 - e^{-\lambda_{B0}}}{\lambda_{B0}} e^{-\lambda_{A0}} \pi_{z0} = \hat{V}_{B0}. \quad (26)$$

Given that $b_0 > e^{-\lambda_{A0}} \pi_{z0} = b_{B0}$ and $h(\lambda)$ is declining in λ we must have that $\lambda_0 > \lambda_{B0}$. From proposition 14 we have that $E(\pi_0^{net}) > E(\pi_B^{net})$ and because the additional N_0 firms implies that $\pi_z > \pi_{z0}$ we also have that $E(\pi_0^{net}) > E(\pi_{B0}^{net})$.

Second, the relationship between λ_{B0} and λ_0 is given by:

$$\lambda_{B0} = \frac{\Lambda_B - \Lambda_0}{N_{B0}} = \frac{\Lambda_B - N_0 \lambda_0}{N_{B0}}. \quad (27)$$

Third, the profits of the discriminatory firms must be equal so that

$$E(\pi_{A0}^{net}) = [1 - (1 + \lambda_{A0}) e^{-\lambda_{A0}}] \pi_{z0} = [(1 - e^{-\lambda_{B0}}) (1 - e^{-\lambda_{A0}})] \pi_{z0} = E(\pi_{B0}^{net}). \quad (28)$$

Rewriting this equal profits condition and using the relationship between the variables yields our third and fourth equations: $\lambda_{B0} = \frac{\beta_0 \lambda_0 \lambda_{A0}}{\lambda_{A0} - (1 - \beta_0) \lambda_0}$ and $\lambda_{B0} = \ln\left(\frac{1 - e^{-\lambda_{A0}}}{\lambda_{A0} e^{-\lambda_{A0}}}\right)$. These last two equations are similar to those in proposition 9. The four equations define the four endogenous variables: λ_0 , λ_{A0} , λ_{B0} , and b_0 . Alternatively, we can think of these four equations defining N_{B0} , N_{A0} , Λ_0 , and b_0 .

Now, if $\lambda_{A0} \geq \lambda_A$, then $N_{A0} \leq N_A$ (because Λ_A cannot decrease). But then $N_{B0} \geq N_B$ and, therefore, $\lambda_{B0} < \lambda_B$ so that $E(\pi_{A0}^{net}) > E(\pi_{B0}^{net})$ which does not satisfy equation (28). Hence, $\lambda_{A0} < \lambda_A$, which then implies that $E(\pi_{B0}^{net}) = E(\pi_{A0}^{net}) < E(\pi_A^{net}) = E(\pi_B^{net})$. Finally, note that $\lambda_{A0} < \lambda_A$ implies that $\lambda_{B0} < \lambda_B$ in order for equation (28) to be satisfied. Hence, an increase in b_0 generates a reduction in λ_{B0} and λ_{A0} and an increase in λ_0 so that there exists a monotonic relationship between λ_0 , λ_{A0} , λ_{B0} , and b_0 so that the equilibrium is unique. \square

An additional facet of the equilibrium with N_0 non-discriminatory firms is that holding π constant we have $\hat{V}_0 = \hat{V}_{B0} > \hat{V}_B$ as seen in figure 5. To see this last point consider equation 26 and note that $\lambda_{B0} < \lambda_B$ and that $\lambda_{A0} < \lambda_A$.

We now consider the vacancy rate in the equilibrium with N discriminatory and N_0 label-blind firms. We use $\tilde{N} = N + N_0$ to denote the total number of firms. The average vacancy rate in this equilibrium can be written as:

$$\Psi_0 = \frac{N_{A0}}{\tilde{N}} e^{-\lambda_{A0}} + \frac{N_{B0}}{\tilde{N}} e^{-\lambda_{B0}} + \frac{N_0}{\tilde{N}} e^{-\lambda_0} = \eta_A e^{-\frac{\lambda_A}{\eta_A \tilde{N}}} + (1 - \eta_A - \eta_0) e^{-\frac{\lambda_{B0}}{(1 - \eta_A - \eta_0) \tilde{N}}} + \eta_0 e^{-\frac{\lambda_0}{\eta_0 \tilde{N}}}, \quad (29)$$

where $\eta_A = \frac{N_{A0}}{\tilde{N}}$ and $\eta_0 = \frac{N_0}{\tilde{N}}$. If N_0 is not too large then the average vacancy rate, Ψ , is strictly declining in N_0 . Hence, as the ratio of label-blind to discriminatory firms grows the matching success rate and output of the differentiated good sector must grow as well. We state this result as proposition 16.

Proposition 16. *If $N_0 < \min \{ \beta \tilde{\Lambda}, (1 - \beta) \tilde{\Lambda} \}$, then as the ratio $\frac{N_0}{\tilde{N}}$ increases the number of vacancies falls.*

An important implication of proposition 16 is that if there are two economies that differ only in percent of label-blind firms (while holding the total number of firms constant), then the country with fewer label-blind firms would have a comparative advantage in the numeraire sector. We analyze that implication in the following section.

8 Can trade ameliorate discrimination?

We start by analyzing the pattern of trade in our augmented model. Remembering that $p_z = \frac{\sigma}{\sigma-1} \frac{1}{\phi}$, we can rewrite equation (23) as:

$$\frac{P_M}{P_0} = \frac{\alpha}{1 - \alpha} \frac{C_0}{C_M} = \frac{M^{\frac{1}{1-\sigma}} \sigma}{1(\sigma - 1)\phi} > \frac{(M^*)^{\frac{1}{1-\sigma}} \sigma}{1(\sigma - 1)\phi} = \left(\frac{P_M}{P_0} \right)^*. \quad (30)$$

Analysis of equation (30) reveals that as long as the potential number of matches (the total number of manufacturing firms is the same in both countries, then the result from proposition 10 still holds when there are some non-discriminatory firms in each country. We state this result below as a corollary of proposition 10.

Corollary 17. *If the home country has N discriminatory and N_0 non-discriminatory firms, the foreign country has N^* discriminatory and N_0^* non-discriminatory firms, the total number of firms is the same, $\tilde{N} = \tilde{N}^*$, and technology is the same in both countries, then the country with more discriminatory firms has a comparative advantage in the numeraire sector.*

Finally, we consider the effect of trade liberalization on the prevalence of discrimination. In particular, we analyze how the movement from autarky to free trade affects the profits of discriminatory and non-discriminatory firms. The important difference between the two types of firms is that the non-discriminatory firms have larger expected profits. The realized profits of all successful firms is the same, π_{z0} , however, a non-discriminatory firm will receive a greater proportion of that profit in expectation. Hence, the effect of trade liberalization on realized profits will have a larger (magnified) effect on the expected profits of a non-discriminatory firm.

Proposition 18. *In the movement from autarky to free trade the expected profits of the label-blind firms will change by more than those of discriminatory firms. Hence, trade liberalization will disproportionately effect the non-discriminatory firms.*

Proposition 18 suggests that trade liberalization will make it more costly to discriminate in countries where there are fewer discriminatory firms and less costly where it already more prevalent. In this way trade will magnify the good and the bad institutions that a country has in autarky.

Propositions 15 and 18 together provide both some support and some limitations of the suggestions in Becker's (1957) book that the market can ameliorate discrimination. First, proposition 15 shows that non-discriminatory firms earn larger expected profits (the extra cost that discriminatory firms pay for their preferences are in the form of a reduced matching rate), which provides some support for Becker's hypothesis. On the other hand, proposition 18 shows that trade liberalization can reinforce a country's market imperfections (and perfections) and reduce the expected profits of non-discriminatory firms by more than discriminatory firms.

9 Conclusion

We embed a competitive search model with labor market discrimination into a two-sector two-country framework in order to analyze the relationship between international trade and labor market discrimination. Discrimination reduces the matching probability and output in the skilled-labor differentiated-product sector so that the country with more discriminatory firms has a comparative advantage in the simple sector. As countries alter their production mix in accordance with their comparative advantage, trade liberalization can then reinforce the negative effect of discrimination on development in the more discriminatory country and reduce its effect in the country with fewer discriminatory firms. Similarly, the relative profit difference between non-discriminatory and discriminatory firms will increase in the less discriminatory country and shrink in the more discriminatory one. In this way trade can further reduce discrimination in a country where it is less prevalent and increase it where it is more firmly entrenched.

References

- [1] Black, D. A., 1995. "Discrimination in an Equilibrium Search Model," *Journal of Labor Economics*, vol. 13(2), pp. 309-333.
- [2] Becker, G. S., 1957. "The Economics of Discrimination," University of Chicago Press, Chicago, IL.
- [3] Bloom, N., and Van Reenen, J., 2007. "Measuring and Explaining Management Practices Across Firms and Countries," *Quarterly Journal of Economics*, vol. 122(4), pp. 1351-1408.
- [4] Cavalcanti, T., and Tavares, J., 2011. "The Output Cost of Gender Discrimination: A Model-Based Macroeconomic Estimate," working paper, Universidade Nova de Lisboa.
- [5] Cuberes, D., and Teignier, M., 2014. "Gender Inequality and Economic Growth: A Critical Review," *Journal of International Development*, forthcoming.
- [6] Davidson, C., Martin, L., and Matusz, S., 1999. "Trade and search generated unemployment," *Journal of International Economics*, vol. 48(2), pp. 271-299.

-
- [7] Davidson, C., Matusz, S., and Shevchenko, A., 2008. "Globalization and firm level adjustment with imperfect labor markets," *Journal of International Economics*, vol. 75(2), pp. 295-309.
- [8] Dixit, A., and Stiglitz, J., 1977. "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, vol. 67(3), pp. 297-308.
- [9] Esteve-Volart, B., 2009. "Gender Discrimination and Growth: Theory and Evidence from India," manuscript.
- [10] Fang, H., and Moro, A. 2010. "Theories of Statistical Discrimination and Affirmative Action: A Survey," in: Benhabib, J., Bisin, A., and Jackson, M. (eds.): *Handbook of Social Economics*, Vol. IA, Elsevier, Amsterdam et al., pp. 133-200.
- [11] Galor, O., and Weil, D., 1996. "The Gender Gap, Fertility, and Growth," *American Economic Review*, vol. 85(3), pp. 374-387.
- [12] Hsieh, C., Hurst, E., Jones, C., and Klenow, P., 2013. "The Allocation of Talent and U.S. Economic Growth," NBER working paper no. 18693.
- [13] Lagerlöf, N.-P., 2003. "Gender Equality and Long Run Growth," *Journal of Economic Growth*, vol. 8(4), pp. 403-426.
- [14] Grossman, G., Helpman, E., and Kircher, P., 2013. "Matching and Sorting in a Global Economy," NBER working paper no. 19513.
- [15] Helpman, E., and Itskhoki, O., 2010. "Labour Market Rigidities, Trade and Unemployment," *Review of Economic Studies*, vol. 77(3), pp. 1100-1137.
- [16] Helpman, E., Itskhoki, O., and Redding, S., 2010. "Inequality and Unemployment in a Global Economy," *Econometrica*, vol. 78(4), pages 1239-1283.
- [17] Lang, K., Manove, M., and Dickens, W., 2005. "Racial Discrimination in Labor Markets with Posted Wage Offers," *American Economic Review*, vol. 95(4), pp. 1327-1340.
- [18] Lang, K., and Lehman, J., 2012. "Racial Discrimination in the Labor Market," *Journal of Economic Literature*, vol. 50(4), pp. 959-1006.

-
- [19] Murphy, K., 2014. "How Gary Becker Saw the Scourge of Discrimination," *Capital Ideas*, Winter 2014.
- [20] Ranjan, P., 2013. "Offshoring, Unemployment, and Wages: The Role of Labor Market Institutions," *Journal of International Economics*, vol. 89(1), pp. 172-186.
- [21] Rosen, A., 1997. "An Equilibrium Search-Matching Model of Discrimination," *European Economic Review*, vol. 41(8), pp. 1589-1613.
- [22] Rosen, A., 2003. "Search, Bargaining, and Employer Discrimination," *Journal of Labor Economics*, vol. 21(4), pp. 807-830.
- [23] Teignier, M., and Cuberes, D., 2014. "Aggregate Costs of Gender Gaps in the Labor Market: A Quantitative Estimate," *UB Economics Working Papers 2014/308*.