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Globalization and Risk Averse Workers: The Roles of Labor Market and Trade Policies [1]

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Abstract

This paper studies the implications of globalization for aggregate output and welfare when risk averse workers face the risk of unemployment. The impact of globalization on the welfare of workers and aggregate output depends on the degree of substitutability between domestic workers and imported inputs. When the degree of substitutability is high (low), then globalization reduces (increases) wages and increases (reduces) unemployment. Irrespective of the substitutability, free trade doesn't maximize the aggregate output. A small tariff (import subsidy) increases aggregate output when the substitutability is low (high), however, it can exacerbate the distributional conflict. Domestic labor market policies such as unemployment benefits and severance payments can protect workers against labor income risk but the firing restrictions do not. Free trade is optimal when labor market policies provide insurance against unemployment.

Keywords: offshoring, unemployment, endogenous job destruction, severance payments, unemployment benefits

JEL Codes: F16, F66, F68

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1 Introduction

While economists traditionally have devoted a lot of attention to the impact of various aspects of globalization on wage and income inequality, the policymakers and the public at large have been more concerned with the implications of globalization for jobs. As a result, there has been a recent surge in the research on the implications of globalization for jobs. The empirical literature using datasets from various countries and industries finds mixed results. Dutt, Mitra, and Ranjan (2009) find trade liberalization to be associated with lower unemployment at longer intervals in a cross-country study, however, there is a spike in unemployment in the immediate aftermath of trade liberalization. A recent influential study by Autor, Dorn, and Hanson (2013) finds that the increased competition from Chinese imports has increased unemployment in the local U.S. labor markets and explains about one quarter of the contemporaneous aggregate decline in the U.S. manufacturing employment. Monarch, Park, and Sivadasan (2014) find a decline in employment for offshoring firms.[2] Wright (2014) finds that offshoring has differential effects on the employment of workers with different skills, however, the overall effect seems to be positive. Gorg (2011) provides a survey of the empirical literature on offshoring and unemployment and finds a diverse set of results: offshoring affects employment adversely in some industries/countries and positively in others. Given the possibility of globalization increasing unemployment, at least in the short to medium run, a serious discussion of policies related to this issue is warranted which is the subject of this paper.

We construct a theoretical model with risk averse workers which is a key departure from the standard models of globalization and labor market. A single good is produced using domestic labor and imported inputs with a constant elasticity of substitution production function. While all workers are *ex ante* identical, the match specific productivity is random, and it is not worthwhile for firms to keep very low productivity matches. Wage determination follows the competitive search tradition of Moen (1997), and Acemoglu and Shimer (1999) where firms post a wage to attract workers. The advantage of this framework is that the decentralized outcome is efficient when workers are risk neutral and therefore, any inefficiency that arises is solely due to risk aversion. We show that the risk aversion of workers

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[2] Offshoring in these papers refers to input trade and not the trade-in-tasks view of offshoring following the seminal work of Grossman and Rossi-Hansberg (2008). See Feenstra (2008) for an excellent discussion of older and newer concepts of offshoring.

causes unemployment to be inefficiently low. A consequence is that the decentralized aggregate output in the economy is lower than what would happen if a social planner were maximizing output.

In this set up, it is shown that the impact of globalization on labor market outcomes as well as aggregate output crucially depends on the degree of substitution/complementarity between domestic labor and imported inputs. If there is sufficient complementarity between domestic labor and imported inputs, then globalization improves the welfare of workers by lowering unemployment, however, the impact on aggregate output is ambiguous because the lowering of unemployment worsens the existing distortion. On the other hand, if imported inputs can be easily substituted for domestic labor then workers are adversely affected by globalization: unemployment increases and wages decrease. However, the aggregate output increases unambiguously because globalization alleviates the existing distortion.[3] Irrespective of the substitution/complementarity between domestic labor and imports, free trade does not maximize aggregate output. A small tariff increases aggregate output when the substitutability between domestic labor and imported inputs is low while an import subsidy increases aggregate output when the substitutability is high. In both cases the commercial policy intervention reduces the welfare of workers, however, raising the possibility of a conflict between equity and efficiency.

Next, we explore the role of some commonly used social protection programs in restoring efficiency in the decentralized case.[4] In particular, we study the roles of unemployment insurance (UI) and employment protection (EP) legislation. While the role of UI as an instrument of social protection is relatively well known, it is less clear how some elements of EP programs can act as an instrument of social protection. Employment protection refers to a host of mandatory restrictions pertaining to the separation of workers from firms. The two key elements of EP programs are severance payments (SP) which is a transfer from firms to workers and an administrative cost borne by employers which does

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[3] Our theoretical prediction that globalization can increase unemployment in some industries and reduce them in others is consistent with the diverse empirical findings summarized in Gorg (2011). A more direct evidence is provided in Harrison and McMillan (2011). Using data on the U.S. multinationals, they find that when the tasks performed by the subsidiary of a multinational are complementary to the tasks performed at home, offshoring (in the sense of input trade) leads to more job creation in the United States; however, offshoring causes job losses when the tasks performed in the subsidiary are substitutes for the tasks performed at home.

[4] While social protection refers to safety nets of various kinds, in this paper we restrict it to mean social insurance programs that enable individuals to negotiate labor market risk. The main reason for the existence of such programs in market economies is that the market for private insurance against income risk is missing for various reasons.

not accrue to employees directly. Given the widespread use of SP, a serious discussion of this policy is warranted.[5]

We show that both UI and SP can restore production efficiency in the decentralized case.[6] That is, by protecting workers against the risk of unemployment, both UI and SP make the economy production efficient. The efficient level of SP fully insures workers against the risk of unemployment while the efficient level of UI provides incomplete insurance. A consequence is that while the aggregate output, profits, and unemployment are the same under both policies, the worker welfare is higher with efficient SP than with efficient UI. Therefore, SP Pareto dominates UI in our set up. An administrative cost of firing (which is not a transfer to workers), on the other hand, exacerbates the existing inefficiency and does not provide insurance to workers. Since unemployment is inefficiently low, it turns out that a firing subsidy can restore efficiency. What this suggests is that not all components of employment protection have the same efficiency and welfare effects, an insight that may be relevant for empirical work. Empirical work on the subject lumps together all elements of employment protection in constructing an aggregate index of employment protection. We also show that globalization in the presence of efficient labor market policies unambiguously increases aggregate output. There is no need for commercial policy intervention to increase aggregate output when efficient labor market policies are in place.

The baseline model discussed above abstracts from matching frictions to focus on job destruction which creates a role for severance payments. Since matching frictions are an integral part of the unemployment story, in an online appendix we extend the model to incorporate matching frictions. Now the adjustment in response to globalization takes place through changes in both job creation and job destruction. Again the decentralized outcome is production inefficient due to the risk aversion of workers. The impact of globalization on labor market outcomes and aggregate output is similar to that in the baseline model. Free trade is not optimal and a commercial policy intervention increases aggregate output. Looking at labor market policies, one difference from the baseline model is that since severance payments (SP) are given at the time of separation, they cannot be used to insure workers

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[5]In a cross-country study of severance payments, Holzmann et al. (2011) find that out of 183 countries for which information is available, 152 have mandated severance payments schemes (82 percent), 18 have quasi-mandated schemes through comprehensive collective agreements, and only 13 (7 percent) have neither.

[6]The difference between the two in our static framework is in terms of funding. While SP is either paid directly by firms or indirectly through a tax on firing, UI is financed either through a tax on workers or a payroll tax on firms.

who are unemployed because they fail to match. Unemployment insurance (UI) can be used to insure unmatched workers as well as fired workers. Therefore, either UI alone or a combination of UI and SP can be used to achieve efficiency in the decentralized setting. Consistent with the welfare results earlier, worker welfare is higher with a policy that combines SP with UI than UI alone. That is, SP can complement UI when unemployment arises due to a combination of job destruction and matching frictions.

1.1 Related Literature

Many papers studying the labor market implications of globalization in economies with search frictions carry out comparative static exercises with respect to labor market policies such as unemployment benefits, hiring and firing costs etc.[7] A common approach in these papers is to lump these labor market interventions together with search frictions and to conclude that the implications of these interventions are similar to that of an increase in search frictions. This equivalence arises because workers are risk neutral in these papers. An important contribution of our paper is to show that the welfare implications of these policy interventions are very different from an increase in search frictions when workers are risk averse. By ignoring risk aversion these papers miss out on the insurance role that these interventions play in protecting workers against the risk of unemployment in both closed and open economies.

The paper most closely related to our work is Keuschnigg and Ribi (2009), which to the best of our knowledge is the only paper to study the policy implications of globalization in a model with unemployment and risk averse workers. Our model differs from their model in several respects. While they assume domestic labor and offshored inputs to be perfect substitutes, we work with a CES production function which allows us to study cases when offshored inputs are complementary to domestic labor as in the seminal paper by Grossman and Rossi-Hansberg (2008) where this raises the possibility of wages increasing for workers whose jobs are offshored. In fact, we get a cutoff value of the elasticity of substitution parameter such that if the elasticity of substitution is higher than the cutoff then the workers are hurt by globalization, but gain otherwise. Additionally, while wages are determined through Nash bargaining in their set up, firms post wages in our framework. A consequence is that

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[7]e.g. Moore and Ranjan (2005), Helpman and Itskhoki (2010), Egger and Etzel (2012), Felbermayr, Larch and Lechthaler (2013).

the distortion in our framework arises solely due to the risk aversion of workers even in the presence of search frictions. This allows us to focus on policy issues arising from risk aversion.[8] Also, while in Keuschnigg and Ribi (2009) unemployment arises solely because some workers are unmatched, in our baseline model unemployment arises solely from job destruction while in the extension unemployment arises due to both matching frictions and endogenous job destruction. Additionally, while Keuschnigg and Ribi (2009) focus on unemployment benefits, we study severance payments and unemployment benefits as alternative ways to provide social protection, and in this sense the two papers are complementary. Finally, our set up with endogenous job destruction allows us to discuss the roles of other firing related policies such as administrative burden of firing, firing subsidy etc.

While most of the recent papers on labor market implications of globalization use models with risk neutral workers thereby obviating the need for social protection, there is an older literature in international trade dealing with risk averse agents. For example, Newbery and Stiglitz (1984) construct a model with risk averse agents where trade can be Pareto inferior to autarky. Dixit and Rob (1994) show how trade may be inferior to autarky in the presence of missing insurance markets when individuals are risk averse. Due to missing insurance markets, the decentralized solution differs from the planner's problem and hence trade can be inferior to autarky or even a tariff equilibrium can be inferior to autarky. A recent working paper by Allen and Atkin (2016) theoretically and empirically studies the implications of a decrease in trading cost for the welfare of risk averse farmers using a dataset from India. Theoretically, they show that trade liberalization provides unambiguous gains if the comparative advantage is in the safe crop but has an ambiguous effect if the comparative advantage is in the risky crop. In the former case trade induces farmers to specialize more in safe crops which reduces the amount of risk they bear while in the latter case it increases the risk they bear. In the empirical estimation they find that trade increases the volatility in income which points towards the case of comparative advantage in the risky crop. That is, the gains from trade are reduced due to increased volatility. Our paper shares the idea that gains from trade are lower if trade exacerbates the existing distortion arising

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[8]For example, we are able to show that free trade is not optimal and and commercial policy interventions can increase aggregate output. With Nash bargaining in the presence of search frictions and large firms, as in Keuschnigg and Ribi (2009), there are two distortions even with risk neutral workers when large firms hire many workers: search externalities and the "overhiring effect" identified by Stole and Zwiebel (1996). This makes the policy analysis more complicated in such a setting.

from missing insurance market with these studies. However, these studies do not deal with the labor market risk arising from unemployment which is the focus of our paper.

Among other related papers, Brander and Spencer (1994), Feenstra and Lewis (1994), and Davidson and Matusz (2006) study various policies to compensate the workers who lose from trade. However, workers are risk neutral in these papers. Closer to our approach is the paper by Brecher and Chaudhuri (1994) which examines the issue of Pareto superiority of free trade over autarky through Dixit-Norman compensation schemes when there is unemployment in the economy caused by efficiency wage considerations and unemployed workers get unemployment compensation. In this setting, workers who become unemployed due to trade can be fully compensated for their losses only if unemployment benefits become equal to the wages. However, in this case, no effort will be undertaken by any worker, and hence output will become zero. Therefore, fully compensating workers who lose their jobs is not feasible. Even though this paper has unemployment as well as unemployment compensation, workers are risk neutral and hence the insurance motive for unemployment benefits is not present. As far as the related work on social protection is concerned, while much work in labor/macro economics focuses on the administrative cost aspect of employment protection, Pissarides (2001) and Blanchard and Tirole (2008) highlight the potential role of severance payments in providing insurance.

Our static model of endogenous job destruction with large firms employing multiple inputs can be viewed as a generalization of the one-worker-firm model of endogenous job destruction in Blanchard and Tirole (2008). The large firm model with heterogeneous match specific productivity of workers is also similar to Helpman, Itskhoki and Redding (2010). In their model firms have to screen the matched workers after bearing a cost to find out if the productivity of workers is above a cutoff. Workers below the cutoff are not hired. Given firm heterogeneity, more productive firms screen more which leads to different firms having workers with different average productivities resulting in different wages. This set up allows them to study the implications of globalization for wage inequality. Since our focus is on the employment effects of globalization with risk averse workers, we create a simpler framework with homogeneous firms where the match specific productivities are revealed to firms costlessly as in Blanchard and Tirole (2008). The model also bears similarity to Fernandez (1992) where firms hire risk averse workers before the realization of output prices and the contracts take the form of state contingent wages and employment probabilities. Fernandez (1992) excludes the possibility of transfers to unemployed workers either by firms or by the planner. Therefore, the decentralized outcome is

constrained Pareto optimal in her setting and policies (including trade policies) cannot improve upon the decentralized outcome.

To summarize, the key contributions of this paper are the following. In the absence of any government intervention, the decentralized equilibrium is inefficient. The impact of globalization on aggregate output, unemployment, and the welfare of workers depends crucially on the substitutability/complementarity between domestic labor and imported inputs. However, free trade is not optimal irrespective of this. A small tariff increases aggregate output if the imported inputs are complementary to domestic labor while an import subsidy is the optimal policy if imported inputs are substitutes for domestic labor. While a trade intervention increases aggregate output, it has undesirable distributional consequences because it reduces the welfare of workers. Since the distortion in the economy arising from the risk aversion of workers is of domestic nature, labor market interventions like severance payments or unemployment insurance make the economy production-efficient. Additionally, severance payments are superior to unemployment benefits when job destruction is the sole source of unemployment, and a combination of severance payments and unemployment benefits is superior to unemployment benefits alone when unemployment is caused by both job destruction and matching frictions. Finally, with efficient labor market policies in place, globalization increases aggregate output unambiguously even though it may have adverse distributional consequences.

The remainder of the paper is organized as follows. Section 2 provides the baseline model showing the inefficiency of the decentralized equilibrium. Section 3 studies the implications of globalization for labor market and welfare and analyzes the optimal trade policy. Section 4 provides an analysis of labor market policies. Section 5 provides a discussion of robustness issues. Section 6 provides concluding remarks.

2 The Model

The production function for a single final good is given by

$$Z = A((L^e)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma\gamma}{\sigma-1}};\ 0 < \gamma \leq 1, \tag{1}$$

where L^e is the domestic labor in efficiency units and M denotes foreign produced inputs. σ captures the elasticity of substitution between domestic labor and foreign produced inputs and $\gamma < 1$ captures the diminishing returns. Diminishing returns can arise either due to limited span of control as in Lucas

(1978) or due to the presence of some specific factor in fixed supply. It is worthwhile making the notion of substitutability/complementarity between domestic labor and imported inputs more precise given that many results depend on it. In our set up whether domestic workers gain (lose) from globalization depends on whether the domestic labor and imported inputs are gross q-complements (q-substitutes) where q-complementarity is defined in the sense of Hicks elasticity of complementarity: two inputs are gross q-complements (q-substitutes) in the production of a variable output if an increase in the quantity of one input increases (decreases) the marginal product of another.[9] With our production function, the two inputs are gross q-complements (q-substitutes) if $\sigma < (>)\frac{1}{1-\gamma}$. Clearly, with $\gamma = 1$, they will always be gross q-complements. $\gamma < 1$ allows us to discuss both the cases of gross q-substitution and gross q-complementarity.

It is also assumed that there is a continuum of domestic firms of unit mass so there is no distinction between a firm level variable and an economy level variable. Workers are identical *ex ante* but their match specific productivity, λ, is random. Without loss of generality, assume that λ is drawn from a uniform distribution over $[0, 1]$. This is a standard distributional assumption in the literature on endogenous job destruction (e.g. Mortensen and Pissarides (1994)).

As mentioned in the introduction, in the model presented in the text we assume the matching to be frictionless and in an online appendix we extend the model to allow for matching frictions. Once the match specific productivity of a worker is revealed, the firm can decide whether to retain the worker or fire them. If firms use a cutoff rule whereby they retain workers with productivity above λ_c and fire others, then the average productivity of retained workers is $\frac{1+\lambda_c}{2}$. If they hire L_h workers then they retain $(1 - \lambda_c)L_h$ of them, and hence the amount of labor in efficiency units that is used in production is

$$L^e = \frac{1 - \lambda_c^2}{2}L_h = \frac{1 + \lambda_c}{2}L, \tag{2}$$

where L is the number of workers retained by the firm. Therefore, the production function (1) can be written as

$$Z = A\left(\left(\frac{1 + \lambda_c}{2}L\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\gamma}{\sigma-1}}. \tag{3}$$

The above implies that firms face a quantity-quality trade-off in the hiring of workers. To produce a given level of output, they can go for higher quality and lower quantity or vice-versa. Since firing is

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[9]See Sato and Koizumi (1973) for details.

costly, higher quality comes at a higher cost.

The total number of workers in the economy is denoted by $\overline{L}$. Denote the aggregate profit of firms by Π. When $\gamma = 1$ profits are going to be zero.

All workers are risk averse with the utility function given by

$$U(x); \ U' > 0, U'' < 0, \tag{4}$$

where x is their income. Since all workers are matched in the baseline model and some are retained while others are fired, the income of workers when they are retained is $x = w$, where w is the wage, while the income when they are fired is $x = z$ where z is the value of leisure/home production and should be thought of as the wage equivalent of being unemployed.

Firms post wages and firing rates to attract workers. Since workers are risk averse while firms are risk neutral, firms will have an incentive to insure workers. One way this can be done is through a severance payment to the fired worker. We are going to discuss the implications of voluntary severance payments paid by firms later. For now let us assume that firms are unable to offer severance payments. Denote the wage rate posted by firm-i by w_i and the cutoff productivity by λ_{ci} (same as firing rate given the uniform distribution of λ). Workers direct their applications to the firm whose (w_i, λ_{ci}) pair gives them the highest expected utility. Suppose W is the highest utility that a worker can expect from a job at another firm. Now, in order to attract workers, (w_i, λ_{ci}) must satisfy

$$(1 - \lambda_{ci})U(w_i) + \lambda_{ci}U(z) \geq W. \tag{5}$$

Effectively, for any firing rate that the firm posts, (5) determines the wage that the firm has to offer.[10] If a firm wants to raise the average productivity of its workforce by being more selective (higher λ_{ci}) then it will have to offer higher wages. The main advantage of using wage posting is that, as shown later, the decentralized equilibrium is efficient (corresponds to the planner's solution) when workers are risk neutral. Therefore, any inefficiency in the model arises due to the risk aversion of workers. This allows us to focus on the policy issues arising from risk aversion. Even though looking at (5) one

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[10]Note that this way of modeling labor market is similar in spirit to the competitive search framework of Moen (1997) and Acemoglu and Shimer (1999) where firms post wages and workers direct their search. The difference is that in the competitive search framework firms post wages, which for a given W determines the length of the queue, q_i, and consequently how fast the vacancy is filled. That is, a firm is choosing a pair (w_i, q_i) to ensure that the worker gets a utility of W, while in our framework the firm chooses (w_i, λ_{ci}) to ensure that the worker gets a utility of W.

gets the impression that firms can choose different pairs of (w, λ_c) to satisfy (5), it can be shown from the firm's maximization exercise that all firms end up posting the same wage rate.[11] Therefore, in the analysis below we drop the firm subscript i.

Denote the per unit price of the imported input by ϕ. Now, firms perform the following profit maximization exercise.

$$\underset{L, M, w, \lambda_c}{Max} \{Z - wL - \phi M\}$$

subject to the constraint

$$(1 - \lambda_c)U(w) + \lambda_c U(z) \geq W. \tag{6}$$

In writing the first order conditions for the above maximization exercise and throughout the paper, we use the following compact notation:

$$Notation: F_L = \left(\left(\frac{1+\lambda_c}{2}L \right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma\gamma}{\sigma-1}-1} ; F_{\overline{L}} \equiv \left(\left(\frac{1-\lambda_c^2}{2}\overline{L} \right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma\gamma}{\sigma-1}-1} .$$

Using ϱ to denote the Lagrangian multiplier on the constraint in (6), the first order conditions for the above maximization are given by

$$L \quad : \quad \gamma A F_L \left(\frac{1+\lambda_c}{2} \right)^{\frac{\sigma-1}{\sigma}} L^{\frac{-1}{\sigma}} = w \tag{7}$$

$$M \quad : \quad \gamma A F_L M^{\frac{-1}{\sigma}} = \phi \tag{8}$$

$$w \quad : \quad -L + \varrho(1 - \lambda_c)U'(w) = 0 \tag{9}$$

$$\lambda_c \quad : \quad \frac{\gamma A}{2} F_L \left(\frac{1+\lambda_c}{2} \right)^{\frac{-1}{\sigma}} L^{\frac{\sigma-1}{\sigma}} = \varrho(U(w) - U(z)) \tag{10}$$

Intuitively, the l.h.s of (7) is the marginal product of an additional retained worker while the r.h.s is the cost of a retained worker. Similarly, the l.h.s of (10) is the benefit of a higher λ_c, which for a given L results in higher average productivity of these workers. The r.h.s is the cost of a higher λ_c resulting from the higher wages to satisfy the wage constraint because when the probability of getting fired is higher it must be offset by a higher wage. This cost is related to the risk aversion of workers. The greater the risk aversion, the greater the cost in terms of meeting the reservation wage of workers.

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[11] This can be accomplished by noting that the wage rate can be expressed as a function of W and λ_c in the firm's maximization exercise. Since each firm takes W as given, it ends up choosing the same λ_c, which implies the same wage rate.

Since all workers are matched, the number employed simply equals the number not fired and therefore, the aggregate labor market equilibrium condition is given by

$$L = \overline{L}(1 - \lambda_c). \tag{11}$$

The 5 equations (7)-(10), and (11) determine $w, L, M, \lambda_c,$ and ϱ.

It is shown in the appendix that using (7)-(10) and (11) we can obtain the following two key equations in w and λ_c which are useful for proving the existence of equilibrium as well as comparative statics.

$$w = \frac{1 + \lambda_c}{1 - \lambda_c} \psi, \tag{12}$$

$$\gamma A \left(1 + \omega^{\sigma-1} \left(\frac{1 + \lambda_c}{2} \right)^{1-\sigma} \right)^{\frac{\sigma\gamma}{\sigma-1} - 1} \left(\frac{1 - \lambda_c^2}{2} \right)^{\gamma} \overline{L}^{\gamma-1} = w(1 - \lambda_c), \tag{13}$$

where we use the following compact notation:

$$Notation: \psi \equiv \frac{U(w) - U(z)}{U'(w)}; \ \omega \equiv \frac{w}{\phi}$$

When workers are risk neutral, the existence and uniqueness of an interior equilibrium with $\lambda_c \in (0, 1)$ and $w > z$ is easily established in the appendix. When workers are risk averse, the possibility of a corner solution ($\lambda_c = 0$) with full employment, but $w > z$, exists. This case can be ruled out by assuming that workers are not too risk averse.[12] This yields the following result.

Proposition 1: *If workers are not too risk averse, a unique interior equilibrium exists with $w > z$ and positive unemployment:* $\lambda_c \in (0, 1)$.

To show the production-inefficiency of the decentralized equilibrium we solve the planner's problem next.

2.1 Planner's problem

The planner can choose a cutoff productivity, λ_c, offshored input, M, and employment L to maximize the following expression for aggregate output.

$$Z - \phi M + z(\overline{L} - L). \tag{14}$$

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[12] In the case of CRRA utility function with the risk aversion parameter ρ, we numerically verify that for each parametric configuration there exists a $\overline{\rho}$ such that if $\rho < \overline{\rho}$ then the interior solution is guaranteed. This $\overline{\rho}$ is increasing in z, $\overline{L}$, ϕ, and σ, and is decreasing in A and γ.

The planner recognizes that higher λ_c leads to higher unemployment, that is $L = (1 - \lambda_c)\overline{L}$, and therefore, the planner maximizes

$$Z_P - \phi M + z\lambda_c \overline{L}, \tag{15}$$

where

$$Z_P \equiv A \left(\left(\frac{1 - \lambda_c^2}{2} \overline{L} \right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma\gamma}{\sigma-1}}. \tag{16}$$

It is shown in the appendix that the efficient level of λ_c is given by the solution to the following equation.

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{z} \right)^{1-\sigma} \right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2} \right)^{\gamma-1} \overline{L}^{\gamma-1} = z. \tag{17}$$

It is proved in the appendix that the equation above has a unique solution which we call λ_c^e where $\lambda_c^e \in (0, 1)$.

2.1.1 Comparison of decentralized equilibrium with the planner's problem

To facilitate comparison of the planner's problem with the decentralized equilibrium derived earlier, we derive the following equation determining λ_c in the decentralized equilibrium.

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{z'} \right)^{1-\sigma} \right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2} \right)^{\gamma-1} \overline{L}^{\gamma-1} = z', \tag{18}$$

where $z' \equiv w - \psi$.

Case of Risk Neutral Workers

Suppose the utility function is of the form: $U(x) = ax + b$ where $a > 0$ and b are constants. It immediately follows that $w - \psi = z$ and hence, (18) corresponds to (17), which gives the following result.

Lemma 1: *When workers are risk neutral the decentralized equilibrium is production-efficient.*

That is, when workers are risk neutral, the decentralized equilibrium unemployment rate and output are same as one obtained by a social planner interested in maximizing output. Therefore, when workers are risk neutral there are no distortions in the model economy from the point of view of production efficiency. The results parallel the efficiency of decentralized equilibrium in a competitive search framework as in Moen (1997). Similar to Moen (1997), wage posting by firms delivers an efficient outcome

in the decentralized case. When we incorporate search frictions in the extension provided in the online appendix, it is still the case that the decentralized outcome is efficient when workers are risk neutral.

Case of risk averse workers

Recall that the value of λ_c in the planner's problem is denoted by λ_c^e. Denote the decentralized equilibrium value of λ_c by λ_c^r. The following result is easily proved in the appendix.

Lemma 2: *When workers are risk averse, the decentralized equilibrium level of λ_c is inefficiently low $(\lambda_c^r < \lambda_c^e)$ for $\gamma \leq 1$.*

To gain more intuition for this result, compare the equation determining λ_c in the planner's problem given in (17) with the decentralized case given in (18). The left hand side of these equations gives the benefit from hiring an additional worker by lowering λ_c slightly. The right hand side is the cost of doing so. In the planner's problem the cost is simply z while in the decentralized case the cost is $w - \psi$. That is, when a firm retains an extra worker by lowering λ_c, its cost of hiring that worker is lower than w. This is because the firm can afford to offer a lower wage contract because the probability of unemployment is lower. This additional effect is captured by the term ψ. In the risk neutral case $w - \psi$ exactly equals z the social opportunity cost of a worker, and hence the decentralized outcome corresponds to the planner's problem. When workers are risk averse then $w - \psi < z$, and hence firms hire more than what is optimal from the point of view of production efficiency. Essentially, the risk aversion of workers causes firms to overhire.

The result in lemma 2 is similar to the result of Acemoglu and Shimer (1999) that the decentralized equilibrium level of unemployment is too low when workers are risk averse. While they work with single-worker-firms and the source of unemployment in their framework is search frictions, here we obtain this result in a large firm model with endogenous job destruction.

Lemmas 1 and 2 clearly establish that the decentralized outcome is production-inefficient due to the risk aversion of workers.

As mentioned earlier, we restricted firms from making severance payments to fired workers. What happens when firms can make severance payments?

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2.2 When firms offer severance payments voluntarily

Denote the severance payment by the firms by f_w. Now, the maximization problem of firms is given by

$$\underset{L,M,w,\lambda_c,f_w}{Max} \left\{ Z - wL - \left(\frac{\lambda_c}{1 - \lambda_c} \right) f_w L - \phi M \right\}$$

subject to the constraint

$$(1 - \lambda_c)U(w) + \lambda_c U(f_w + z) \geq W. \tag{19}$$

It is shown in the appendix that in this case the equilibrium wage and severance payments are such that the workers are fully insured: $w = f_w + z$. A consequence is that the equilibrium unemployment is given by (17). That is, the equilibrium is production-efficient. Therefore, the inefficiency arising from the risk aversion and lack of insurance can be eliminated by a severance payments contract.

A natural question to ask then is why don't firms offer severance payments voluntarily. The literature has suggested a couple of answers that goes beyond the model: wage rigidity and contracting issues. Note that in order for firms to offer insurance through severance payments, they should have the ability to reduce the wages of employed workers. However, wage rigidity may prevent them from doing so. Minimum wage regulation would be an example of wage rigidity. In the context of our model, it is possible that the minimum wage doesn't bind when firms don't offer severance payments, but would start binding once firms offer severance payments and thereby reduce the wage they desire to offer. Firms may be constrained from lowering wages in exchange for severance payments due to efficiency wage considerations as well. That is, if workers shirk then a higher wage may be required to prevent shirking, and a lower wage in this setting may violate the no shirking constraint.

Alternatively, in real world severance payments rely on a long term contract whereby workers accept a lower wage in return for a promise to get severance payments when they are fired. Now, contractual frictions can create problems with this kind of contract. Modeling these issues is beyond the scope of this paper, but they suggest why there may be a role for mandated severance payments. In addition, Blanchard and Tirole (2008) provide some other reasons why even when firms are allowed to offer severance payments, the layoff decision of firms is not efficient, for example when there are limits to insurance due to moral hazard, or if firms face financial constraints. We don't want to complicate the model too much, however, to get a flavor of how introducing some of these factors will lead to production-inefficiency in the decentralized case, suppose that workers suffer some non-pecuniary losses from being unemployed given by $B > 0$. That is, their utility when unemployed is $U(f + z) - B$. This

change doesn't affect the planner's problem so the production efficient level of λ_c is same as before. However, the decentralized outcome becomes production-inefficient even when firms can offer severance payments (shown in the appendix).[13]

While voluntary severance payments is enough to deliver production efficiency in our baseline model where the sole source of unemployment is job destruction, when we extend the model to introduce matching frictions (shown in online appendix) it is not going to be enough. Voluntary severance payments either by themselves or in combination with unemployment benefits paid to unmatched workers do not lead to production efficiency. In that extension we show that production efficiency can be attained through a combination of mandatory severance payments to fired workers and unemployment benefits to unmatched workers.

Given the discussion above, in the text below to keep things simple we assume that firms do not offer severance payments. However, when discussing mandated severance payments in the baseline model, it should be borne in mind that firms have an incentive to offer it voluntarily.

3   Impact of Globalization

Globalization is captured by a decrease in the price, ϕ, of imported inputs. A decrease in ϕ is like a productivity shock for the economy, so it yields benefits. However, since the economy is distorted to begin with, we are in a second best world. In this case, the impact of globalization depends on whether it ameliorates the existing distortions or worsens them. Since the unemployment rate is suboptimally low in the decentralized case, if globalization increases the unemployment rate, it ameliorates the distortion and if reduces the unemployment rate, then it worsens the distortion.

The following proposition is proved on the impact of globalization in a decentralized equilibrium.

Proposition 2: *A reduction in the cost of imported inputs increases wages and reduces unemployment if $\sigma < \frac{1}{1-\gamma}$, leaves them unchanged if $\sigma = \frac{1}{1-\gamma}$, and reduces wages and increases unemployment if $\sigma > \frac{1}{1-\gamma}$.*

Intuitively, a decrease in ϕ has two effects on the demand for domestic labor. Since imported inputs

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[13] For this result we do not require the non-pecuniary cost of unemployment to enter the utility function linearly. The result obtains more generally. For example, if the utility in the case of unemployment is $BU(x)$ where $B < 1$ and x is the income in the unemployment state, the results go through.

are cheaper now, firms substitute away from domestic labor. However, there is a productivity/scale effect because firms want to produce more output and hence hire more of both inputs. For $\sigma > \frac{1}{1-\gamma}$ the substitution effect dominates, and hence the demand for domestic labor decreases (domestic labor and imported inputs are gross q-substitutes). As firms reduce their demand for domestic labor, the expected reward of labor, W, decreases. This decrease in W allows firms to raise λ_c. More mechanically, at the aggregate level the amount of labor employed in efficiency units is $L^e = \frac{(1-\lambda_c^2)}{2}\overline{L}$. Therefore, the only way the amount of labor employed in efficiency units can decrease is through an increase in λ_c. For $\sigma < \frac{1}{1-\gamma}$ the productivity/scale effect dominates (domestic labor and offshored inputs are gross q-complements) leading to an increase in the demand for domestic labor resulting in lower unemployment and higher wages.

To see the impact of globalization on production-efficiency, note that the aggregate output in the economy can be written as

$$Y = Z_P - \phi M + z\lambda_c\overline{L}, \tag{20}$$

where Z_P is defined in (16). Recall from (15) that the above is exactly the output that the planner maximizes. In the appendix we obtain the following 3 expressions for the impact of globalization on aggregate output, profits, and worker welfare.

$$\frac{dY}{d\phi} = -M + (z - (w - \psi))\,\overline{L}\frac{d\lambda_c}{d\phi}. \tag{21}$$

$$\frac{d\Pi}{d\phi} = -M + \psi\overline{L}\frac{d\lambda_c}{d\phi} - (1 - \lambda_c)\overline{L}\frac{dw}{d\phi}. \tag{22}$$

$$\frac{dW}{d\phi} = U'(w)\left((1 - \lambda_c)\frac{dw}{d\phi} - \psi\frac{d\lambda_c}{d\phi}\right). \tag{23}$$

Let us first obtain the results for the risk neutral worker case. In this case $\psi = w - z$, and it immediately follows from (21) that globalization increases aggregate output unambiguously. It also follows from proposition 2 that workers' welfare increases if $\sigma < \frac{1}{1-\gamma}$ and decreases if $\sigma > \frac{1}{1-\gamma}$. Profits increase unambiguously if $\sigma > \frac{1}{1-\gamma}$. In the $\sigma < \frac{1}{1-\gamma}$ case, since $\frac{d\lambda_c}{d\phi} > 0$ and $\frac{dw}{d\phi} < 0$, the impact on profits is ambiguous. The result is summarized in the proposition below.

Proposition 3: *When agents are risk neutral, globalization increases aggregate output unambiguously. Workers' welfare decreases and profits increase if $\sigma > \frac{1}{1-\gamma}$. In the $\sigma < \frac{1}{1-\gamma}$ case, workers' welfare increases but the impact on profits is ambiguous.*

Moving to the case of risk averse workers, recall that $z > w - \psi$ in this case. Therefore, it follows from the results in proposition 2 that $\frac{dY}{d\phi} < 0$ when $\sigma > \frac{1}{1-\gamma}$, but the sign of $\frac{dY}{d\phi}$ is ambiguous when $\sigma < \frac{1}{1-\gamma}$. It also follows from proposition 2 that the impact on profits and the welfare of workers is similar to the one in the risk neutral case. The result is summarized in the proposition below.

Proposition 4: *When $\sigma > \frac{1}{1-\gamma}$, globalization unambiguously increases aggregate output but the impact is ambiguous when $\sigma < \frac{1}{1-\gamma}$. The welfare of workers increases with globalization when $\sigma < \frac{1}{1-\gamma}$ but decreases when $\sigma > \frac{1}{1-\gamma}$. Profits increase unambiguously in the latter case, but the impact is ambiguous in the former case. In the special case of $\gamma = 1$, profits are zero but globalization unambiguously increases aggregate output and worker welfare.*[14]

Intuitively, since unemployment is inefficiently low in the decentralized equilibrium, when a reduction in ϕ increases unemployment, it reduces the existing distortion and thereby unambiguously increases the production-efficiency of the economy. In the other case, a reduction in unemployment worsens the existing distortion which must then be weighed against the direct positive effect of a decrease in ϕ (which is like a terms of trade gain). Even though the impact of globalization on aggregate output and profits is theoretically ambiguous in the $\sigma < \frac{1}{1-\gamma}$ case, we were unable to find a parametric configuration where globalization actually reduced output or profits. That is, in our numerical exercise we found the direct positive effect of globalization dominating the indirect negative effect on output due to the worsening of existing distortion. Therefore, this case may be viewed more appropriately as one where the gains from globalization are smaller because it worsens the distortion. Similarly, the increased income of workers reduces profits but is not enough to outweigh the direct positive effect on profits due a cheapening of imported inputs. However, results based on numerical exercises should not be treated as definitive because numerical exercises are not exhaustive and we are unable to resolve these ambiguities theoretically. [15]

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[14]$\gamma = 1$ case also corresponds to the case when instead of a fixed mass of firms, there is free entry of firms. In this case profits will be zero and all the gains from globalization will accrue to workers. Essentially, these alternatives make it a one factor model in which case the gains from globalization must accrue to this factor, and hence, labor cannot lose from globalization. However, risk aversion still implies the inefficiency of the decentralized equilibrium.

[15]In our numerical exercises we also found profits to be increasing with globalization in the $\sigma < \frac{1}{1-\gamma}$ case even when workers are risk neutral despite the ambiguous results mentioned in proposition 3.

3.1 Optimal Trade Policy

Whether a decrease in ϕ increases or reduces aggregate output, free trade is not optimal due to the distortion pointed out in lemma 2. This suggests that trade interventions can be efficiency enhancing. To see this, suppose t is the per unit tariff (import subsidy if $t < 0$) on the imported input. In the presence of tariffs, the expression for the aggregate output of the economy remains the one given in (20).

While discussing the impact of a tariff in this set up one question that needs to be answered is what happens to the tariff revenue. The algebra is much simpler if we assume that the tariff revenue goes to profit owners or the money for import subsidy comes from the profit owners.[16] In this case, the wage constraint of workers given in (6) is unaffected. It is shown in the appendix that, starting from free trade, the impact of a tariff on aggregate output is given by

$$\frac{dY}{dt}\Big|_{t=0} = (z - (w - \psi))\,\overline{L}\frac{d\lambda_c}{dt}.$$

Since a tariff raises the price of the imported input, proposition 2 above implies that $\frac{d\lambda_c}{dt} > (<)0$ if $\sigma < (>)\frac{1}{1-\gamma}$. It immediately follows that $\frac{dY}{dt}\big|_{t=0} > (<)0$ if $\sigma < (>)\frac{1}{1-\gamma}$. The result is summarized below.

Proposition 5: *Starting from a free trade situation, a small tariff increases aggregate output when $\sigma < \frac{1}{1-\gamma}$, while an import subsidy increases aggregate output when $\sigma > \frac{1}{1-\gamma}$.*

Intuitively, since the distortion in the free trade situation causes unemployment to be less than the optimal unemployment, when $\sigma < \frac{1}{1-\gamma}$, a tariff corrects the distortion by increasing unemployment, while in the case of $\sigma > \frac{1}{1-\gamma}$ an import subsidy would correct the distortion by increasing unemployment.

It is also shown in the appendix that in the case when tariff revenue goes to firms the welfare of workers decreases while the profit of firms gross of tariff revenue increases as a result of optimal commercial policies. If workers are worse off than profit owners then the optimal commercial policy in this case is going to be regressive. That is, it leads to an equity-efficiency trade off. While it increases production efficiency, it leads to worse equity outcomes. To ensure the gains from the improvement in

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[16]In the online appendix we show that the qualitative results are similar in the case when the tariff revenue is redistributed to workers. In the $\gamma = 1$ case, tariff revenues must be distributed to workers because profits are zero.

production efficiency are widely distributed, redistribution will be required.[17]

The result in proposition 5 is similar to the Copeland (1989) result that a tariff is optimal if the distorted sector is import-competing. In his model the division of labor between those who need to be monitored (type 1 jobs) and those who do not (type 2 jobs) is distorted. If the import competing sector is more intensive in type 1 jobs, then a small tariff is optimal. Also, similar to Copeland (1989) a tariff in our setting improves aggregate output but has adverse distributional consequences if workers are poorer than profit owners. In Copeland (1989) type 1 workers have higher wages and therefore, they gain from a tariff. Copeland (1989) discusses the role of transfers from type 1 workers to type 2 workers and shows how they can be used to offset the distributional consequences of a tariff. Transfers by themselves are efficiency reducing in Copeland (1989) because they worsen the incentive constraint for type 1 workers. He shows that a transfer (that keeps the utility of type 2 workers at the initial level) completely offsets the efficiency gains obtained from a tariff. A lump sum transfer from profit owners to workers in our set up would not have the efficiency reducing effect as in Copeland (1989). Therefore, if a tariff is combined with a transfer, the latter wouldn't offset the efficiency gains from the former as in Copeland (1989).

Also, labor market interventions discussed below will be superior to trade policy intervention. In our setting a transfer from employed to unemployed workers is efficiency enhancing. In fact, the unemployment insurance financed by a tax on employed workers precisely does this in our framework. Severance payments is a transfer from firms to unemployed workers and is also efficiency enhancing.

4   Labor Market Policies

We study some common labor market policies- severance payments, unemployment insurance, and firing taxes which are not transfers to workers- and analyze their potential to restore production-efficiency in the economy and analyze the impact of globalization in the presence of these policies.

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[17]While we have analytically shown the distributional conflict arising from a production-efficiency enhancing commercial policy for the case when tariff revenue is distributed to profit owners, the result can arise even when tariff revenue goes to workers because the direct effect of an optimal commercial policy is to reduce wages and increase unemployment. In the special case of $\gamma = 1$, however, it is shown in the online appendix that the optimal commercial policy intervention, which is a tariff, improves the welfare of workers. Since workers receive all income in this case, there is no distributional conflict.

4.1 Decentralized equilibrium with alternative policies

The first policy we discuss is a firing tax, f_t, by the government which is not a transfer to workers. This can be thought of as the administrative burden imposed on firms with the aim of reducing firing. Even though firing subsidy is never used in practice, we discuss it for the sake of completeness. Next, we discuss mandated severance payments (SP), f_w. This is a transfer from the firm to the fired worker. Finally, we discuss unemployment insurance (UI) given to fired workers. In the public finance literature the funding of UI takes many alternative forms: a lump sum tax on all workers; a tax on only employed workers; or a payroll tax on firms. The results in all cases are qualitatively similar and we choose to discuss only the case where the tax is on employed workers (same as in Keuschnigg and Ribi (2009)). Denote the unemployment benefits by b. This is financed by a tax, τ, on employed workers, therefore, the balanced budget condition is given by

$$\lambda_c b = (1 - \lambda_c)\tau.$$

Note that if UI is financed by a tax imposed on firms for each worker they fire, then in our current framework it is equivalent to the mandated severance payments. Therefore, the key difference between SP and UI in the baseline model is in terms of financing. While the former is either paid directly by firms to fired workers or funded by a firing tax collected by the government, the latter is funded through one of the three alternative ways discussed above.[18]

Below we develop a unified framework that nests all these policies and then discuss each in turn. Our goal is to see if production-efficiency can be restored using these policies. The equilibrium with policies is solved using a two stage game where the planner chooses the policy in the first stage and then firms maximize their profits taking the policies as given. With the above policies in place the firms perform the following maximization exercise in the second stage.

$$\underset{L,M,w,\lambda_c}{Max} \left\{ Z - wL - \frac{\lambda_c}{1 - \lambda_c}\left(f_w + f_t\right)L - \phi M \right\},$$

subject to the constraint

$$(1 - \lambda_c)U(w - \tau) + \lambda_c U(b + f_w + z) \geq W. \tag{24}$$

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[18]While the U.S. does not have a mandated SP, the contribution of the employers towards funding UI is experience rated which essentially means that it is related to the number of workers they fire. That is, the funding of UI in the U.S. makes it similar to a severance payment program.

The first order conditions for the above maximization exercise are derived in the appendix where we derive the following condition characterizing the equilibrium choice of λ_c.

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p - (f_t + f_w)} \right)^{1-\sigma} \right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2} \overline{L} \right)^{\gamma-1} \lambda_c = w - \psi_p - (f_t + f_w), \qquad (25)$$

where $\psi_p \equiv \frac{U(w-\tau) - U(b + f_w + z)}{U'(w-\tau)}$. Below we discuss each of the policies mentioned earlier in turn.

4.1.1 Administrative cost of firing

Setting $b = \tau = f_w = 0$ in (25) obtain

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p - f_t} \right)^{1-\sigma} \right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2} \overline{L} \right)^{\gamma-1} \lambda_c = w - \psi_p - f_t, \qquad (26)$$

where $\psi_p = \frac{U(w) - U(z)}{U'(w)}$ in this case.

Comparing (26) to (17), note that firing taxes lead to efficient λ_c if $\psi_p = w - z - f_t$. The concavity of $U(\ )$ implies that $\psi_p > w - z$ (since w exceeds z), therefore, the efficient level of f_t is characterized by $w - z - f_t > w - z$ or $f_t < 0$. That is, efficiency requires a negative level of administrative burden of firing. Since the administrative burden of firing can at most be reduced to zero, it cannot help achieve efficiency because we have already seen earlier that when $f_t = 0$ the decentralized outcome is inefficient. Intuitively, since λ_c is too low in the absence of any intervention, a policy restoring efficiency must raise λ_c. Increasing the administrative burden of firing (increase in f_t) ends up reducing λ_c which makes the existing distortion worse.[19]

While we are focusing on efficiency, it is worth noting that increased administrative burden of firing does succeed in lowering λ_c, and hence reduces unemployment. Therefore, if the goal of policy is to simply reduce unemployment (say due to extraneous social costs of high unemployment), then in our set up an increase in f_t is able to achieve this goal.

4.1.2 Firing Subsidy

The result above suggests that a firing subsidy by the government may achieve efficiency. Suppose we think of $f_t < 0$ as a monetary firing subsidy. Can such a firing subsidy restore efficiency? The efficient

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[19]To see how $f_t > 0$ lowers λ_c below the efficient level, note that $\psi_p > w - z$ implies that $z > w - \psi_p$ and hence $z > w - \psi_p - f_t$. Following the same reasoning as in the proof of lemma 2, one can verify that the λ_c that solves (26) is lower than the λ_c that solves (17).

level of firing subsidy is given by $s = -f_t = \psi_p - (w - z)$. That is, a firing subsidy can restore efficiency in the model. It can be financed by taxing profits of firms since such a taxation is non-distortionary in our setting. How would the government choose such a f_t? For any f_t chosen by the government the corresponding decentralized equilibrium is $\lambda_c(f_t)$ and $w(f_t)$ where $x(f_t)$ is the equilibrium value of x for a given f_t. The government solves $-f_t = \psi_p(f_t) - (w(f_t) - z)$ to get the efficient level of f_t. Therefore, a firing subsidy delivers the efficient level of λ_c in the model.

4.1.3 Mandated severance payments

To obtain the expression for the equilibrium level of λ_c with mandated severance payments, use $b = \tau = f_t = 0$ in (25) and obtain

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p - f_w}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2}\overline{L}\right)^{\gamma-1} \lambda_c = w - \psi_p - f_w, \tag{27}$$

where $\psi_p = \frac{U(w) - U(f_w + z)}{U'(w)}$.

Comparing (27) with (17) note that severance payments lead to efficient λ_c if $\psi_p = w - f_w - z$. Since $U''(\ ) < 0$, the only solution to $\psi_p = w - f_w - z$ is $f_w = w - z$, that is, a severance payment that provides full insurance restores efficiency.

How would the government choose such a f_w? For any f_w chosen by the government the corresponding decentralized equilibrium is $\lambda_c(f_w)$ and $w(f_w)$ where $x(f_w)$ is the equilibrium value of x for a given f_w. The government solves $f_w = w(f_w) - z$ to get the efficient level of f_w.

As mentioned earlier, in our baseline model firms have an incentive to offer severance payments of their own accord. However, in the extension with search frictions provided in the online appendix we show that voluntary severance payments alone cannot achieve efficiency.

4.1.4 Unemployment insurance

To obtain the expression for λ_c with unemployment insurance, set $f_t = f_w = 0$ in (25) and obtain

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2}\overline{L}\right)^{\gamma-1} = w - \psi_p, \tag{28}$$

where $\psi_p = \frac{U(w-\tau) - U(b+z)}{U'(w-\tau)}$ and the balanced budget condition implies $\tau = \frac{\lambda_c}{1-\lambda_c}b$.

Again, comparing (28) with (17) note that a level of unemployment benefits, b, leads to efficient λ_c if $\psi_p = w - z$. The efficient level of b can be found as follows. For each b there is an equilibrium $w(b)$ and $\psi_p(b)$. The planner solves for b such that $w(b) - \psi_p(b) = z$.[20]

It can also be verified that the efficient level of unemployment benefits does not imply full insurance. Full insurance implies $\psi_p = 0$, while efficiency requires $\psi_p = w - z$. The two can be satisfied together only if $w = z$ and $b = \tau = 0$, which cannot be true in any equilibrium (see proposition 1).

Thus, both severance payments and unemployment benefits can be used to achieve efficiency, however, while the former provides full insurance to workers, the latter doesn't. Intuitively, full insurance through unemployment benefits is not efficient because it reduces the cost of firing for firms leading to too much firing. There is no such problem in the case of severance payments because severance payments make it costly for firms to fire workers. That is, firms correctly internalize the cost of firing in the case of severance payments but not so in the case of unemployment benefits. The result has implications for welfare which is summarized in the proposition below and proved in the appendix.

Proposition 6: *The efficient levels of severance payments and unemployment benefits yield the same levels of output, unemployment, and profits, however, the welfare of workers is higher with efficient severance payments than with efficient unemployment insurance. Therefore, severance payments is Pareto superior to unemployment insurance.*

While comparing severance payments and unemployment insurance, it is worth reiterating that mandated severance payments are equivalent to unemployment benefits funded by a layoff tax. Therefore, another way to state the result above is that unemployment benefits funded by a layoff tax are superior to the unemployment benefits funded by a payroll tax.

Comparing an efficient firing subsidy financed by a tax on profits with the other two interventions, we find that the wage is higher in the case of a firing subsidy, however, the welfare of workers is not necessarily higher because there is no insurance against unemployment risk. The profit of firms before taxes is same as the profits in the other two cases but the profit net of taxes is lower.

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[20]It was mentioned earlier that unemployment benefits can be financed alternatively using a payroll tax on firms or a lump sum tax on all workers. The outcome (output, unemployment, profits, welfare) with the efficient level of unemployment insurance in either of these cases corresponds exactly to the case discussed in the text.

4.2 Globalization in the presence of labor market policies

As expected, if the labor market policies correct the distortion and restore efficiency, then free trade is optimal. The following result is easily verified in the appendix.

Proposition 7: *With efficient labor market intervention in place, globalization unambiguously increases aggregate output.*

The result above holds irrespective of the labor market intervention (firing subsidy, severance payments, unemployment insurance) used to achieve efficiency.

The impact of globalization on the welfare of workers and profit owners depends on what happens to the wages and unemployment rates, the key result summarized in proposition 2. It turns out that the result summarized in proposition 2 remains valid when labor market policies are optimally chosen.[21] Therefore, we obtain the same results on the welfare of workers and profit owners as summarized in proposition 4. That is, workers lose and profit owners gain if $\sigma > \frac{1}{1-\gamma}$, while workers gain and the impact on profits is ambiguous if $\sigma < \frac{1}{1-\gamma}$.

While we have talked about commercial policies as well as labor market policies, it should be obvious that since the distortion is of a domestic nature (missing insurance market), commercial policies are inferior to labor market policies. Since commercial policy interventions distort the choice of imported inputs for firms, they cannot restore production-efficiency in the economy.

5 Discussions

In the model we have assumed that there is a unit measure of firms and the production function exhibits diminishing returns to labor. We mentioned earlier that diminishing returns to labor could arise either due to limited span of control or due to the presence of a specific factor in fixed supply. To see the latter interpretation, suppose the production function in (1) is

$$Z = A((L^e)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma\gamma}{\sigma-1}} H^{1-\gamma},$$

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[21] For mandated severance payments and unemployment insurance the results in proposition 2 go through without any additional conditions, but in the case of firing subsidy, we need a sufficient condition, $(1 - \lambda_c)w > \lambda_c \rho \psi_p$, which is easily satisfied for reasonable values of the risk aversion parameter ρ.

where H is another factor of production in fixed supply (It could be physical capital or human capital). The reward of this factor is r which is competitively determined. If the total amount of H in the economy is $\overline{H}$, then it is easily verified that $r\overline{H} = (1-\gamma)Z$ which is same as Π. Therefore, all the results in the paper go through with this alternative production function.[22]

While our model is one of input trade, what is crucial for the results is the risk aversion of workers and the complementarity/substitutability between domestic labor and imports. The imports could alternatively be modeled as a final good instead of an input. The model can also be extended to a two final good setting with one of the two goods being labor intensive and the other being intensive in another factor of production. In this case the impact of globalization for the country importing the labor intensive good will be similar to the results for $\sigma > \frac{1}{1-\gamma}$ case of our model (when domestic labor and imported input are gross q-substitutes), while for the country exporting the labor intensive good, the impact will be similar to the $\sigma < \frac{1}{1-\gamma}$ (when domestic labor and imported inputs are gross q-complements). The advantage of our current framework with imported inputs is that we can capture these various cases in a more tractable set up with a single final good.

The model can also be adapted to the trade in tasks view of offshoring. While the earlier literature referred to any kind of input trade as offshoring, the more recent literature following Grossman and Rossi-Hansberg (2008) views trade in tasks as offshoring. Instead of there being two inputs in the production process, we could easily have a continuum of tasks some of which can be offshored more easily than others. Given this, some tasks will be performed at home and others will be performed abroad. Increase in offshoring would mean more tasks being performed abroad. Whether that would lead to increase in demand for home labor or not will depend on the elasticity of substitution between tasks (See Groizard, Ranjan, and Rodriguez-Lopez (2014) for a model along these lines). The qualitative results will remain unchanged.

The model can also be applied to study the implications of immigration for the welfare of native workers. Instead of viewing the input M as the imported input, we could think of it as immigrant labor, in which case a change in the cost of hiring immigrant labor will affect the welfare of native workers along the lines discussed in the paper. In fact, Ottaviano, Peri, and Wright (2013) use a model in a similar spirit where native workers, immigrant labor, and offshored inputs compete with each other in the production of a continuum of tasks. Each of the three groups has a comparative advantage in

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[22] The proof is available in the online appendix.

a subset of tasks, and the tasks themselves are combined using a CES function to produce the final good. In this setting they explore the implications of a decline in the offshoring cost or immigration cost on the employment of native workers.

6 Concluding Remarks

Unlike the standard models of unemployment where workers are risk neutral, we construct a model with risk averse workers and endogenous job destruction to study the welfare and policy implications of globalization. Globalization is modeled as a decrease in the price of an imported input which is combined with domestic labor to produce a final good. In this setting, the impact of globalization on aggregate output and the welfare of workers and profit owners depends crucially on whether domestic labor and the imported input are gross q-substitutes or gross q-complements.

Looking at policies, it is shown that the decentralized outcome is not production-efficient due to the missing market for insurance against labor income risk. Therefore, a trade policy intervention can improve aggregate output. However, trade policy interventions have adverse distributional conse-quences if workers are poorer than profit owners. Common labor market policies such as mandated severance payments and unemployment benefits can fill the gap created by the missing market for insurance and make the economy production efficient. A firing tax which does not result in a transfer to workers exacerbates the distortion due to missing insurance market. In fact, a firing subsidy can make the economy production-efficient. While both unemployment benefits and severance payments can alleviate the distortion and make the economy production-efficient, severance payments result in better welfare outcomes when unemployment is caused solely by job destruction. When unemployment is caused by both job destruction and matching frictions, a policy that combines severance payments with unemployment benefits provides better welfare outcomes than a policy relying solely on unem-ployment benefits. Since setting up and administering unemployment insurance is costly, the use of severance payments by many developing countries may be an effective policy tool to insure workers against the labor market risk. Finally, in the presence of labor market interventions that make the economy production efficient, globalization necessarily increases aggregate output.

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7 Appendix

7.1 Derivation of key equations (12), (13), (18)

Using (9) in (10) obtain

$$\gamma A F_L \left(\frac{1+\lambda_c}{2}\right)^{\frac{-1}{\sigma}} L^{\frac{-1}{\sigma}} \left(\frac{1-\lambda_c}{2}\right) = \psi. \tag{29}$$

Next, substitute (7) in (29) and simplify to obtain (12). Next, note that equations (7) and (8) imply

$$M^{\frac{\sigma-1}{\sigma}} = \omega^{\sigma-1} L^{\frac{\sigma-1}{\sigma}} \left(\frac{1+\lambda_c}{2}\right)^{-\frac{(\sigma-1)^2}{\sigma}}. \tag{30}$$

Using (30) and (11) in (7) obtain (13).

Subtract (29) from (7) to obtain

$$\gamma A \lambda_c F_L L^{\frac{-1}{\sigma}} \left(\frac{1+\lambda_c}{2}\right)^{\frac{-1}{\sigma}} = w - \psi \tag{31}$$

Next, use (8) and (31) to obtain

$$M = L \left(\frac{1+\lambda_c}{2}\right) \left(\frac{w-\psi}{\lambda_c \phi}\right)^{\sigma} \tag{32}$$

Therefore, $F_{\overline{L}}$ can be written as

$$F_{\overline{L}} = \left(1 + \left(\frac{\lambda_c \phi}{w-\psi}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\left(\frac{\sigma\gamma-\sigma+1}{\sigma}\right)} \tag{33}$$

Use the above in (31) to obtain

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{w-\psi}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\gamma-1} = w - \psi \tag{34}$$

Equation (34) above is the expression (18) in the text.

7.2 The Planner's problem

Using the notation defined in the text, write the f.o.c with respect to λ_c and M as

$$\lambda_c \gamma A F_{\overline{L}} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\frac{-1}{\sigma}} = z; \tag{35}$$

$$\gamma A F_{\overline{L}} M^{\frac{-1}{\sigma}} = \phi. \tag{36}$$

From the above two f.o.c obtain

$$M = \left(\frac{\lambda_c \phi}{z}\right)^{-\sigma} \left(\frac{1 - \lambda_c^2}{2}\overline{L}\right). \tag{37}$$

Substitute the above in (35) to eliminate M and obtain

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{z}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2}\right)^{\gamma-1} \overline{L}^{\gamma-1} = z. \tag{38}$$

Re-write (38) as

$$\Gamma(\lambda_c, z) = 1, \tag{39}$$

where

$$\Gamma(\lambda_c, z) \equiv \frac{\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{z}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1 - \lambda_c^2}{2}\right)^{\gamma-1} \overline{L}^{\gamma-1}}{z}.$$

Next, verify that $\frac{\partial \Gamma(\lambda_c, z)}{\partial \lambda_c} > 0$. Since $\Gamma(0, z) = 0$, $\Gamma(1, z) = \infty$, there exists a $\lambda_c^e \in (0, 1)$ such that $\Gamma(\lambda_c^e, z) = 1$.

7.3   When firms offer severance payments

Firms undertake the following maximization exercise.

$$Z - wL - \phi M - \frac{\lambda_c}{1 - \lambda_c} f_w L \text{ subject to } \lambda_c \left(U(f_w + z) - B\right) + (1 - \lambda_c)U(w) \geq W.$$

where $B \geq 0$ is the extra disutility from unemployment.

Using ϱ to denote the Lagrangian multiplier on the constraint, the first order conditions for the maximization problem in this case are given by

$$L \quad : \quad \gamma A F_L \left(\frac{1 + \lambda_c}{2}\right)^{\frac{\sigma-1}{\sigma}} L^{\frac{-1}{\sigma}} = w + \frac{\lambda_c}{1 - \lambda_c} f_w \tag{40}$$

$$M \quad : \quad \gamma A F_L M^{\frac{-1}{\sigma}} = \phi \tag{41}$$

$$w \quad : \quad -L + \varrho(1 - \lambda_c)U'(w) = 0 \tag{42}$$

$$\lambda_c \quad : \quad \frac{\gamma A}{2} F_L \left(\frac{1 + \lambda_c}{2}\right)^{\frac{-1}{\sigma}} L^{\frac{\sigma-1}{\sigma}} = \varrho(U(w) - U(f_w + z) + B) + \frac{1}{(1 - \lambda_c)^2} f_w L \tag{43}$$

$$f_w \quad : \quad -\frac{\lambda_c}{1 - \lambda_c} L + \varrho \lambda_c U'(f_w + z) = 0 \tag{44}$$

The aggregate employment condition is again given by

$$L = \overline{L}(1 - \lambda_c). \tag{45}$$

The 6 equations (40)-(44), and (45) determine w, L, M, λ_c, f_w and ϱ.

Using (42) and (44) obtain

$$U'(w) = U'(f_w + z). \tag{46}$$

That is, firms want to fully insure workers through severance payments (except for the disutility from unemployment component B): $w = f_w + z$.

Next, using equations (40)-(43) obtain the equation below by following the same steps used in the derivation of (34) above.

$$\gamma \lambda_c A \left(1 + \left(\frac{\lambda_c \phi}{w - f_w - \frac{B}{U'(w)}} \right)^{1-\sigma} \right)^{\frac{\sigma \gamma}{\sigma-1}-1} \overline{L}^{\gamma-1} \left(\frac{1 - \lambda_c^2}{2} \right)^{\gamma-1} = w - f_w - \frac{B}{U'(w)} \tag{47}$$

Next, note that $w = f_w + z$. Therefore, (47) can be written as

$$\gamma \lambda_c A \left(1 + \left(\frac{\lambda_c \phi}{z - \frac{B}{U'(w)}} \right)^{1-\sigma} \right)^{\frac{\sigma \gamma}{\sigma-1}-1} \overline{L}^{\gamma-1} \left(\frac{1 - \lambda_c^2}{2} \right)^{\gamma-1} = z - \frac{B}{U'(w)} \tag{48}$$

Therefore, for $B = 0$, the above becomes (17). For $B > 0$ the decentralized λ_c is production inefficient.

7.4   Proof of Proposition 1

Totally differentiating (12) obtain

$$dw = \frac{(1 + \lambda_c)}{(1 - \lambda_c)} \left(dw - \psi \frac{U''(w)}{U'(w)} dw \right) + \frac{2}{(1 + \lambda_c)(1 - \lambda_c)} \left(\left(\frac{1 + \lambda_c}{1 - \lambda_c} \right) \psi \right) d\lambda_c,$$

where $\psi \equiv \frac{U(w) - U(z)}{U'(w)}$. Re-arrange the above as

$$C_{1w} dw + C_{1\lambda} d\lambda_c = 0, \tag{49}$$

where

$$C_{1w} \equiv \left(2\lambda_c(1 - \lambda_c) - \frac{U''(w)}{U'(w)} \left(1 - \lambda_c^2 \right) \psi \right) > 0; C_{1\lambda} \equiv 2\psi > 0$$

Re–arrange the key equation (13) as

$$\frac{\gamma A}{2^\gamma} \overline{L}^{\gamma-1} \left(1 + \left(\omega^{\sigma-1} \left(\frac{1 + \lambda_c}{2} \right)^{-(\sigma-1)} \right) \right)^{\frac{\sigma \gamma}{\sigma-1}-1} (1 - \lambda_c)^{\gamma-1} (1 + \lambda_c)^\gamma = w. \tag{50}$$

Use the following compact notation.

$$\Omega \equiv \frac{\omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}}{1+\left(\omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}\right)}; \Lambda \equiv \frac{\gamma A}{2\gamma}\overline{L}^{\gamma-1}\left(1+\left(\omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}\right)\right)^{\frac{\sigma\gamma}{\sigma-1}-1}$$

$$d\Lambda = \left(\frac{\sigma\gamma-\sigma+1}{\sigma-1}\right)\frac{\Lambda}{1+\omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}}$$

Note from (50) and the definition of Λ that

$$\Lambda = \frac{(1-\lambda_c)\omega\phi}{(1-\lambda_c^2)\gamma}; d\Lambda = \left(\frac{\sigma\gamma-\sigma+1}{\sigma-1}\right)\Omega\frac{(1-\lambda_c)\omega\phi}{(1-\lambda_c^2)\gamma\omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}} \tag{51}$$

Now, totally differentiate (50) to obtain

$$(\sigma-1)\,d\Lambda\frac{(1-\lambda_c^2)^\gamma}{1-\lambda_c}\left(\omega^{\sigma-2}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}d\omega - \frac{\omega^{\sigma-1}}{2}\left(\frac{1+\lambda_c}{2}\right)^{-\sigma}d\lambda_c\right) + \left(\frac{1+\lambda_c-2\lambda_c\gamma}{1-\lambda_c^2}\right)wd\lambda_c = dw. \tag{52}$$

Next, from the definition of ω obtain

$$d\omega = \frac{1}{\phi}dw - \omega\frac{d\phi}{\phi}. \tag{53}$$

Using the above expression for ω in (52) and (51) obtain

$$(\sigma\gamma-\sigma+1)\,\Omega\left((dw-\omega d\phi)-\frac{w}{1+\lambda_c}d\lambda_c\right)+\left(\frac{1+\lambda_c-2\lambda_c\gamma}{1-\lambda_c^2}\right)wd\lambda_c = dw. \tag{54}$$

Collect the terms and re-write the above as

$$C_{2w}dw + C_{2\lambda}d\lambda_c + C_{2\phi}d\phi = 0, \tag{55}$$

where

$$C_{2w} = -\left(\sigma(1-\gamma)-1\right)\Omega - 1 < 0. \tag{56}$$

The inequality above follows from the fact that $-\left(\sigma(1-\gamma)-1\right) < 1$. Next,

$$C_{2\phi} = -\left(\sigma\gamma-\sigma+1\right)\omega\Omega. \tag{57}$$

Finally,

$$C_{2\lambda} = -\left(\sigma\gamma-\sigma+1\right)\Omega\left(\frac{w}{1+\lambda_c}\right)+\left(\frac{1+\lambda_c-2\lambda_c\gamma}{1-\lambda_c^2}\right)w. \tag{58}$$

Re-write above as

$$C_{2\lambda} = -C_{2w}\left(\frac{w}{1+\lambda_c}\right)+\left(\frac{2\lambda_c(1-\gamma)}{1-\lambda_c^2}\right)w \tag{59}$$

The inequality above follows from the fact that $C_{2w} < 0$.

Therefore, the coefficients of (55) are

$$C_{2w} = -\left((\sigma(1-\gamma) - 1)\Omega + 1\right) < 0; C_{2\lambda} = \frac{w}{1+\lambda_c}\left(\frac{2\lambda_c(1-\gamma)}{1-\lambda_c} - C_{2w}\right) > 0; C_{2\phi} = (\sigma(1-\gamma) - 1)\Omega\omega.$$

The coefficients above imply that (50) gives a positive relationship between λ_c and w in the (λ_c, w) space. As well, $\lambda_c \to 1$ implies $w \to \infty$ while w is a constant for $\lambda_c = 0$. Let us call this constant w_1.

Next, note from (49) that (12) gives a negative relationship between λ_c and w. Moreover, $w \to z$ from above as $\lambda_c \to 1$ and $w \ (> z)$ is a constant for $\lambda_c = 0$. Let us call this constant w_2. w_2 solves $w = \psi(w)$ where $\psi(w) \equiv \frac{U(w) - U(z)}{U'(w)}$.

Therefore, existence and uniqueness of an interior solution $(\lambda_c \in (0, 1))$ is guaranteed if $w_2 > w_1$. In the risk neutral case, $w_2 \to \infty$ as $\lambda_c \to 0$, therefore, we always get a unique interior equilibrium. With risk averse workers, interior solution requires $w_2 > w_1$ which for a given set of parameters requires the workers to be not too risk averse. For CRRA utility function with ρ as the risk aversion parameter, we numerically verify that there exists a $\overline{\rho}$ such that at $\rho = \overline{\rho}$, $\lambda_c = 0$ and for $\rho < \overline{\rho}$, $\lambda_c \in (0, 1)$. As well, $\overline{\rho}$ is increasing in $z, \overline{L}, \sigma$, and ϕ and decreasing in A and γ. Essentially, the first order condition with respect to λ_c (10) implies that for $\lambda_c = 0$ the l.h.s of (10) must be less than the r.h.s at $\lambda_c = 0$. Using (7), this boils down to $w_1 < \psi(w_1)$. $w_2 > w_1$ ensures that $w_1 > \psi(w_1)$, and hence, $\lambda_c > 0$.

7.5   Proof of Lemma 2

It was verified earlier from (39) that $\frac{\partial \Gamma(\lambda_c, z)}{\partial \lambda_c} > 0$. Next, verify from (39) that $\frac{\partial \Gamma(\lambda_c, z)}{\partial z} < 0$. Next, $\psi \equiv \frac{U(w) - U(z)}{U'(w)}$, therefore, $U''(\ ) < 0$ implies $\psi > w - z$, and hence, z' in (18) is less than z. It follows that the solution to $\Gamma(\lambda_c, z') = 1$ is smaller than the solution to $\Gamma(\lambda_c, z) = 1$. That is, $\lambda_c^r < \lambda_c^e$. Verify that the above argument goes through for $\gamma = 1$ as well.

7.6   Proof of Proposition 2

From (49) and (55) obtain the following expressions for the impact of offshoring on w and λ_c.

$$\frac{dw}{d\phi} = -\frac{C_{2\phi}}{\left(C_{2w} - \frac{C_{2\lambda}}{C_{1\lambda}}C_{1w}\right)}; \frac{d\lambda_c}{d\phi} = -\frac{C_{2\phi}}{\left(C_{2\lambda} - \frac{C_{2w}}{C_{1w}}C_{1\lambda}\right)}. \tag{60}$$

Note from the signs of the coefficients defined earlier that $C_{2w} - \frac{C_{2\lambda}}{C_{1\lambda}}C_{1w} < 0$ and $C_{2\lambda} - \frac{C_{2w}}{C_{1w}}C_{1\lambda} > 0$. Therefore, w and λ_c move in opposite directions in response to globalization. Since the sign of $C_{2\phi}$ is

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ambiguous, we have two relevant cases to discuss.

Case I: $\sigma < \frac{1}{1-\gamma}$

In this case, $C_{2\phi} < 0$, therefore, (60) implies $\frac{dw}{d\phi} < 0, \frac{d\lambda_c}{d\phi} > 0$.

Case II: $\sigma > \frac{1}{1-\gamma}$

In this case, $C_{2\phi} > 0$, therefore, (60) implies $\frac{dw}{d\phi} > 0, \frac{d\lambda_c}{d\phi} < 0$.

7.7 Proof of Proposition 4

Note from (20) that

$$\frac{dY}{d\phi} = -M + z\overline{L}\frac{d\lambda_c}{d\phi} + \frac{\partial Z_P}{\partial \lambda_c}\frac{d\lambda_c}{d\phi} \tag{61}$$

where Z_P is the output given in (16) in the text. It follows from (16) that

$$\frac{\partial Z_P}{\partial \lambda_c} = -\lambda_c A\gamma F_{\overline{L}}\overline{L}^{\frac{\sigma-1}{\sigma}}\left(\frac{1-\lambda_c^2}{2}\right)^{\frac{-1}{\sigma}} \tag{62}$$

Next, using (31) in the above expression obtain

$$\frac{\partial Z_P}{\partial \lambda_c} = -\left(w - \psi\right)\overline{L}. \tag{63}$$

Therefore,

$$\frac{dY}{d\phi} = -M + (z - (w - \psi))\overline{L}\frac{d\lambda_c}{d\phi}. \tag{64}$$

7.7.1 Impact of globalization on profits

Note that the expression for equilibrium profit is given by

$$\Pi = Z_P - \phi M - (1 - \lambda_c)w\overline{L}. \tag{65}$$

Therefore,

$$\frac{d\Pi}{d\phi} = \frac{\partial Z_P}{\partial \lambda_c}\frac{d\lambda_c}{d\phi} - M - (1 - \lambda_c)\overline{L}\frac{dw}{d\phi} + w\overline{L}\frac{d\lambda_c}{d\phi} \tag{66}$$

Using (63) obtain

$$\frac{d\Pi}{d\phi} = -M + \psi\overline{L}\frac{d\lambda_c}{d\phi} - (1 - \lambda_c)\overline{L}\frac{dw}{d\phi} \tag{67}$$

So, $\frac{d\Pi}{d\phi} < 0$ when $\sigma > \frac{1}{1-\gamma}$, but the impact is ambiguous when $\sigma < \frac{1}{1-\gamma}$.

7.7.2   Impact of globalization on worker welfare

The expression for worker welfare is

$$W = (1 - \lambda_c)U(w) + \lambda_c U(z) \tag{68}$$

Therefore,

$$\frac{dW}{d\phi} = U'(w)\left((1 - \lambda_c)\frac{dw}{d\phi} - \psi\frac{d\lambda_c}{d\phi}\right) \tag{69}$$

7.7.3 $\gamma = 1$ case

In this case, the aggregate output can be written simply as

$$Y = w(1 - \lambda_c)\overline{L} + z\lambda_c\overline{L} \tag{70}$$

Therefore,

$$\frac{dY}{d\phi} = (1 - \lambda_c)\overline{L}\frac{dw}{d\phi} - (w - z)\overline{L}\frac{d\lambda_c}{d\phi} \tag{71}$$

From proposition 2 which is valid for $\gamma = 1$ as well, it follows that $\frac{dY}{d\phi} < 0$ since $\frac{dw}{d\phi} < 0$ and $\frac{d\lambda_c}{d\phi} > 0$.

7.8   Proof of proposition 5 (Impact of tariffs)

In this case firms maximize

$$\underset{L,M,w,\lambda_c}{Max} \{Z - wL - (\phi + t)M\}$$

subject to the constraint

$$(1 - \lambda_c)U(w) + \lambda_c U(z) \geq W. \tag{72}$$

The above maximization is same as the baseline model except that ϕ has been replaced by $\phi + t$. Therefore, the comparative statics with respect to ϕ given in proposition 2 go through. Denote $\phi + t$ by ϕ'. The expressions for $\frac{dw}{d\phi'}$ and $\frac{d\lambda_c}{d\phi'}$ are those in (60). Since $d\phi' = dt$, we obtain $\frac{dw}{dt} < (>)0, \frac{d\lambda_c}{dt} > (<)0$ when $\sigma < (>)\frac{1}{1-\gamma}$.

Recall from the text that the aggregate output is

$$Y = A\left(\left(\frac{1 - \lambda_c^2}{2}\overline{L}\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\gamma}{\sigma-1}} - \phi M + z\lambda_c\overline{L} = Z_P - \phi M + z\lambda_c\overline{L} \tag{73}$$

Therefore,

$$\frac{dY}{dt} = \left(\frac{\partial Z_P}{\partial M} - \phi\right)\frac{dM}{dt} + z\overline{L}\frac{d\lambda_c}{dt} + \frac{\partial Z_P}{\partial \lambda_c}\frac{d\lambda_c}{dt}. \tag{74}$$

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Since the price of M faced by firms is $(\phi + t)$, the optimal choice of M implies $\frac{\partial Z_P}{\partial M} = \phi + t$. Using this as well as (63) re-write the above as

$$\frac{dY}{dt} = t\frac{dM}{dt} + (\psi - (w - z))\overline{L}\frac{d\lambda_c}{dt}. \tag{75}$$

Therefore, starting from free trade $(t = 0)$, we get

$$\left.\frac{dY}{dt}\right|_{t=0} = (z - (w - \psi))\overline{L}\frac{d\lambda_c}{dt}. \tag{76}$$

7.8.1 Impact of tariffs on profits and workers:

Since tariff revenue is given back to profit owners, profits gross of tariff revenue, denoted by Π' where $\Pi' = \Pi + tM$, is given by

$$\Pi' = Z_P - \phi M - (1 - \lambda_c)w\overline{L}. \tag{77}$$

The above implies

$$\left.\frac{d\Pi'}{dt}\right|_{t=0} = \frac{\partial Z_P}{\partial\lambda_c}\frac{d\lambda_c}{dt} - (1 - \lambda_c)\overline{L}\frac{dw}{dt} + w\overline{L}\frac{d\lambda_c}{dt} \tag{78}$$

Again, using (63) re-write the above as

$$\left.\frac{d\Pi'}{dt}\right|_{t=0} = \overline{L}\left(\psi\frac{d\lambda_c}{dt} - (1 - \lambda_c)\frac{dw}{dt}\right). \tag{79}$$

Since we have $\frac{dw}{dt} < 0, \frac{d\lambda_c}{dt} > 0$ when $\sigma < \frac{1}{1-\gamma}$, $\left.\frac{d\Pi'}{dt}\right|_{t=0} > 0$, that is, a tariff increases gross profits. Similarly, when $\sigma > \frac{1}{1-\gamma}$ we get $\frac{dw}{dt} > 0, \frac{d\lambda_c}{dt} < 0$, that is a tariff reduces gross profits, but an import subsidy increases gross profits in this case.

The impact on worker welfare follows simply from $\frac{dw}{dt} < (>)0, \frac{d\lambda_c}{dt} > (<)0$ when $\sigma < (>)\frac{1}{1-\gamma}$.

7.9 Equations for Labor Market Policies

In the decentralized equilibrium firms maximize

$$Z - wL - \phi M - \frac{\lambda_c}{1 - \lambda_c}(f_w + f_t)L \text{ subject to } \lambda_c U(b + f_w + z) + (1 - \lambda_c)U(w - \tau) \geq W.$$

The f.o.c are given by

$$L \; : \; \gamma A F_L \left(\frac{1 + \lambda_c}{2} \right)^{\frac{\sigma - 1}{\sigma}} L^{-\frac{1}{\sigma}} = w + \frac{\lambda_c}{1 - \lambda_c} (f_w + f_t) \, ; \tag{80}$$

$$M \; : \; \gamma A F_L M^{\frac{-1}{\sigma}} = \phi \, ; \tag{81}$$

$$w \; : \; -L + \varrho (1 - \lambda_c) U'(w - \tau) = 0 \, ; \tag{82}$$

$$\lambda_c \; : \; \gamma A F_L \left(\frac{1 + \lambda_c}{2} L \right)^{\frac{-1}{\sigma}} \frac{L}{2} + \varrho (U(b + f_w + z) - U(w - \tau)) - \frac{1}{(1 - \lambda_c)^2} (f_t + f_w) L = 0. \tag{83}$$

Using (82) write (83) as

$$\gamma A F_L \left(\frac{1 + \lambda_c}{2} L \right)^{\frac{-1}{\sigma}} \left(\frac{1 - \lambda_c}{2} \right) = \psi_p + \frac{(f_t + f_w)}{1 - \lambda_c}, \tag{84}$$

where $\psi_p \equiv \frac{U(w - \tau) - U(f_w + b + z)}{U'(w - \tau)}$.

Next, subtract (84) from (80) to obtain

$$\gamma A F_L L^{-\frac{1}{\sigma}} \left(\frac{1 + \lambda_c}{2} \right)^{\frac{-1}{\sigma}} \lambda_c = w - \psi_p - (f_t + f_w). \tag{85}$$

Use (81) and (85) to obtain

$$M = \left(\frac{\lambda_c \phi}{w - \psi_p - (f_t + f_w)} \right)^{-\sigma} \left(\frac{1 + \lambda_c}{2} \right) L. \tag{86}$$

Now, substitute out M in (85) using (86) and use the equilibrium condition $L = (1 - \lambda_c) \overline{L}$ to obtain

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p - (f_t + f_w)} \right)^{1 - \sigma} \right)^{\frac{\sigma \gamma}{\sigma - 1} - 1} \left(\frac{1 - \lambda_c^2}{2} \overline{L} \right)^{\gamma - 1} \lambda_c = w - \psi_p - (f_t + f_w). \tag{87}$$

Equation (87) is equation (25) in the text.

7.10   Proof of proposition 6

Denote the wage with efficient firing subsidy by w_{ft}, with efficient unemployment insurance by w_b, and with efficient severance payments by w_{fw}. From (86) above verify that the value of M is identical in all cases. It follows from (80) and (81) that $w_b = w_{fw} + \frac{\lambda_c}{1 - \lambda_c} f_w = w_{ft} + \frac{\lambda_c}{1 - \lambda_c} f_t$. Therefore, the profit in the case of efficient severance payments, $Z - \left(w_{fw} + \frac{\lambda_c}{1 - \lambda_c} f_w \right) L - \phi M$, is identical to the profits with efficient unemployment insurance, $Z - w_b L - \phi M$. Both these, in turn, equal the profit before taxes in the case of firing subsidy: $Z - \left(w_{ft} + \frac{\lambda_c}{1 - \lambda_c} f_t \right) L - \phi M$. If the firing subsidy comes from profit taxes,

then the net of tax profits are $Z - w_{ft}L - \phi M$, where the profit tax equals the amount of firing subsidy: $-\frac{\lambda_c}{1-\lambda_c} f_t L$. Therefore, after tax profit is less in the case of firing subsidy.

Note from (27) and (28) in the text that $w_b - z = \frac{U(w_b - \tau) - U(b+z)}{U'(w_b - \tau)}$ and $w_{fw} - z = f_w$.

Next, verify that the expected income with UI is same as the expected income with SP.

The expected income in the UI case is

$$(1 - \lambda_c)(w_b - \tau) + \lambda_c(b + z) = (1 - \lambda_c)(w_b - \frac{\lambda_c}{1 - \lambda_c} b) + \lambda_c(b + z) = (1 - \lambda_c)w_b + \lambda_c z \tag{88}$$

Next, use $w_b = w_{fw} + \frac{\lambda_c}{1-\lambda_c} f_w$ to write the above as

$$(1 - \lambda_c)w_b + \lambda_c z = (1 - \lambda_c)w_{fw} + \lambda_c f_w + \lambda_c z = w_{fw} \tag{89}$$

where the last equality follows from the fact that $z = w_{fw} - f_w$. That is, the expected income with UI is same as the expected income with SP. It follows from the concavity of U that

$$U(w_{fw}) > (1 - \lambda_c)U(w_b - \tau) + \lambda_c U(b + z). \tag{90}$$

The expected income of workers in the case of firing subsidy is

$$(1 - \lambda_c)w_{ft} + \lambda_c z \tag{91}$$

Since $w_{fw} + \frac{\lambda_c}{1-\lambda_c} f_w = w_{ft} + \frac{\lambda_c}{1-\lambda_c} f_t$ and $f_t < 0$, clearly, $w_{ft} > w_{fw}$. As well,

$$(1 - \lambda_c) w_{ft} + \lambda_c z = (1 - \lambda_c) w_{fw} + \lambda_c(z + f_w) - \lambda_c f_t = w_{fw} - \lambda_c f_t > w_{fw} \tag{92}$$

The above verifies that the expected income in the firing subsidy case is higher than the expected income in the severance payments case. However, the gap in income between the employment and unemployment states is the highest here.

7.11   Proof of proposition 7

Recall that aggregate output is

$$Y = Z_P - \phi M + z\lambda_c \overline{L} \tag{93}$$

Therefore,

$$\frac{dY}{d\phi} = \frac{\partial Z_P}{\partial \lambda_c} \frac{d\lambda_c}{d\phi} + z\overline{L} \frac{d\lambda_c}{d\phi} - M \tag{94}$$

The expression for $\frac{\partial Z_P}{\partial \lambda_c}$ is given in (62). Noting that $L = (1 - \lambda_c)\overline{L}$, it follows from (85) that in the case of policy interventions we obtain

$$\frac{\partial Z_P}{\partial \lambda_c} = -\left(w - \psi_p - f_t - f_w\right)\overline{L}. \tag{95}$$

The efficient labor market policy is characterized by $w - \psi_p - f_t - f_w = z$. Therefore,

$$\frac{dY}{d\phi} = -M. \tag{96}$$

7.12 Implications of globalization for workers and profits with optimal labor market policies

7.12.1 Mandated Severance Payments Case

The expression for profit in the case of severance payments is

$$\Pi = Z_P - \phi M - (1 - \lambda_c)w\overline{L} - \lambda_c f_w \overline{L} \tag{97}$$

Therefore,

$$\frac{d\Pi}{d\phi} = \frac{\partial Z_P}{\partial \lambda_c}\frac{d\lambda_c}{d\phi} - M - (1 - \lambda_c)\overline{L}\frac{dw}{d\phi} + (w - f_w)\overline{L}\frac{d\lambda_c}{d\phi} - \lambda_c\overline{L}\frac{df_w}{d\phi} \tag{98}$$

Using (95) the above can be written as

$$\frac{d\Pi}{d\phi} = \psi_p\overline{L}\frac{d\lambda_c}{d\phi} - M - (1 - \lambda_c)\overline{L}\frac{dw}{d\phi} - \lambda_c\overline{L}\frac{df_w}{d\phi} \tag{99}$$

Since $\psi_p = 0$ in the case of optimal severance payments, and $\frac{df_w}{d\phi} = \frac{dw}{d\phi}$, therefore,

$$\frac{d\Pi}{d\phi} = -M - \overline{L}\frac{dw}{d\phi}. \tag{100}$$

Since workers are fully insured ($w = f_w + z$), the welfare of workers is simply

$$\frac{dW}{d\phi} = U'(w)\frac{dw}{d\phi}. \tag{101}$$

It is verified that (results in online appendix) proposition 2 goes through when the policymaker chooses the level of severance payments optimally. Therefore, the impact of globalization on profits and worker welfare is the same as in proposition 4.

7.12.2 Firing Subsidy Case

Since we assumed that a firing subsidy is financed by a tax on profits, the expression for profits net of taxes and subsidy is

$$\Pi = Z_P - \phi M - (1 - \lambda_c) w \overline{L} \tag{102}$$

Therefore,

$$\frac{d\Pi}{d\phi} = \frac{\partial Z_P}{\partial \lambda_c} \frac{d\lambda_c}{d\phi} - M - (1 - \lambda_c) \overline{L} \frac{dw}{d\phi} + w\overline{L} \frac{d\lambda_c}{d\phi}. \tag{103}$$

Again, using (95) in the above and noting the fact that optimal firing subsidy implies $\psi_p = w - z - f_t$, we obtain

$$\frac{d\Pi}{d\phi} = -M - (1 - \lambda_c) \overline{L} \frac{dw}{d\phi} + (w - z) \overline{L} \frac{d\lambda_c}{d\phi}. \tag{104}$$

Since the firing subsidy doesn't affect workers directly, the change in worker welfare is

$$\frac{dW}{d\phi} = U'(w) \left((1 - \lambda_c) \frac{dw}{d\phi} - \psi_p \frac{d\lambda_c}{d\phi} \right). \tag{105}$$

It is verified that proposition 2 goes through under a sufficient condition that $(1 - \lambda_c)w > \lambda_c \rho \psi_p$, when the policymaker chooses the level of firing subsidy optimally (results in online appendix). This condition is easily satisfied in numerical simulations. Therefore, the impact of globalization on profits and worker welfare is the same as in proposition 4.

7.12.3 Unemployment Insurance case

The expression for profit in this case is given by (102), and therefore, the change in profits is given by (103). Using (95) in (103) and noting that optimal unemployment insurance requires $\psi_p = w - z$, we again obtain (104). That is, the expression for the change in profits is exactly the same as in the case of a firing subsidy.

It is verified that proposition 2 goes through even in the case when a planner chooses the efficient of level of unemployment insurance funded by a tax on employed workers (results in the online appendix). Therefore, the impact of globalization on profits is same as in proposition 4.

The impact on worker welfare is slightly complicated. Recall that worker welfare in this case is given by

$$W = (1 - \lambda_c) U(w - \tau) + \lambda_c U(b + z) \tag{106}$$

and the balanced budget implies $\tau = \frac{\lambda_c}{1-\lambda_c} b$. Therefore, the change in the welfare of workers is

$$\frac{dW}{d\phi} = U'(w-\tau)\left(\left((1-\lambda_c)\frac{dw}{d\phi} - \left(\psi_p + \frac{b}{1-\lambda_c}\right)\frac{d\lambda_c}{d\phi}\right) + \lambda_c\left(\frac{U'(b+z)}{U'(w-\tau)} - 1\right)\frac{db}{d\phi}\right) \qquad (107)$$

Grinding through algebra (proof in online appendix), it is verified that the sign of $\frac{dW}{d\phi}$ is the opposite of the sign of $\frac{d\lambda_c}{d\phi}$. Since proposition 2 is valid, it follows that the impact on worker welfare is same as in proposition 4.