Optimal Trade Policy, Equilibrium Unemployment and Labor Market Inefficiency[*]

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Abstract

Why do politicians advocate trade protections to save domestic jobs when neoclassical trade models suggest that small open economies should implement free trade? This paper shows that trade protections can be rationalized as a second-best policy that improves the domestic welfare when the equilibrium unemployment is different from the constrained-efficient unemployment. To understand this puzzle, I incorporate a Diamond-Mortensen-Pissarides frictional labor market into the standard Heckscher-Ohlin model of International Trade. The results suggest that (i) a country that has an inefficient level of unemployment experiences welfare losses from free trade if the size of trade volume is not sufficiently large; (ii) having unemployment is not sufficient to justify a use of trade policy, because free trade is still optimal when the labor market is constrained-efficient; and (iii) a small country that has inefficiently high unemployment should use trade policy to raise the domestic prices of labor-intensive goods.

Keywords: Optimal Trade Policy; Employment; Gains from Trade; Heckscher-Ohlin; Search and Matching Frictions; Labor Market.

JEL classification numbers: F11, F13, F16, F66, J64.

1 Introduction

Politicians criticizing trade liberalization have traditionally declared, "Jobs are lost." Seeking to insulate domestic jobs in import-competing sectors, politicians often advocate for trade protection; yet, this has had surprisingly little impact on how economists think about unemployment and optimal trade policy. In fact, from economists' models, the expansion of export sectors would create new jobs to compensate for job losses in import-competing sectors. Displaced workers have only to relocate from the contracting import-competing sectors to the expanding export sectors. Based on traditional trade models with full employment, trade protections in a small open economy generate distortions and decrease total welfare. This raises the question: "Why do politicians advocate for trade policies to prevent job losses given that trade protections are not rational economically?"

The objective of this paper is to uncover the labor-motive of trade protections and investigate to what extent unemployment that arises from search frictions in the labor market rationalizes a use of import tariffs and/or export subsidies in a small open economy. I develop a one-period model that introduces labor-market matching frictions into a standard Heckscher-Ohlin model with two factors of production (labor and capital) and two goods (capital intensive and labor intensive goods). The model is the simplest tractable model that captures distributional effects from international trade. In this model, all workers are initially unemployed. In order to hire a worker, a firm must pay a vacancy cost to open a vacancy before the position is randomly filled. This paper initially focuses on a small open economy because abstracting from terms-of-trade externalities highlights the novel incentive for protectionism from the labor market. I later extend the basic model to study the trade policy of a large economy, which could impact world prices.

The first part of the analysis compares the equilibrium employment in a competitive equilibrium and the constrained-efficient employment in the social planner's problem. The equilibrium unemployment may be different from the constrained-efficient unemployment, in which case the labor market is said to be inefficient. This result is consistent with the Hosios efficiency condition (Hosios, 1990), which states that a labor market is constrained-efficient only if the wage bargaining power of the firms is equal to the elasticity of an exogenous job-matching function with respect to the total number of vacancies. There are two sources of inefficiency: a hold-up problem and a congestion externality. Depending on the magnitude of each effect, total employment could be either inefficiently low or inefficiently high.

The second part of the analysis studies the impact of international trade on equilibrium employment and welfare. Surprisingly, while other trade models conclude aggregate welfare gains from trade, this paper shows that the distributional effects could result in welfare losses from trade. To be precise, the first novel result of this paper is that a capital-abundant country with inefficiently high unemployment (or, correspond-

ingly, a labor-abundant country with inefficiently low unemployment) experiences welfare loss from trade if a world price is not sufficiently different from the country's autarky price. To conclude this result, I first establish that total employment increases when the relative price of the labor-intensive good rises, and vice versa. An increase in the price of the labor-intensive good raises the value of the marginal product of labor, inducing firms to search for workers more intensively and resulting in an increase in total employment in the economy. In a capital-abundant country with inefficiently high unemployment, when a free-trade world price is sufficiently close to the country's autarky price, the reduction of labor income, which is magnified by the reduction in employment, dominates the gain on capital income and results in welfare loss from exposure to international trade.

The final part of the analysis then investigates optimal trade policy for a small open economy in the competitive equilibrium. Motivated by the threat of job losses and welfare losses due to international trade, I characterize the condition in which it is optimal to use trade policies to protect domestic workers. The main contribution of this paper is the argument that optimal tariffs do not result from search frictions per se, but from labor market inefficiencies caused by the failure of the Hosios condition to hold.[1] Implementing free trade is optimal if and only if the labor market is initially efficient. It is interesting that the labor-market motive of trade policy can be obtained without political weight on producer surplus or concerns on distributional effects from trade.

More specifically, when unemployment is inefficiently high, the government should use trade policy to protect its labor-intensive sectors. Regardless of the country's comparative advantage, a country with in-efficiently high unemployment has to raise the prices of labor-intensive goods because the labor-intensive sectors are where most of the demand for labor is created. A capital-abundant country would use import tariffs and export taxes, while a labor-abundant country would use export subsidies and import subsidies. From a policy perspective, it is interesting that protecting an import-competing industry is not always an effective means of preventing aggregate job losses. For example, when unemployment is inefficiently high, protecting the capital-intensive import-competing sector actually increases the demand for capital and re-

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[1] As pointed out by Bhagwati (1971), a trade policy is normally a second-best policy; the first-best policy is likely to be a purely domestic policy aimed directly at the inefficiency. My exercise demonstrates that a trade policy is a practical employment-inducing policy when the first-best policy, a direct tax-cum-subsidy on the vacancy posting, is impractical. In this sense, my analysis best describes developing economies whose informal sector is large and whose labor market is underdeveloped. It is extremely difficult to implement a direct non-distortive tax-cum-subsidy on vacancy postings in countries where most firms are unregistered, or can avoid labor, government, or other institutional regulations. The informal sector in developing countries can be as large as 70% of all employment (Bosch & Esteban-Pretel, 2012; Djankov et al., 2002; Schneider, 2003). Developing countries often are also considered as small open countries.

leases more workers into the labor market than the labor-intensive sector can absorb. Thus, aggregate unemployment rises and welfare is worsened.

Having established optimal trade policy in the small-country model, I extend it to a large-country model. In this model, the labor-market motive interacts with the terms-of-trade motive. Optimal trade policy depends on the magnitudes of these effects. In this case, the country's size and comparative advantage play important roles in determining optimal trade policy. Interestingly, a unilaterally optimal trade policy of a large open economy that has labor market inefficiency may benefit the country's trading partners. For example, when a labor-abundant country uses an export subsidy to reduce inefficiently high unemployment, the country's capital-abundant trading partner benefits from the trade policy because the export subsidy improves the terms of trade. The model concludes that world free trade is not optimal if at least one country has labor market inefficiency. This main result also suggests an endogeneity problem in estimating the impact of price changes on unemployment (for example, Dutt et al. (2009)). The reason is that import taxes that are sources of price variations are potentially induced by unemployment.

The results of this paper are based on labor market inefficiency, which depends on the wage bargaining power and the elasticity of the job-matching function. In this paper, I also review empirical studies on the estimates of these two key parameters. There is no consensus in the literature regarding the size of the bargaining weight of the firms or the size of the matching elasticity. The bottom line is that there is no empirical evidence that we should expect labor markets to be efficient. On average, the estimates suggest that labor markets in developed countries likely have inefficiently high unemployment.

Perhaps concern about job losses is common to all countries. If one thinks in broad terms of nonindustrialized countries as the most likely to be small open economies and of agricultural production as among the most labor-intensive activities in nonindustrialized countries, the theoretical results suggest that these nonindustrialized countries likely use trade policy to protect their workers in agricultural production. This can explain why the commitments that WTO member countries are asked to make in the agricultural sector are, in general, still less restrictive than commitments in nonagricultural sectors.[2]

To the best of my knowledge, this paper is the first that studies how labor market inefficiency from search frictions in a labor market affects gains from trade and addresses the labor-market motive for trade policy. Previous works by Davidson, Martin, and Matusz (1988, 1999), Helpman and Itskhoki (2010), Dutt et al. (2009), Felbermayr et al. (2011), and Costinot (2009) have introduced a frictional labor market into trade models and have studied the theoretical impacts of trade liberalization on employment and gains

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[2] For example, the Agreement on Agriculture has no red (forbidden) box for domestic support — the agricultural sector is allowed to have more types of domestic supports.

from trade. However, none of these works mention *labor market inefficiency,* or study the role of labor market inefficiency on gains from trade or optimal trade policy. The main contribution of this paper is to link gains from trade and optimal trade policy with labor market inefficiency.

This paper is closest to the Costinot (2009) study, which explores the determinants of trade policy in a small open economy that has search frictions in the labor market. Costinot (2009) extends the model devised by Pissarides (2000) and investigates how a trade tax in each sector responds to that sector's labor market characteristics, such as the productivity of workers, the world price, and the job turnover rate. The model in this paper, however, differs from that in Costinot (2009) in several ways. It uses capital and labor as factors of production, captures the impact of price changes on the returns on factors and the welfare of factor owners. The model can illustrate how labor market inefficiency changes the impacts of price fluctuations and the possibility of welfare losses from trade. Furthermore, this paper allows for sectoral factor movements and their general-equilibrium effects. Although in this paper all sectors have identical workers and share the same aggregate matching technology, the degrees of capital intensity and labor market inefficiency play an important role in determining trade policy.

Suwanprasert (2017) applies the main finding of this paper to the model of Costinot (2009). In particular, Suwanprasert (2017) shows that Costinot (2009) assumes a parameter space that implicitly creates inefficiently high unemployment, suggesting that import tariffs that reduce unemployment can improve welfare. In a larger parameter space, unemployment could be inefficiently low and import subsidies may be optimal. When the labor market is efficient, free trade is optimal.

In terms of the research question, this paper is close to Brecher (1974a, 1974b) and Matschke (2010). Brecher (1974a) uses a Heckscher-Ohlin model to investigate unemployment caused by minimum wages, while Brecher (1974b) employs the model of Brecher (1974a) to study optimal trade policy. In contrast to Brecher (1974a, 1974b), who requires exogenous minimum wages to generate structural unemployment, this paper begins with the microeconomic foundations of a labor market and allows search frictions to naturally generate unemployment. Matschke (2010) adds minimum wages to the lobbying game in Grossman and Helpman (1994) and shows that unemployment may not necessarily result in an increase in trade protection. In Brecher (1974a, 1974b) and Matschke (2010), wages are exogenous because of minimum wages and are independent of trade policy. In contrast, this paper endogenizes wages through Nash bargaining and, hence, the effect of trade policy comes through equilibrium wages as well as through employment.

In terms of methodology, this analysis builds on the work of Dutt et al. (2009). I simplify the model of Dutt et al. (2009) to a one-period model so that we can explicitly solve for the autarky price which is used for studying gains from trade. The contribution of this paper relative to Dutt et al. (2009) is that they only consider the impact of price change on unemployment while this paper characterizes the efficiency of the

labor market and how labor market inefficiency affects welfare gains from trade, and then investigates the labor-market motive for optimal trade policy.

The remainder of the paper is organized as follows. Section 2 introduces the model. I characterize the competitive equilibrium and the constrained-efficient equilibrium in Section 3. In Section 4, I investigate the impact of price changes on factor prices, employment, and welfare. Section 5 derives the optimal trade policy in a small economy and Section 6 derives the optimal trade policy in a large economy. Section 7 summarizes the main results and identifies directions for future work.

2 The Basic Model

Consider a small open economy in a static one-period model. The economy is endowed with the homogenous labor force L and capital K. All workers are initially unemployed. There are two types of tradable goods in the world, which are called X and Y. Households produce and consume a consumption good C, which is a combination of good X and good Y. The small economy takes world prices as given and its trade policies do not alter world prices. Let p be the world price of good X and normalize the price of good Y to unity; hence, p is the relative price of good X in terms of good Y in the world markets. It is not necessary to define comparative advantage until Section 4, where I compare the world price and the autarky price. Without loss of generality, consider a trade policy in sector X that changes the domestic price from p to $(1 + t) p$. When good X is an imported good, the trade policy is considered an import tariff (subsidy) if $t > 0$ $(t < 0)$. In contrast, when good X is an exported good, $t > 0$ $(t < 0)$ is an export subsidy (tax).[3]

2.1 Households

Households receive utility from a consumption good C that is assembled from goods X and Y. The preference of the representative household is given by

$$U(C) = C,$$

$$C = \frac{\left(X^d\right)^\alpha \left(Y^d\right)^{1-\alpha}}{\alpha^\alpha (1-\alpha)^{1-\alpha}}$$

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[3] Introducing sectoral trade instruments in both sectors, t_x and t_y, does not change any results because only the relative price matters to the equilibrium allocation. In other words, for any t_x and t_y, we can define t such that $1 + t = (1 + t_x) / (1 + t_y)$ and the equilibria under the two situations have the same allocations. In addition, I restrict the attention to $t \in [-1, t_{max}]$ such that unemployment drops to zero at $t = t_{max}$. Removing the upper bound, t_{max}, does not significantly change the results.

where X^d and Y^d denote the home-country aggregate demand of goods X and Y, respectively, and $\alpha \in (0,1)$ is the weight of good X in the Cobb-Douglas utility function.

Because trade policy causes price distortions, households choose their consumptions of goods X and Y as if the prices were $(1+t)\, p$ and 1 respectively. The price of consumption good C is equal to the minimum expenditure required to produce one unit of good C.

$$p_C = \min_{x,y} (1+t)\, px + y$$
$$\text{s.t.} \quad C = \frac{x^\alpha y^{1-\alpha}}{\alpha^\alpha (1-\alpha)^{1-\alpha}} = 1$$

In equilibrium, the price of consumption good C is

$$p_C = ((1+t)\, p)^\alpha. \tag{1}$$

2.2 Firms

Production of X and Y uses both capital K and labor L. Firms must choose a sector to enter, pay the vacancy cost p_V to open a vacancy in that sector, and then wait until the vacancies are randomly filled. Then the firms and the workers bargain bilaterally over the surplus of the successful match via Nash bargaining. After jobs are created, the firms rent capital at the market rate r, produce output, and sell it in the goods market. Hereafter, I use subscript $i \in \{X, Y\}$ to index a statement that holds true for any X and Y.

Job Creation

The real cost of producing a vacancy is $1/\chi$ units of final good C. Therefore, based on the price of the consumption good p_C in equation (1), the nominal cost of vacancy p_V is

$$p_V = \frac{p_C}{\chi} = \frac{((1+t)\, p)^\alpha}{\chi}. \tag{2}$$

Let V be the number of total economy-wide posted vacancies. In this one-period model, all workers are initially unemployed and wait to be matched. The matching technology which creates aggregate employment E from vacancy V and total population L is

$$E = M(V, L) = V^\lambda L^{1-\lambda}, \tag{3}$$

where $0 < \lambda < 1$ is the (constant) elasticity of job creation with respect to vacancies. The matching function

satisfies the standard properties in the labor-economics literature: it is strictly increasing in each argument, has a diminishing return in each argument, and has a constant return to scale. All vacancies are randomly filled with the same probability. The probability that a position is filled is $E/V = M(V, L)/V$. The parameter values are restricted such that the total employment is always less than the size of the workforce, $E < L$, to prevent negative unemployment.

Wage Determination

Anticipating the surplus from a match, the worker and the firm bargain over wage w_i to determine the division of the surplus via Nash bargaining. In this one-period model, unmatched agents receive nothing and do not have an opportunity to be matched again. Thus, the outside options of firms and workers are zero.

Let S_i be a surplus of a filled position in sector i. Nash bargaining determines the wage such that

$$w_i = \text{argmax} \, (S_i - w_i)^{\beta} (w_i)^{1-\beta}, \tag{4}$$

where $\beta \in (0, 1)$ is the bargaining power of the firm and $1 - \beta$ is the bargaining power of the worker. The bargaining power β is common across the two sectors. Under Nash bargaining, the surplus is divided according to bargaining power. The worker's wage w_i and the firm's profit π_i for each matched position are

$$
\begin{aligned}
w_i &= (1 - \beta) S_i, \\
\pi_i &= \beta S_i.
\end{aligned}
$$

Final Goods

After a firm posts a vacancy in sector i and the vacancy is filled by a worker, the firm rents capital k_i for the worker to produce good i. For each employed worker, the production function for good i is

$$g_i(k_i) = k_i^{\phi_i},$$

where $0 < \phi_i < 1$ represents the capital intensity of good i. Without loss of generality, I assume $\phi_y > \phi_x$; good X is labor-intensive and good Y is capital-intensive. The aggregate outputs are $X^s = k_x^{\phi_x} L_x = K_x^{\phi_x} L_x^{1-\phi_x}$ and $Y^s = k_y^{\phi_y} L_y = K_y^{\phi_y} L_y^{1-\phi_y}$, where L_i is total labor employed in sector i, and $K_i = k_i L_i$ is total capital employed in sector i. Firms in both sector can freely rent capital from a perfectly competitive market. The rental rate r is determined from the value of the marginal product of capital and is identical in both sectors.

That is,

$$r = (1 + t) \, p\phi_x k_x^{\phi_x - 1} = \phi_y k_y^{\phi_y - 1}. \tag{5}$$

Therefore, after a vacancy is filled by a worker, the matched position in sector i generates a surplus

$$
\begin{aligned}
S_x &= (1 + t) \, pk_x^{\phi_x} - rk_x = (1 - \phi_x)(1 + t) \, pk_x^{\phi_x}, \tag{6} \\
S_y &= k_y^{\phi_y} - rk_y = (1 - \phi_y) \, k_y^{\phi_y}, \tag{7}
\end{aligned}
$$

2.3 Free Entries and Exits

Before firms choose a sector to enter, they compare the expected profits from producing in each sector. A firm pays a vacancy cost p_V, and with probability E/V, the vacancy is filled and the firm receives profit π_i. The expected profit before firms post vacancies in sector i is

$$\pi_i^{\text{Expected}} = \frac{E}{V} \pi_i - p_V. \tag{8}$$

Free entries and exits ensure that equilibrium profits are driven down to zero:

$$\pi_i^{\text{Expected}} = 0. \tag{9}$$

2.4 Endowments Market

Sectoral allocations satisfy resource constraints in the labor market and the capital market:

$$
\begin{aligned}
L_x + L_y &= E, \tag{10} \\
k_x L_x + k_y L_y &= K. \tag{11}
\end{aligned}
$$

The first constraint is the allocation of employed workers across sectors and the second constraint is how capital is allocated between two sectors. The parameter values are restricted to ensure that the two sectors are active, i.e., $L_x > 0$, $L_y > 0$, $k_x > 0$, and $k_y > 0$.

3 Equilibrium

In this section, I solve for a competitive equilibrium in which the government can use only trade policy and a constrained-efficient equilibrium in which the government can perfectly allocate resources and con-

sumption to maximize aggregate welfare. Then, I characterize the sufficient condition that ensures that the competitive equilibrium coincides with the constrained-efficient equilibrium.

3.1 Competitive Equilibrium

First, because firms can freely enter a market, the expected profits in all sectors are driven down to zero according to equation (9). Combining equation (8) and (9) leads to

$$\frac{E}{V}\pi_i = p_V. \tag{12}$$

This implies that $\pi_i = \frac{p_V V}{E}$ where the right-hand side is common across both sectors. Therefore, $\pi_x = \pi_y = \pi$ in equilibrium. This implies that $w_x = w_y = w$ and $S_x = S_y = S$; wages and surplus are equalized across sectors. From now on, the sector-specific subscript i is dropped, unless its exclusion results in ambiguity. Using $S_x = S_y$, we have

$$(1+t)(1-\phi_x) p k_x^{\phi_x} = (1-\phi_y) k_y^{\phi_y}. \tag{13}$$

We can use equations (5) and (13) to solve for k_x and k_y:

$$k_x = \left(\frac{1-\phi_x}{1-\phi_y}\right)^{\frac{1-\phi_y}{\phi_y-\phi_x}} \left(\frac{\phi_x}{\phi_y}\right)^{\frac{\phi_y}{\phi_y-\phi_x}} ((1+t)p)^{\frac{1}{\phi_y-\phi_x}}, \tag{14}$$

$$k_y = \left(\frac{1-\phi_x}{1-\phi_y}\right)^{\frac{1-\phi_x}{\phi_y-\phi_x}} \left(\frac{\phi_x}{\phi_y}\right)^{\frac{\phi_x}{\phi_y-\phi_x}} ((1+t)p)^{\frac{1}{\phi_y-\phi_x}}. \tag{15}$$

One immediate result is

$$k_x = \left(\frac{1-\phi_y}{1-\phi_x}\right)\left(\frac{\phi_x}{\phi_y}\right) k_y. \tag{16}$$

Equation (16) confirms that the capital-intensive (large ϕ) sector Y uses more capital per worker than the labor-intensive (small ϕ) sector X. The return on capital r, the surplus of job S, and the wage w can be solved by substituting equations (14) and (15) into equations (5), and (13):

$$r = \Phi_1 ((1+t)p)^{-\frac{1-\phi_y}{\phi_y-\phi_x}}, \tag{17}$$

$$S = \Phi_2 ((1+t)p)^{\frac{\phi_y}{\phi_y-\phi_x}}, \tag{18}$$

$$w = (1-\beta)\Phi_2 ((1+t)p)^{\frac{\phi_y}{\phi_y-\phi_x}}, \tag{19}$$

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where $\Phi_1 = \left[\left(\frac{1-\phi_y}{1-\phi_x} \right)^{(1-\phi_y)(1-\phi_x)} \frac{\phi_y^{\phi_y(1-\phi_x)}}{\phi_x^{\phi_x(1-\phi_y)}} \right]^{\frac{1}{\phi_y - \phi_x}}$ and $\Phi_2 = \left[\left(\frac{\phi_x}{\phi_y} \right)^{\phi_x \phi_y} \frac{(1-\phi_x)^{\phi_y(1-\phi_x)}}{(1-\phi_y)^{\phi_x(1-\phi_y)}} \right]^{\frac{1}{\phi_y - \phi_x}}$ are constants that depend on ϕ_x and ϕ_y only.

The next step is to solve for the equilibrium total vacancies V and total employment E. Substituting p_V in equation (2) and E in equation (3) into equation (12) gives an explicit solution for the equilibrium vacancy V:

$$V = \left(\frac{\pi_i \chi}{((1+t)\, p)^\alpha} \right)^{\frac{1}{1-\lambda}} L.$$

Using S from equation (18) and $\pi_i = \pi = \beta S$, the equilibrium vacancy V and the equilibrium employment E are

$$V = \left[\beta \chi \Phi_2 \left((1+t)\, p \right)^{\frac{\phi_y}{\phi_y - \phi_x} - \alpha} \right]^{\frac{1}{1-\lambda}} L, \tag{20}$$

$$E = V^\lambda L^{1-\lambda} = \left[\beta \chi \Phi_2 \left((1+t)\, p \right)^{\frac{\phi_y}{\phi_y - \phi_x} - \alpha} \right]^{\frac{\lambda}{1-\lambda}} L. \tag{21}$$

Labor allocations, L_x and L_y, that clear the resource markets can be solved from equations (10) and (11):

$$L_x = \frac{k_y E - K}{k_y - k_x} \text{ and } L_y = \frac{K - k_x E}{k_y - k_x}.$$

The country's budget constraint is

$$(1+t)\, p X^s + Y^s - p_V V + t p \left(X^d - X^s \right) = (1+t)\, p X^d + Y^d.$$

The left-hand side shows the net income. The first two terms are producer income; producers sell goods X^s and Y^s at domestic price $(1+t)\, p$ and 1, respectively. The next term is the vacancy cost that arises from posting V vacancies. The last term is the tariff revenue if the country has excess demand of X (i.e., $X^d - X^s > 0$), or it is import subsidy cost if the country has excess supply of X (i.e., $X^d - X^s < 0$). The tariff revenue is redistributed back to the representative household in a lump-sum transfer. The right-hand side shows how income is spent on consumption according to the demand functions X^d and Y^d.

Rewriting the budget constraint leads to

$$p X^S + Y^S - p_V V = p X^d + Y^d. \tag{22}$$

There are two important observations. First, the country's budget constraint is subject to the free trade world price ratio p, while producers and households behave as if the world relative price was $(1+t)\, p$. Second,

because the country is small, the entire tax burden belongs to domestic households. The trade policy causes a transfer between the government and consumers but it does not change the total income.

The demand functions and the aggregate welfare can be derived from the utility maximization problem. The representative household maximizes his utility subject to his budget constraint in equation (22). The demand for each good is

$$X^d(p,t) = \frac{1}{(\alpha + (1-\alpha)(1+t))} \times \frac{\alpha}{p} \times I(p,t),$$ (23)

$$Y^d(p,t) = \frac{(1+t)}{(\alpha + (1-\alpha)(1+t))} \times (1-\alpha) \times I(p,t),$$ (24)

where $I(p,t) = pX^S(p,t) + Y^S(p,t) - p_V V(p,t)$ is the country's net income. Under free trade $(t = 0)$, the demand functions are simplified to the standard demand functions from a Cobb-Douglas utility function.

Substituting the demand function into the utility function yields the direct welfare function that is a function of the relative price p and trade policy t:

$$U(p,t) = I(p,t) \times P(p,t),$$ (25)

where $P(p,t) = \frac{(1+t)^{1-\alpha}}{(\alpha + (1-\alpha)(1+t))p^\alpha}$ is the inverted price level that captures the impact of the price distortion on the country's social welfare. The function $P(p,t)$ is strictly concave in t, and, for any given p, it is maximized at $t = 0$. Tariffs always distort domestic prices as perceived by households and make consumption choice sub-optimal. The inverted price level $P(p,t)$ is different from the price of consumption good P_C because $P(p,t)$ includes the change in tariff revenue.

3.2 Social Planner's Problem

This section analyzes a benchmark constrained-efficient equilibrium. The formal social planner's problem is fully described in Appendix A.1. In short, a benevolent social planner directly allocates endowments to maximize the country's welfare, when the planner is subject to search frictions and the prices are determined by the markets.

On the production side, the government chooses an allocation such that the value of the marginal product of labor and the value of the marginal product of capital are equalized across sectors and the vacancy level maximizes the country's net income, which is the value of aggregate output subtracted by the vacancy cost. The optimal vacancy level satisfies

$$\frac{\partial E(V,L)}{\partial V}\mu_1 = p_V,$$ (26)

where μ_1 is a Lagrange multiplier that represents the shadow price of having one more vacancy. The left-hand side represents the marginal social benefit of creating one additional vacancy and the right-hand side represents the vacancy cost.

The value of Lagrange multiplier μ_1 is

$$\mu_1 = S|_{t=0}, \tag{27}$$

where $S|_{t=0}$ is the surplus of a matched position in the competitive equilibrium when $t = 0$.

3.3 Efficiency of the Competitive Equilibrium

The competitive equilibrium under free trade coincides with the constrained-efficient equilibrium when both equilibria are characterized by identical conditions. This can occur if and only if (i) the competitive equilibrium has $t = 0$ and (ii) equation (12) of the competitive equilibrium is the same as equation (26) of the constrained-efficient equilibrium.

Lemma 1 summarizes the sufficient conditions.

Lemma 1. *A competitive equilibrium coincides with a constrained-efficient equilibrium if and only if $\beta = \lambda$ and $t = 0$.*

Proof. See Appendix. □

Lemma 1 is consistent with the Hosios efficiency condition (Hosios, 1990), which identifies the sufficient condition for labor market efficiency: the labor market is efficient when the bargaining power of firms (β) is equal to the elasticity of the job-matching function with respect to vacancy level (λ). Beside the Hosios condition, Lemma 1 requires an additional restriction that free trade must be obtained to eliminate price distortions. Lemma 1 is robust to any proper matching functions. As we can see from equations (12) and (26), these conditions are general and do not require a specific functional form.[4]

There are two sources of labor market inefficiency in labor markets with search-and-matching frictions. First, unemployment can be too high because of a hold-up problem. Because the upfront vacancy cost is not included in ex-post wage bargaining and firms get only a fraction β of the surplus from a filled vacancy, the share of the surplus that firms receive may not be enough to cover the vacancy cost. As a result, not enough jobs are created and unemployment is inefficiently high. Second, unemployment can be too low because firms do not recognize the congestion externality imposed on other firms. Firms post additional vacancies as long as it is profitable to do so. However, they do not consider the fact that posting another vacancy

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[4]Note that in general λ is a function of V/L but it is a constant under a Cobb-Douglas matching function.

reduces the expected profits of other firms because it lowers the probability that any given vacancy will be filled.

Constrained efficiency arises only when the two sources of inefficiency perfectly offset each other $(\beta = \lambda)$. When $\beta < \lambda$, the hold-up problem dominates the congestion externality problem and equilibrium employment is inefficiently low (unemployment is inefficiently high). When $\beta > \lambda$, the congestion externality problem dominates the hold-up problem and equilibrium employment is inefficiently high (unemployment is inefficiently low). In other words, a relatively high value of β could imply that the bargaining power of firms is relatively high and thus it could depress the wage of workers determining an inefficiently low level of unemployment, with the opposite taking place when β is relatively low. The threshold of β is determined by λ.

Definition. Labor market inefficiency is defined as $\lambda - \beta$.

I define labor market inefficiency as the difference between the elasticity of the job-matching function with respect to vacancy level (λ) and the bargaining power of firms (β). The labor market is efficient when $\lambda - \beta = 0$. Unemployment is inefficiently high when $\lambda - \beta > 0$, and it is inefficiently low when $\lambda - \beta < 0$.

4   Comparative Statics

In this section, I analyze the effect of a price change in a competitive equilibrium under free trade. The country faces a price change from the market-clearing price in autarky to a new fixed world prices.

Throughout this section, I slightly abuse notation by writing variables as a function of a relative price only: that is, the trade policy t is dropped.

4.1   Factor Prices and Allocation of Endowments

This subsection investigates how the competitive equilibrium adjusts when a country faces a price change from the market-clearing price in autarky to a new fixed world prices.

An increase in the price of labor-intensive goods improves the value of the labor-intensive product, raises the value of the marginal product of labor, and creates demand for labor in the labor-intensive sector. Firms intensively seek more workers: more vacancies in the labor-intensive sector are posted and more workers are employed. The opposite occurs in the capital-intensive sector: the value of the capital intensive good shrinks, the value of the marginal product of labor decreases, and so does demand for labor. Fewer jobs are created in the capital-intensive sector. Because the demand for labor is largely created in the labor-intensive sector, the increase in labor demand in the labor-intensive sector dominates the decrease in labor demand in

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the capital-intensive sector. As a result, total employment increases. In addition, the decrease in the rental price reflects the fact that capital is less important in production.

When p increases after trade liberalization, capital becomes relatively cheaper than labor—as shown in equations (17) and (19). A price change affects L_x and L_y through two channels. First, due to a standard price effect, firms use more capital per worker; k_x and k_y increase and to clear a capital market L_x and L_y are re-allocated. Second, and importantly, the price ratio affects the aggregate employment level E; this effect changes the relative endowment K/E and causes another adjustment as in the Rybczynski theorem. The effect on K_i arises from the only effect through k_x and k_y. As a result, both K_x and L_x increase and sector X (the labor-intensive sector) expands, while both K_y and L_y decrease and sector Y shrinks.

Proposition 1 summarizes these findings:

Proposition 1. *When a relatively labor (capital)-abundant country moves from autarky to free trade:*

1. Real wages increase (decrease) and real returns to capital decrease (increase)

2. Employment increases (decreases)

3. A labor-intensive sector expands (contracts) while a capital-intensive sector contracts (expands)

Proof. See Appendix. □

This first result is consistent with the Stolper-Samuelson theorem, in which a relatively abundant factor gives higher real returns, while the other factor gives lower real returns. The novel result of this paper is how this affects employment. In full-employment models, there is no fluctuation in employment. As is intuitively obvious, when the price of labor-intensive goods increases, firms want to use less capital and have more incentive to search for a worker, and vice versa. The change in equilibrium employment also indirectly affects the expansion or contraction of a sector, suggesting that total labor increases according to the Rybczynski theorem.

How Does Aggregate Income Respond to a Price Change?

In the model, according to equations (17), (19), and (21), the change of net aggregate income due to a one percentage change of price p is

$$\frac{\triangle I}{I} = \left(\frac{rK}{rK + wE}\right) \underbrace{\left(-\frac{1 - \phi_y}{\phi_y - \phi_x}\right)}_{\frac{\triangle r}{r}} + \left(\frac{wE}{rK + wE}\right) \left(\underbrace{\left(\frac{\phi_y}{\phi_y - \phi_x}\right)}_{\frac{\triangle w}{w}} + \underbrace{\left(\frac{\phi_y}{\phi_y - \phi_x} - \alpha\right)\left(\frac{\lambda}{1 - \lambda}\right)}_{\frac{\triangle E}{E}} \right).$$

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The total change in aggregate income is decomposed into the change in capital income and the change in labor income. What distinguishes this model is its specification that the two effects in the change in labor income—the effect through the wages and the effect through employment—coexist. Other models do not recognize this. In the traditional Heckscher-Ohlin model, there is only the effect through wages; the effect through employment is absent because of the assumption of full employment. In Brecher (1974a, 1974b) and Matschke (2010), the wage is exogenously bounded from below at the minimum wage, and thus the effect through wages is absent. In Helpman and Itskhoki (2010), the two effects coexist but they move in opposite directions, and thus they completely offset each other. Indeed, the expected wage is fixed by an exogenous wage rate in a numeraire sector.

In the standard Heckscher-Ohlin model with full employment, and in this model, the elasticities of real factor prices with respect to a price ratio are the same, but the labor income in this paper is more volatile because of the additional effect from employment. This model, therefore, predicts that when a capital-abundant country opens to trade, its labor income drops more than the traditional Heckscher-Ohlin model predicts because there is an additional decrease in the amount of labor employed.

Proposition 2 concludes the effect on the real factor income:

Proposition 2. *The elasticities of real factor prices with respect to a price ratio in the Heckscher-Ohlin model with labor market frictions are identical to those predicted by the traditional Heckscher-Ohlin model. The employment effects reinforce the real income effects and make the labor income more volatile than in the standard Heckscher-Ohlin model.*

It is surprising that the Stolper-Samuelson theorem is completely unaffected by labor market friction. The intuition is that labor market frictions affect job creation and act as a change in the labor endowment, which does not affect a real wage and a real rental rate.

Proposition 2 also highlights that when the distributional impacts of trade policy are quantified labor market frictions should be taken into account. Abstracting from the employment effects underpredicts the variation in labor income.

4.2 Welfare Gains from Trade

This subsection explores how introducing a frictional labor market into a Heckscher-Ohlin model shapes our understanding of welfare gains from trade. To begin with, I identify the autarky price ratio, which is the market-clearing price in a closed economy. Later, I compare welfare at the autarky price in a closed economy to welfare at a new world price in an open economy under free trade.

The autarky price p_A, which clears the output markets in the autarky, can be solved explicitly as

$$p_A = \left[\frac{1 - (\alpha\phi_x + (1-\alpha)\phi_y)}{\alpha\phi_x + (1-\alpha)\phi_y} \times \frac{\Phi_1}{\Phi_2} \times \left(\frac{1}{\beta\chi\Phi_2} \right)^{\frac{\lambda}{1-\lambda}} \times \frac{K}{L} \right]^{\frac{1}{\left(\frac{\phi_y}{\phi_y - \phi_x} - \alpha \right) \frac{\lambda}{1-\lambda} + \frac{1}{\phi_y - \phi_x}}} . \tag{28}$$

As in a traditional Heckscher-Ohlin model, the autarky price p_A is increasing in an endowment ratio K/L; the capital-labor ratio is a source of comparative advantage. When a country has access to international trade and faces a world price $p_w > p_A$, the country is said to be relatively labor-abundant compared to the world and has a comparative advantage in good X. On the other hand, if a country faces a world price $p_w < p_A$, this country is said to be relatively capital-abundant and has a comparative advantage in good Y.

According to equation (25), the welfare function in free trade, given an arbitrary world price p_w, is

$$U(p_w) = \frac{r(p_w)}{P(p_w)} K + \frac{w(p_w)}{P(p_w)} E(p_w). \tag{29}$$

The welfare function is strictly convex in the world price p_w and the welfare converges to infinity as the price converges to either zero or infinity.[5]

Proposition 3 establishes the sufficient statistic of welfare change due to price change.

Proposition 3. *The welfare change due to price change is*

$$dlog(U(p_w)) = \left[\gamma + \left(\frac{\lambda - \beta}{(1-\lambda)(1-\beta)} \right) \left(\frac{\phi_y}{\phi_y - \phi_x} - \alpha \right) \frac{w(p_w) E(p_w)}{I(p_w)} \right] dlog(p_w),$$

where $\gamma = Export_x(p_w) / I(p_w)$ is the share of total output on the net export of good X.

Proposition 3 sheds light that labor market inefficiency affects the magnitude of welfare changes. To show a possibility of welfare loss from trade, I evaluate the elasticity of welfare change that is due to price change at the autarky price.

Corollary 1. *The elasticity of welfare change due to price change evaluated at $p_w = p_A$ is*

$$\left. \frac{dlog(U(p_w))}{dlog(p_w)} \right|_{p_w=p_A} = \frac{\lambda - \beta}{(1-\lambda)(1-\beta)} \left(\frac{\phi_y}{\phi_y - \phi_x} - \alpha \right) \frac{w(p_A) E(p_A)}{I(p_A)}.$$

In the standard literature, welfare gains from trade can be illustrated by the fact that for any world price ratio $p_w \neq p_A$, welfare under free trade is larger than welfare under autarky, $U(p_w) > U(p_A)$. In other words, the welfare function is minimized at the autarky price p_A. The above expression shows that the welfare function in this model reaches its global minimum at the autarky price ($dU(p_w)/dp_w|_{p_w=p_A} = 0$)

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[5]$d^2U(p_w)/dp_w^2 > 0$, $lim_{p_w \to 0^+} U(p_w) = \infty$ and $lim_{p_w \to \infty} U(p_w) = \infty$.

only if $\lambda = \beta$, or when the labor market is efficient. The bottom line is that if $\beta \neq \lambda$, there exists a range of world price ratio Γ such that $U(p) < U(p_A)$, $\forall p \in \Gamma$. A small deviation in price from the autarky price can hurt the welfare of the country if there is a labor market inefficiency. To be precise, a capital-abundant country with inefficiently high unemployment ($\beta < \lambda$) and a labor-abundant country with inefficiently low unemployment ($\beta > \lambda$) can experience welfare loss from trade.

To see the mechanism, consider a country that has inefficiently low employment ($\beta < \lambda$) in autarky. A small reduction in price from the autarky price would cause job losses and put more pressure on employment. An increase in return on capital is overwhelmingly dominated by a decrease in wage and employment. Initially, the country is worse off. Once the price change is larger, the increase in capital income begins to dominate the loss in labor income and thus the country gains from trade. The opposite is true for a country beginning with inefficiently high employment ($\beta > \lambda$).

Corollary 2. *A capital-abundant country that has inefficiently high unemployment and a labor-abundant country that has inefficiently low unemployment may experience welfare loss from trade if the size of international trade flow is not sufficiently large.*

Corollary 2 simply states that the new world price may not be large enough to induce sizable international trade and improve a country's welfare. In other words, a country that has an inefficient labor market and that is trading a sufficiently small volume will lose from trade provided it is trading in the "bad direction" because an increase in the return to one factor does not cover the loss from a fall in returns to the other factor. One relevant example is a relatively capital-abundant country that has inefficiently high unemployment. Thus, the country would prefer autarky to free trade. This result sheds light that a country may use trade policy to avoid a welfare loss from trade.

5 Optimal Trade Policy - A Small Open Economy

Having established how a price change causes an adjustment in employment and affects welfare, I now turn to the main goal of this paper: What is the optimal trade policy when unemployment exists and under what conditions can trade protection improve welfare? In this section, I characterize optimal trade policy in a competitive equilibrium in which the benevolent government can use only trade policy to maximize the country's welfare.

The welfare maximization problem of the benevolent government is

$$\text{Gov } \underset{t}{Max} \ U(p,t) \quad = \quad I(p,t) \times P(p,t)$$

The necessary condition of the welfare maximization problem is

$$\underbrace{\frac{d\log I\,(p,t)}{dw\,(p,t)}\frac{w\,(p,t)}{dt}+\frac{d\log I\,(p,t)}{dr\,(p,t)}\frac{r\,(p,t)}{dt}}_{\text{Returns on factors}} + \underbrace{\frac{d\log P\,(p,t)}{dt}}_{\text{Price distortions}} + \underbrace{\frac{d\log I\,(p,t)}{dE\,(p,t)}\frac{E\,(p,t)}{dt}}_{\text{Employment}} = 0,$$

The government faces a trade-off between the country's net income and a distorted price ratio. A small change in t affects welfare through three channels. First, it distorts the production of final goods and it causes an inefficient allocation of factors. The net returns to factors are smaller than they are under free trade. Second, the trade policy distorts the representative household's consumption choice. Last and most important, the trade policy's only benefit is to move the employment level closer to the efficient level of employment. A trade policy acts as a tax on the household and the proceeds subsidize job creation. An optimal trade policy balances the trade-offs: it adjusts employment while it sacrifices price distortions and production distortions.

To find the condition in which free trade is optimal, I evaluate the first order condition at $t = 0$:

$$\left.\frac{d\log U\,(p,t)}{dt}\right|_{t=0} = \frac{(\lambda - \beta)}{(\phi_y - \phi_x)}\left(\frac{\phi_y}{\phi_y - \phi_x} - \alpha\right)\frac{w\,(p,0)\,E\,(p,0)}{I\,(p,0)}. \tag{30}$$

Observe that the derivative is zero only when $\lambda = \beta$; the welfare function is maximized at $t = 0$ when a competitive equilibrium is constrained-efficient. The intuition is straightforward. When the labor market is constrained-efficient, the economy is at its second-best equilibrium and the government has no room to improve its welfare. Therefore, free trade is optimal. When $\lambda \neq \beta$, the derivative is not zero, which signifies a possibility that a trade policy can improve welfare in the competitive equilibrium.

The following proposition concludes the main finding:

Proposition 4. *Beginning at free trade, a trade policy improves a country's welfare if $\lambda \neq \beta$, and free trade is the optimal trade policy if $\lambda = \beta$.*

Proof. See Appendix. □

Proposition 4 delivers two interesting results. First, it establishes a labor-market motive for a trade policy. The motivation exists even without additional assumptions of political economy or political weight on producer surplus. Although the government does not target unemployment directly, employment potentially matters in decision-making because it is an inefficiency that needs to be corrected. The government wants to move equilibrium employment towards the efficient level of employment while at the expense of price distortions on producers and consumers. Second, in contrast to Costinot (2009), having unemployment is

Sector where the trade	Total employment		
policy is conducted	Too low	Efficient	Too high
Labor intensive	Import tariffs or export subsidies	-	Import subsidies or export taxes
Capital intensive	Import subsidies or export taxes	-	Import tariffs or export subsidies

Table 1: Summary of the optimal trade policy.

not sufficient to justify a use of trade policy. A constrained-efficient labor market needs no protection. Under the presence of search frictions the government cannot improve social welfare beyond the best possible outcome. This conclusion is supported by Suwanprasert (2017).

The sign of the derivative in equation (30) depends on two terms: $\lambda - \beta$, which captures the magnitude of a labor-market inefficiency, and $\phi_y - \phi_x$ which describes the difference of capital intensity between two sectors when a trade policy is used in sector x.

Proposition 5. *The optimal trade policy t^* in sector X has the same sign as the sign of*

$$\frac{\lambda - \beta}{\phi_y - \phi_x}.$$

Proof. See Appendix. □

Proposition 5 indicates that if the sign of $(\lambda - \beta) / (\phi_y - \phi_x)$ is positive, then slightly increasing t will locally raise the welfare. Hence, the optimal trade policy is positive;[6] the trade policy raises the domestic price of labor-intensive goods $(\phi_y > \phi_x)$ when unemployment is inefficiently high $(\lambda > \beta)$ or it raises the domestic price of capital-intensive goods $(\phi_y < \phi_x)$ when unemployment is inefficiently low $(\lambda < \beta)$. On the other hand, when the sign of $(\lambda - \beta) / (\phi_y - \phi_x)$ is negative, the optimal trade policy is also negative. There are two possibilities: to reduce the domestic price of labor-intensive goods $(\phi_y > \phi_x)$ when unemployment is inefficiently low $(\lambda < \beta)$ or to reduce the domestic price of capital-intensive goods $(\phi_y < \phi_x)$ when unemployment is inefficiently high $(\lambda > \beta)$. Table 1 summarizes the optimal trade policy in all cases.

It is interesting that the sign of the optimal trade policy is independent of the country's comparative advantage. This result is different from the terms-of-trade theory in which a capital-abundant country uses $t^* > 0$ and a labor-abundant country uses $t^* < 0$.

I place more emphasis on the case of inefficiently high unemployment. A capital-abundant country imposes tariffs on imported labor-intensive goods or an export tax on exporting capital-intensive goods. In contrast, a labor-abundant country raises the relative price of labor-intensive goods by subsidizing its exported labor-intensive goods and its imported capital-intensive goods. In other words, in the presence of

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[6]The welfare function is strictly concave in t.

Country	$\hat{\lambda}$	Author(s)	Country	$\hat{\lambda}$	Author(s)
U.K.	0.3	Pissarides (1986)	U.S.	0.77	Hall (2005)
U.K.	0.22	Burda and Wyplosz (1994)	U.S.	0.54-0.71	Blanchard and Diamond (1990)
France	0.09				
Germany	0.27		U.S.	0.69	Borowczyk-Martins et al. (2013)
Spain	0.14				
Slovenia	0.1	Burda (1993)	U.S.	0.54	Nagypal (2009)
Czech Republic	0.44	Burda (1993)	U.S.	0.25	Shimer (2005)
Israel	0.87	Yashir (2000)	U.S.	0.66	Sahin et al. (2014)

Table 2: Summary of estimates

inefficiently high unemployment, a capital-abundant country wants to decrease its trade openness whereas a labor-abundant country wants to expand its trade openness. The Lerner symmetry theorem applies here. An import tariff is equivalent to an export tax and an export subsidy is equivalent to an import subsidy—the objective is to expand or contract trade openness. I conclude this model prediction in Corollary 3:

Corollary 3. *A small open economy that is concerned about inefficiently high unemployment should use a trade policy to raise the domestic relative price of labor-intensive goods, regardless of its comparative advantage.*

Proof. See Appendix. □

How inefficient are labor markets around the world? The magnitude of inefficiency depends on two parameters. The first parameter is the elasticity of the matching function with respect to vacancy λ. Petrongolo and Pissarides (2001) provide a good survey of papers that estimate matching functions in developed countries. Based on their survey, the estimates of λ lie between 0.19 and 0.88. In an earlier work, Pissarides (1986) uses quarterly data about U.K. male workers between 1967 and 1983 to estimate a restricted CRS Cobb-Douglas matching function. He finds that $\lambda = 0.3$. Blanchard and Diamond (1990) use various specifications and find that λ is in a range of 0.54-0.71. Burda (1993) reports that $\lambda = 0.44$ in the Czech Republic and $\lambda = 0.1$ in Slovenia. Burda and Wyplosz (1994) report that $\lambda = 0.09$ in France, $\lambda = 0.27$ in Germany, $\lambda = 0.14$ in Spain, and $\lambda = 0.22$ in UK. Yashir (2000) finds that $\lambda = 0.87$ in Israel. Shimer (2005) finds that, in the U.S., $\lambda = 0.25$. These empirical works suggest that λ varies across countries, but no shared conclusion has been reached. Other estimates that use U.S. data include 0.765 in Hall (2005), 0.539 in Nagypal (2009), 0.692 in Borowczyk-Martins et al. (2013), and 0.66 in Sahin et al. (2014). Table 2 provides a summary of the estimates from the literature.

The second parameter is the wage bargaining power of the firms β. Hagedorn and Manovskii (2008) estimate that a one-percent increase in productivity raises real wages by 0.45 percent, or $\beta = 0.45$. Cahuc et al. (2002), who estimate from 1988-1992 French data, report β at around 0.8. From 1993-2000 data obtained in France, Cahuc et al. (2006) find that the bargaining power of firms against skilled workers is around 0.76.

Flinn (2006) reports that $\beta = 0.576$. These studies agree on an asymmetric bargaining power, $\beta > 0.5$.

There is no widely-accepted evidence that we should expect labor markets to be efficient. Based on the estimates, labor markets outside the U.S. likely have inefficiently high unemployment. For example, in France, the estimates are that $\hat{\beta} = 0.8 > 0.09 = \hat{\lambda}$ which suggest inefficiently high unemployment.

6 Optimal Trade Policy - A Large Open Economy

I relax the assumption of fixed world prices in Section 5 by extending the model to a two-country model. In this section, I describe a two-country model and then investigate how labor market inefficiency affects bilaterally optimal trade policy between two countries.

6.1 Model Description - Large Open Economy

To extend the model presented in Section 2 this model simply adds another country. There are two countries: country 1 and country 2. I use a subscript $j \in \{1, 2\}$ to denote a variable that is associated with country j. The two countries have identical preferences, identical technologies of production, and identical structure in a labor market. As in a traditional Heckscher-Ohlin model, the two countries differ in terms of factor endowments K_j and L_j. Moreover, the two countries may have a different bargaining power of firms, β_j, and a different elasticity of matching with respect to vacancy, λ_j.

In this paper, a comparative advantage is gained from endowment differences across countries. One variation of the model allows the two countries to have the same amount of endowments, and it assumes heterogeneity in their labor markets. This variation's prediction resembles the prediction of Helpman and Itskhoki (2010): that a degree of search frictions can be the source of comparative advantage. In my model, this means that a country that has small search frictions has a comparative advantage in recruiting a worker, and hence it exports labor-intensive goods.

The market-clearing condition is that the world price p_w adjusts so that the global excess demand is zero,

$$ED_1^X \left(p_w \left(t_1, t_2 \right), t_1 \right) + ED_2^X \left(p_w \left(t_1, t_2 \right), t_2 \right) = 0. \tag{31}$$

Trade policy t_j affects the global excess demand through the domestic goods market in country j only. The equilibrium world price, described as $p_w \left(t_1, t_2 \right)$, is a function of two trade policies. This global market clearing condition in equation (31) implies that the equilibrium world price ratio is decreasing in both t_1

and t_2:[7]

$$\frac{dp_w\left(t_1,t_2\right)}{dt_1} \quad < \quad 0, \tag{32}$$

$$\frac{dp_w\left(t_1,t_2\right)}{dt_2} \quad < \quad 0. \tag{33}$$

This effect occurs because a trade policy t_j reduces the domestic demand for good X and raises the production of good X in country j. Consequently, as the total quantity of good X in the world market increases the total demand of good X in the world market decreases. Thus, the equilibrium world price ratio has to fall.

One finding is that a world price is closer to the autarky price of a large country than it is to the autarky price of a small country. According to the analysis in Section 4.2, this finding suggests that a large country with an inefficient labor market is more likely to have welfare loss from trade. A reason for this is that the world price may fall into a price range that makes the country worse off. In contrast, a small country with an inefficient labor market is more likely to escape this problem because the new world price is more likely to be sufficiently different from the country's autarky price. Although the new world price moves into an unfavorable direction, it changes dramatically and passes the unfavorable region.

6.2 Optimal Trade Policy

In this two-country model, the optimal trade policy depends on unknown magnitude of terms-of-trade effect $dp_w\left(t_1,t_2\right)/dt_j$, which is increasing in the relative size of country j to the size of the world.

The effect of trade policy t_1 on the country's welfare is given by

$$\frac{dU_1\left(p_w\left(t_1,t_2\right),t_1\right)}{dt_1} = \underbrace{\frac{\partial U_1\left(p_w\left(t_1,t_2\right),t_1\right)}{\partial t_1}}_{\text{Labor-market inefficiency}} + \underbrace{\frac{\partial U_1\left(p_w\left(t_1,t_2\right),t_1\right)}{\partial p_w} \times \frac{\partial p_w\left(t_1,t_2\right)}{\partial t_1}}_{\text{Terms-of-trade manipulation}}.$$

A trade policy improves welfare for two channels: its direct effect on labor market inefficiency and its indirect effect on the world price. The analysis in Section 5 can be considered a special case when $dp_w/dt_1 = 0$, for any t_1. By allowing for the endogenous world price, the terms-of-trade manipulation becomes an additional government motivation to use a trade policy.

To see a unilaterally profitable deviation from free trade, I evaluate the derivative of welfare with respect to t_1 at $t_1 = 0$:

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[7]See the Appendix for proof.

$$\frac{dU_1}{dt_1}\bigg|_{t_1=0} = \underbrace{\frac{\partial U_1}{\partial t_1}\bigg|_{t_1=0}}_{+/-} + \underbrace{\frac{\partial U_1}{\partial p_w}\bigg|_{t_1=0}}_{+/-} \times \underbrace{\frac{\partial p_w}{\partial t_1}\bigg|_{t_1=0}}_{-}.$$

According to equation (30), the first term, $\partial U_1/\partial t_1$, can be either positive or negative, depending on the degree of labor market inefficiency $\lambda - \beta$. The sign of the second term, $\partial U_1/\partial p_w$, is also ambiguous as it depends on the degree of labor market inefficiency $\lambda - \beta$ and the country's comparative advantage. Based on equation (32), the last term, $\partial p_w/\partial t_1$, is always negative. Combining all three terms, the sign of of dU_1/dt_1 is inconclusive.

Define t_L^* as a unilaterally optimal trade policy of a large country that satisfies

$$\frac{\partial U_1\left(p_w\left(t_L^*, t_2\right), t_L^*\right)}{\partial t_1} + \frac{\partial U_1\left(p_w\left(t_L^*, t_2\right), t_L^*\right)}{\partial p_w} \times \frac{\partial p_w\left(t_L^*, t_2\right), t_L^*}{\partial t_1} = 0,$$

and t_S^* as a unilaterally optimal trade policy of a small country that, as solved in section 5, satisfies

$$\frac{\partial U_1\left(p_w\left(t_S^*, t_2\right), t_S^*\right)}{\partial t_1} = 0.$$

In the case of an efficient labor market $\lambda = \beta$, the optimal trade policies are such that $t_L^* \neq t_S^* = 0$. While a small country cannot manipulate the world price and thus prefers free trade, a large country prefers to alter the terms of trade in a way that benefits itself. The sign of t_L^* depends on the country's comparative advantage. A capital-abundant country has $\partial U_1/\partial p_w|_{t_1=0} < 0$ and prefers $t_L^* > 0$, while a labor-abundant country has $\partial U_1/\partial p_w|_{t_1=0} > 0$ and prefers $t_L^* < 0$. In either case, these countries use import taxes or export taxes. The conclusion is consistent with the terms-of-trade incentive in the literature.

The case of an inefficient labor market $\lambda \neq \beta$ is more interesting because a country has an additional incentive to relieve labor market inefficiency. Without loss of generality, I discuss only a case of $\lambda > \beta$; a case of $\lambda < \beta$ is the opposite of the analysis that follows. When $\lambda > \beta$ the direct effect of t_1 on welfare evaluating at $t_1 = 0$ is positive, $\partial U_1/\partial t_1|_{t_1=0} > 0$. There are three possible situations. First, a capital-abundant country that faces $p_w < p_{MinU} < p_A$ prefers $t_L^* > 0$, because it benefits from the positive direct effect and a favorable terms-of-trade effect. Second, a capital-abundant country that faces $p_{MinU} < p_w < p_A$ has to balance trade-offs between the two effects. On the one hand, it wants to correct labor market inefficiency (the direct effect). On the other hand, its intervention drives the price of labor-intensive goods down and puts additional pressure on unemployment. The net result depends on the magnitudes of all terms, including the sensitivity of the world price with respect to the trade policy. Lastly, a labor-abundant country faces the same trade-off found in the previous case: it wants to increase employment but in doing so it lowers the

price of labor-intensive goods, which causes additional job losses.

The impact of Country 1's trade policy t_1 on welfare of Country 2 is

$$dU_2\left(p_w\left(t_1,t_2\right),t_2\right) = \underbrace{\frac{\partial U_2\left(p_w\left(t_1,t_2\right),t_2\right)}{\partial p_w}}_{+/-} \times \underbrace{\frac{\partial p_w\left(t_1,t_2\right)}{\partial t_1}}_{-} \times \underbrace{dt_1}_{+/-}.$$

A trade policy t_1 affects country 2 through a terms-of-trade externality only. There are two possible situations in which the trade policy that a large country uses to reduce its labor market inefficiency benefits the country's trading partner. First, a large labor-abundant country that has inefficiently high unemployment can use its unilaterally optimal trade policy (an export subsidy) to reduce its unemployment and thus improve its welfare. The country's capital-abundant trading partner benefits from the trade policy because of the policy's better terms of trade. This scenario is likely because developing countries are generally labor-abundant, and it implies that developed, capital-abundant countries are better off. Second, a capital-abundant country that has inefficiently high employment can use an export subsidy on its capital-intensive exports. This intervention raises the price of labor-intensive goods and benefits its labor-abundant trading partner through better terms of trade.

This model points to a conclusion that has an interesting policy implication: under some circumstances a unilaterally optimal trade policy can be a Pareto improvement. I conclude this finding in Proposition 6:

Proposition 6. *A unilaterally optimal trade policy of a large open economy that has labor market inefficiency may benefit the country's trading partners.*

As noted in Proposition 6, a unilaterally optimal trade policy can improve global welfare because it reduces inefficiency in the domestic labor market, and it improves trading partners' welfare by providing better terms of trade. Labor market inefficiency is bad and needs to be removed. Unless all countries can implement a first-best policy—that is, a direct subsidy on vacancy postings—trade policy will be the most practical way to reduce labor market inefficiency.

Corollary 4. *World free trade is not optimal if at least one country has labor market inefficiency.*

7   Conclusion

In this paper I introduce a frictional labor market into an otherwise standard Heckscher-Ohlin model of international trade. The first result is that a change in the relative price ratio affects equilibrium unemployment. When the price of labor-intensive (capital-intensive) goods increases, firms adjust their search

intensity and equilibrium unemployment drops (rises). Welfare gains from trade are affected by labor market inefficiency because the inefficiency alters the way the labor market responds to price changes. The effect of labor market inefficiency can reinforce or weaken welfare gains.

Next, I investigate the rationale of trade policy in a small open economy. The main result is that trade policy can improve efficiency when the labor market is initially inefficient. The government can distort prices to motivate firms to employ more or fewer workers. This intervention comes with a tradeoff: a price distortion in the consumer's points of view. As a result, the government can improve welfare but cannot reach constrained efficiency. This paper's key lesson is that raising employment cannot be achieved by subsidizing an export sector or protecting an import-competing sector. Instead, what matters is a sector's labor-intensiveness. To raise employment, the government must stimulate a sector that is relatively labor-intensive.

While this paper establishes the labor-market-motivation of trade policy in a Heckscher-Ohlin model, my conjecture is this rationale holds in other trade models with search-and-matching functions as well, as illustrated by Suwanprasert (2017). In a possible extension for future work, the model could be extended to a dynamic model that quantifies welfare gain or the time path of the optimal trade policy. Alternatively, the model could be extended to N goods and N factors (e.g., workers with heterogeneous skills), or its empirical counterpart could be studied.

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Conflict of Interest Statement

I declare that I have no relevant or material financial interests that relate to the research described in this paper

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