Globalization, Jobs, and Welfare: The Roles of Social Protection and Redistribution[1]

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Current Draft

December, 2014

Abstract

This paper studies the welfare and policy implications of globalization when risk averse workers face the risk of unemployment. If the jobs performed by domestic workers can be easily substituted by imports, then globalization reduces wages and increases unemployment. In this situation, in the absence of any government intervention globalization not only reduces the welfare of workers but could reduce social welfare as well. Both unemployment benefits and severance payments can protect workers against labor income risk, but the latter enhances welfare more if job destruction is the source of unemployment. When optimal redistribution and social protection policies are in place, globalization necessarily improves social welfare.

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

JEL Codes: F16, F66, F68

[1] I would like thank the seminar parcipants at the Universities of Calgary, Munich, Linz, UC-Irvine, Paris School of Economics, GSIS, Geneva, and Gabriel Felbermayr, Kangoh Lee, and Dalia Marin for useful comments.

1 Introduction

While economists 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. However, 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 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. 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 offshored/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. In this set up, it is shown that the impact of offshoring on the labor market and welfare crucially depends on the elasticity of substitution between domestic labor and offshored inputs. If there is sufficient complementarity between domestic labor and offshored inputs, then offshoring improves the welfare of workers by lowering unemployment and increasing wages and increases social welfare (measured as the sum of welfares of workers and profit owners) as well. On the other hand, if offshored inputs can be easily substituted for domestic labor then workers are adversely affected by offshoring: unemployment increases and wages decrease.[2] In the latter case, there is an increase in inequality in the distribution of income since non-wage income rises and wages fall. More importantly, if workers are sufficiently risk averse, then offshoring not only reduces the welfare of workers but reduces social welfare as well. Therefore, in the absence of any instruments for redistribution or social protection, there would be a case for restricting offshoring to increase social welfare. The potential welfare loss from offshoring is a consequence of the risk aversion of workers. If instead, workers are risk neutral then irrespective of the elasticity of substitution between domestic labor and offshored inputs, offshoring always increases social welfare.

Moving to policy issues, we show that the risk aversion of workers causes production inefficiency independent of distributional concerns. That is, the decentralized output in the economy is lower than what would happen if a social planner were maximizing output. We explore the role of some commonly used social protection programs in restoring efficiency in the decentralized case.[3] 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 employment protection are severance payments (SP) which is a transfer from firms to workers and an administrative cost borne by employers which does not accrue to employees directly. Given the widespread use of severance payments, a serious discussion of this policy is warranted.[4]

[2] Our theoretical prediction that offshoring 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 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.

[3] 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.

[4] 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.

We show that both UI and SP can restore production efficiency in the decentralized case.[5] 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 the worker welfare and social welfare are higher with efficient SP than with efficient UI. 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. 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.

Moving from efficiency to social welfare, while the social protection measures like EP and UI increase output and the welfare of workers, they do not guarantee that offshoring will improve social welfare. We show numerically that social protection alone can convert the negative welfare implications of offshoring into a positive one, however, it may not be enough in all cases. The reason is that in the presence of risk averse agents any inequality in the distribution of income needs to be addressed through redistribution. In the absence of such redistribution, offshoring can cause social welfare losses even if efficient social protection policies are in place. It is shown that when efficient social protection and redistribution policies are in place, then offshoring necessarily increases welfare.

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, we extend the model to incorporate matching frictions. Now the adjustment in response to offshoring takes place through both less job creation and greater job destruction. In particular, when offshored inputs can easily substitute for domestic labor, offshoring increases unemployment by increasing job destruction as well as reducing job creation. The latter happens through a reduction in the market tightness.

Again, offshoring reduces worker welfare if the elasticity of substitution between workers and offshored/imported inputs is high. As well, social welfare decreases if the degree of risk aversion is high. Looking at policies, again the decentralized outcome is production inefficient due to the risk aversion of

[5] 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.

workers and efficiency can be restored using social protection 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 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 and social welfare are 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.[6] 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

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

then the workers are hurt by offshoring, 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 the distortion in our framework arises solely due to the risk aversion of workers even in the presence of search frictions[7]. This allows us to focus on policy issues arising from risk aversion. 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. We show that if unemployment arises solely due to job destruction then severance payments can be a superior tool for insuring workers than unemployment benefits. When unemployment arises due to both job destruction and matching frictions, a policy that combines severance payments and unemployment benefits can be superior to unemployment benefits only.

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. This is similar in spirit to our result described earlier that when domestic labor is a good substitute for offshored inputs, offshoring can reduce social welfare. However, these papers do not deal with the labor market risk arising from unemployment.

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

[7] 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.

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).

To summarize, the key contributions of this paper are the following. In the absence of any government intervention, the decentralized equilibrium is inefficient from the point of view of both production and welfare. In this setting, globalization can reduce worker welfare as well as social welfare by increasing unemployment and redistributing income from workers to profit owners. Labor market interventions like severance payments or unemployment insurance increase unemployment but make the economy production-efficient (maximize the value of output), and in combination with redistribution can ensure that globalization is social welfare improving. Finally, 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.

In the next section we present the baseline model without search frictions. Section 3 studies the implications of offshoring for labor market and welfare and conducts the policy analysis. Section 4 presents the extension with search frictions. Section 5 provides a discussion of robustness issues. Section 6 provides concluding remarks. All the derivations are gathered in appendix A and the proofs of lemmas and propositions in appendix B.

2 The Model

The production function is given by

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

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 γ 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.[8] 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.[9]

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)).

In the benchmark model we assume the matching to be frictionless and later 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. Firing could be costly due to mandated severance payments or administrative burden. If firms use a cutoff rule whereby they retain workers

[8] If $\gamma = 1$, then domestic labor and offshored inputs become gross complements, therefore, one cannot discuss the case of gross substitution which is the case when domestic workers could lose from offshoring. $\gamma < 1$ allows us to discuss both the cases of gross substitution and gross complementarity.

[9] As discussed in the "Discussions" section later, the implications of allowing for free entry which makes the mass of firms endogenous is similar to the case of $\gamma = 1$.

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 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. The profit is distributed among N agents which could be the owners of the specific factor used in production. Each owner gets a share π given by

$$\pi = \frac{\Pi}{N}. \tag{4}$$

All agents are risk averse with the utility function given by[10]

$$U(x);\ U' > 0, U'' < 0 \tag{5}$$

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. For profit owners, $x = \pi$.

Firms post wages and firing rates to attract workers. 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

[10] While we are assuming firms to be risk neutral (they simply maximize profits), the profit recipients are assumed to be risk averse as are the workers. Making the recipients of profits risk neutral won't change any results because there is no uncertainty in their income.

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

$$(1-\lambda_{ci})U(w_i) + \lambda_{ci}U(z) \geq W. \tag{6}$$

Effectively, for any firing rate that the firm posts, (6) determines the wage that the firm has to offer.[11] 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 (6) one gets the impression that firms can choose different pairs of (w, λ_c) to satisfy (6), it can be shown from the firm's maximization exercise that all firms end up posting the same wage rate [12]. Therefore, in the analysis below we drop the firm subscript i.

Denote the per unit price of the imported/offshored 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

$$(1-\lambda_c)U(w) + \lambda_c U(z) \geq W. \tag{7}$$

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

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

[11] 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.

[12] 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.

Using ϱ to denote the Lagrangian multiplier on the constraint in (7), the first order conditions for the above maximization are given by

$$L \quad : \quad \gamma A F_L \left(\frac{1+\lambda_c}{2}\right)^{\frac{\sigma-1}{\sigma}} L^{\frac{-1}{\sigma}} = w \tag{8}$$

$$M \quad : \quad \gamma A F_L M^{\frac{-1}{\sigma}} = \phi \tag{9}$$

$$w \quad : \quad -L + \varrho(1-\lambda_c)U'(w) = 0 \tag{10}$$

$$\lambda_c \quad : \quad \frac{\gamma A}{2} F_L \left(\frac{1+\lambda_c}{2}\right)^{\frac{-1}{\sigma}} L^{\frac{\sigma-1}{\sigma}} = \varrho(U(w) - U(z)) \tag{11}$$

Intuitively, the l.h.s of (8) 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 (11) 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.

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

$$L = \overline{L}(1-\lambda_c). \tag{12}$$

The 5 equations (8)-(11), and (12) determine w, L, M, λ_c,and ϱ.

It is shown in the appendix that using (8)-(11) and (12) 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.

$$w = \frac{1+\lambda_c}{1-\lambda_c}\psi, \tag{13}$$

$$\gamma A \left(1 + \omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\right)^{\gamma} \overline{L}^{\gamma-1} = w(1-\lambda_c), \tag{14}$$

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 a sufficient condition on parameters (high $\overline{L}$ or low A) such that at full employment the marginal product of labor is less than z. This yields the following result.

Proposition 1: *A unique equilibrium always exists with the equilibrium wage, w, necessarily exceeding z. Additionally, under a sufficient condition on parameters (high $\overline{L}$ or low A), there always exists an interior equilibrium with positive unemployment: $\lambda_c \in (0,1)$.*

Next we derive the expressions for profits and social welfare which are useful in deriving some key results in the paper later. Using (12) the expression for aggregate profits in equilibrium is given by

$$\Pi = A\left(\left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\gamma}{\sigma-1}} - w(1-\lambda_c)\overline{L} - \phi M. \tag{15}$$

The measure of welfare of workers is W which can be written as

$$W = (1-\lambda_c)U(w) + \lambda_c U(z). \tag{16}$$

Social welfare is given simply by the sum of welfares of workers and profit owners:

$$SW = NU(\pi) + \overline{L}W. \tag{17}$$

Before studying the implications of offshoring for welfare, it is useful to understand the distortions caused by risk aversion in our model. Below we show that risk aversion makes the decentralized economy production-inefficient and any inequality in the distribution of income between workers and profit owners makes social welfare sub-optimal.

To see the production inefficiency resulting from risk aversion in the decentralized case, we compare it to a planner's problem where the planner is interested in maximizing aggregate output.

2.1 Planner's problem

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

$$Z - \phi M + z(\overline{L} - L). \tag{18}$$

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

$$Z_P - \phi M + z\lambda_c\overline{L}, \tag{19}$$

where

$$Z_P \equiv A\left(\left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\frac{\sigma-1}{\sigma}}+M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\gamma}{\sigma-1}}. \tag{20}$$

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

$$\gamma A\lambda_c\left(1+\left(\frac{\lambda_c\phi}{z}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma-1}\overline{L}^{\gamma-1}=z. \tag{21}$$

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

Case of Risk Neutral Workers

The following lemma is easily verified in the case of risk neutral workers, that is when the utility function is of the form: $U(x) = ax + b$ where $a > 0$ and b are constants.

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. Later when we incorporate search frictions in the model, it is still the case that the decentralized outcome is efficient when workers are risk neutral.

Case of risk averse workers

It is shown in the appendix that when workers are risk averse, the λ_c in the decentralized equilibrium is given by the solution to the following equation.

$$\gamma A\lambda_c\left(1+\left(\frac{\lambda_c\phi}{z'}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma-1}\overline{L}^{\gamma-1}=z', \tag{22}$$

where $z' \equiv w - \psi$. Denote the solution to the above equation by λ_c^r. Comparing (21) which gives us the efficient level of λ_c with (22) giving us the decentralized equilibrium value of λ_c, we obtain the following result.

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

This 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. What happens is that risk averse workers prefer a lower unemployment rate and are willing to accept lower wages to keep the unemployment rate low $(\lambda_c^r < \lambda_c^e)$.

Lemmas 1 and 2 clearly establish that the decentralized outcome is production-inefficient due to the risk aversion of workers. When we talk about social welfare defined in (17), the concavity of the utility function of agents implies that inequality in the distribution of income is another distortion which will be important for results on social welfare.

Having identified the key distortions in the model, we turn to the impact of globalization on unemployment and welfare.

3 Globalization, Unemployment and Welfare

As mentioned earlier, globalization in the model is captured by a reduction in the price of offshored/imported input, M. The following proposition is proved on the impact of globalization in a decentralized equilibrium.

Proposition 2: *A reduction in the cost of offshoring 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 offshored inputs are cheaper now, firms substitute away from domestic labor. However, there is a productivity effect arising from the increased usage of offshored inputs. That is, the increased usage of offshored inputs increases the marginal product of domestic labor. For $\sigma > \frac{1}{1-\gamma}$ the substitution effect dominates, and hence the demand for domestic labor decreases (domestic labor and offshored inputs are gross 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 effect dominates (domestic labor and offshored inputs are gross complements) leading to an increase in the demand for domestic labor resulting in lower unemployment and higher wages.

The expressions for the impact of offshoring on the welfare of workers and social welfare (derived in the appendix) are given by

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

$$NU'(\pi)\frac{d\pi}{d\phi} + \overline{L}\frac{dW}{d\phi} = (U'(w) - U'(\pi))\overline{L}\left((1-\lambda_c)\frac{dw}{d\phi} - \psi\frac{d\lambda_c}{d\phi}\right) - U'(\pi)M \tag{24}$$

Before discussing the welfare implications of offshoring for the case of risk averse agents, it is useful to note the results for the case of risk neutral agents: $U(x) = ax + b$. The following result is easily verified from (23), (24), and proposition 2.

Proposition 3: *When agents are risk neutral, offshoring increases workers' welfare if* $\sigma < \frac{1}{1-\gamma}$, leaves it unchanged if $\sigma = \frac{1}{1-\gamma}$, *and reduces it otherwise. However, offshoring always increases social welfare.*

Lemma 1 verified the efficiency of the decentralized equilibrium with risk neutral workers. Since there is no difference between aggregate output and social welfare when agents are risk neutral, it is not surprising that offshoring, which is like a positive productivity shock, is welfare improving for the economy as a whole.

Going back to the case of risk averse agents, note from proposition 2 that there are two relevant cases to discuss.

Case 1: $\sigma < \frac{1}{1-\gamma} \Rightarrow \frac{dw}{d\phi} < 0$ and $\frac{d\lambda_c}{d\phi} > 0$.

In this case, offshoring unambiguously increases the welfare of workers. Additionally, social welfare increases as well if $U'(w) > U'(\pi)$. That is, as long as the marginal utility of income for workers is higher than for profit owners (we assume this to be the case throughout), social welfare increases with globalization. Offshoring increases profits directly through a decline in the price of offshored inputs which is a source of welfare gain (last term in (24)). In addition, note from (23), (24) that the term giving the change in the welfare of workers ($(1-\lambda_c)\frac{dw}{d\phi} - \psi\frac{d\lambda_c}{d\phi}$) has the opposite effect on profits and, therefore, its net impact on social welfare depends on the respective marginal utilities of workers and profit owners. Under the assumption of $U'(w) > U'(\pi)$ social welfare changes in the same direction as the welfare of workers. Therefore, in case 1 social welfare increases unambiguously.

Case 2: $\sigma > \frac{1}{1-\gamma} \Rightarrow \frac{dw}{d\phi} > 0$, $\frac{d\lambda_c}{d\phi} < 0$, and $\frac{d\Pi}{d\phi} < 0$.

In this case, the welfare of workers clearly decreases. Since workers are poorer than profit owners ($U'(w) > U'(\pi)$), social welfare decreases due to a decrease in the welfare of workers. The direct effect of offshoring on profits is always positive, and therefore, the net impact of offshoring on social welfare is ambiguous. Note that workers are hurt by both a decrease in wage and an increase in unemployment. An increase in unemployment increases the risk they have to bear causing welfare losses in excess of what would obtain in the presence of insurance markets. The greater the risk aversion the larger the decline in the welfare of workers and hence the greater the possibility of social welfare losses from globalization.

Numerical simulations reveal that when the degree of risk aversion is high, social welfare decreases as the cost of offshoring decreases. Figures 1 and 2 provide numerical examples. Both figures are based on a $CRRA$ utility function of the type $U(x) = \frac{x^{1-\rho}}{1-\rho}$ where ρ is the coefficient of risk aversion. In both figures $\sigma = 4$ and $\gamma = 2/3$ so that we are in the $\sigma > \frac{1}{1-\gamma}$ case, and $\rho = 1.5$ (low risk aversion) in figure 1 and $\rho = 3$ (high risk aversion) in figure 2. In both cases as the cost of offshoring decreases unemployment (λ_c) increases (figures 1a and 2a) and wages decrease (figures 1b and 2b) and consequently the welfare of workers decreases (figures 1c and 2c). The difference is in social welfare. While in panel 1d social welfare increases when the degree of risk aversion is low, in panel 2d social welfare decreases with a higher degree of risk aversion.

Since wages decrease and profits increase, the inequality in the distribution of income as measured by profits to wage income also rises.

The results derived above assuming $U'(w) > U'(\pi)$ are summarized in the proposition below.

Proposition 4: *When $\sigma < \frac{1}{1-\gamma}$, offshoring reduces unemployment and increases wages, thereby, increasing the welfare of workers as well as social welfare. When $\sigma > \frac{1}{1-\gamma}$, not only does the welfare of workers decrease but social welfare can decrease as well. In the latter case, there is an increase in inequality in the distribution of income as well since profits rise and wages decrease.*

It follows from proposition 4 that there may be a case for creating obstacles to offshoring if no other policy interventions are available. Since offshoring decreases the welfare of workers and possibly social welfare when $\sigma > \frac{1}{1-\gamma}$, our discussion of various policies below focuses on this case.

4 Policy Analysis

It was shown earlier that the risk aversion of workers creates distortions which give rise to the possibility of globalization causing social welfare losses. As seen in proposition 3, with risk neutral agents (obviating the need for an insurance market or redistribution), globalization is social welfare improving. Below we discuss two types of policies. One, labor market interventions that help workers negotiate labor market risk and two, redistribution.

We study three 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 offshoring in the presence of these policies.

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. The second policy we discuss is 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 fired workers, 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.[13]

[13] 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.

Below we develop a unified framework that nests all 3 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

$$(1-\lambda_c)U(w-\tau) + \lambda_c U(b + f_w + z) \geq W. \tag{25}$$

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.

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

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

4.1.1 Administrative cost of firing

Setting $b = \tau = f_w = 0$ in (26) obtain

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

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

Comparing (27) to (21), 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.[14]

[14] To see how $f_t > 0$ lowers λ_c below the efficient level, note that $\psi > w - z$ implies that $z > w - \psi$ and hence

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 and ignore the issue of raising money for a firing subsidy. Can such a firing subsidy restore efficiency? The answer turns out to be no. We verify numerically that the equilibrium λ_c is non-monotonic in $-f_t$. That is, as the level of firing subsidy increases firms initially fire more workers but after a point (well before the efficient level of λ_c) they start firing less. Therefore, the efficient level of λ_c is not attained by a firing subsidy. The rough intuition is that a firing subsidy doesn't address the underlying distortion arising from the risk aversion of workers.

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, then in our set up an increase in f_t is able to achieve this goal.

4.1.2 Severance payments

To obtain the expression for the equilibrium level of λ_c with severance payments, use $b = \tau = f_t = 0$ in (26) and obtain

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

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

Comparing (28) with (21) note that severance payments lead to efficient choice of 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. Therefore, a severance payment that results in full insurance delivers the efficient level of λ_c in the model.

While we have discussed severance payments as a government mandated policy, it is worth pointing out that firms will have an incentive to provide severance payments to risk averse workers voluntarily. It is easy to verify from the model that if firms could offer severance payments, they would do so

$z > w - \psi - f_t$. Following the same reasoning as in the proof of lemma 2, one can verify that the λ_c that solves (27) is lower than the λ_c that solves (21).

and the equilibrium level of severance payments will correspond to the efficient level discussed above. Essentially, firms would offer a contract with wages and a level of severance payments that fully insures workers. However, there may be reasons why firms are unwilling or unable to offer severance payments. One possible reason is wage rigidity. 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. 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.

4.1.3 Unemployment insurance

To obtain the expression for λ_c with unemployment insurance, set $f_t = f_w = 0$ in (64) and obtain

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\gamma-1} = w - \psi_p, \tag{29}$$

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 (29) with (21) 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 $w(b) - \psi_p(b) = z$.[15]

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. This has implications for welfare which is summarized in the proposition below and proved in the appendix.

Proposition 5: *The efficient levels of severance payments and unemployment benefits yield the same levels of output, unemployment, and profits, however, the welfare of workers as well as social*

[15] 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.

welfare is higher with efficient severance payments than with efficient unemployment insurance.

Intuitively, since the missing market for insurance is the key obstacle preventing firms from choosing efficient λ_c, by providing insurance, both unemployment benefits and severance payments allow firms to choose their λ_c efficiently. The difference between the two in terms of welfare implications arises from the fact that efficient level of severance payments involves full insurance while the efficient level of unemployment insurance involves incomplete insurance.

Figure 3 provides a numerical example of the comparison between efficient severance payments and efficient unemployment insurance when the $CRRA$ risk aversion parameter $\rho = 3$ and $\sigma > \frac{1}{1-\gamma}$. The red line depicts the case of efficient severance payments, the black line depicts the case of efficient unemployment benefits, and the green line depicts the case of no policy intervention. Figure 3a shows that the wage is higher in the case of efficient unemployment insurance compared to the case of severance payments which in turn is higher than the no intervention case. In figure 3b the vertical axis is the ratio of consumption in the unemployed state to the consumption in the employed state. It shows that efficient severance payment provides full insurance but efficient unemployment benefits provide incomplete insurance. The complete insurance with efficient severance payments is also reflected in a higher worker welfare in figure 3c and a higher social welfare in figure 3d compared to the efficient unemployment benefits. As well, efficient unemployment benefits yield higher worker and social welfare than the no intervention case.

It is worth re-iterating that both worker welfare and social welfare are higher with efficient policies (severance payments and unemployment benefits) than without intervention at all levels of offshoring cost (the red and black lines in figures 3c and 3d lie well above the green line). This important result, driven by the risk aversion of workers, is in contrast to several studies mentioned in the introduction (see footnote 6) which lump these policies together with search frictions and conclude that their implications is similar to an increase in search frictions, which is to reduce welfare.[16] The point is that models with risk neutral workers miss out on the insurance role of these policies in both closed and open economies.

In general even with efficient levels of SP or UI in place, offshoring can reduce welfare as can be seen from figure 3. However, there is a range of risk aversion parameter for which the presence of efficient policies turns the impact of offshoring on welfare from negative to positive. Figure 4 provides

[16] Later we show that our results on the welfare implications of severance payments and unemployment benefits are robust to the inclusion of search frictions.

an example when $\rho = 2.5$ and the policy is severance payments. Figures 4a and 4b plot worker welfare and social welfare with respect to the offshoring cost in the absence of efficient social insurance policies and show that both decrease as the offshoring cost decreases. When efficient social insurance policies are in place, figure 4c shows that worker welfare still decreases, however, figure 4d shows that social welfare increases.[17] We summarize the result below.

Proposition 6: *For some parameter values, while offshoring reduces social welfare in the absence of social insurance policies, it increases social welfare with efficient social insurance policies in place.*

More generally, despite the presence of efficient social insurance, offshoring can reduce social welfare because from the point of view of social welfare, there are two distortions in the model: lack of insurance and inequality in the distribution of income. The latter can be addressed using redistribution, which is what we turn to next.

4.2 From Efficiency to Welfare

4.2.1 Welfare maximization by the planner

Our earlier analysis of the planner's problem focused on output maximization because we wanted to talk about production-efficient policies. Now we look at the planner's problem when the planner is interested in maximizing social welfare given by the sum of welfares of workers and profit owners as defined in (17). We assume that the planner provides a transfer b' to unemployed workers, w' to employed workers, and y to profit owners or the owners of the specific factor and performs the following maximization exercise.

$$\underset{\lambda_c, M, b', w, y}{Max} \left\{ \left(\lambda_c U(b' + z) + (1 - \lambda_c) U(w') \right) \overline{L} + NU(y) \right\}$$

subject to the constraint

$$\lambda_c \overline{L}(b' + z) + (1 - \lambda_c)\overline{L}w' + Ny \leq Z_P - \phi M + \lambda_c \overline{L} z,$$

where Z_P is the output defined in (20).

It is verified (see appendix) from the above maximization exercise that there is no trade-off between equity and efficiency. That is, the level of λ_c from the above maximization is given exactly by the

[17] The same result is obtained with efficient unemployment insurance, however, as expected, welfare (both worker and social) is higher with efficient severance payments than with efficient unemployment insurance.

condition (21). Therefore, the planner simply maximizes net output $Z_P - \phi M + \lambda_c \overline{L} z$ and then redistributes it among workers and owners of specific factors to equalize their marginal utilities by choosing b', w', and y such that $U'(b'+z) = U'(w') = U'(y)$. We call this the first-best case.

How can this outcome be achieved in a decentralized equilibrium? Below we show that it can be decentralized using mandated severance payments and a redistributive transfer.

4.2.2 Welfare Maximization with severance payments

In a decentralized equilibrium the planner does not choose the wage rate, w or λ_c. However, the planner can mandate severance payments f_w and a redistributive transfer s where $s > 0$ implies a transfer from profit owners (owners of specific factors) to workers. Unlike the planner's welfare maximization discussed earlier where the transfers to workers were unconstrained, now we are constraining the transfers to employed and unemployed workers to be identical.

The firms and workers take f_w and s as given. Therefore, the decentralized equilibrium can be solved as a two stage problem where in the first stage the planner chooses f_w and s and then firms choose w, L, and λ_c in the second stage. The planner chooses f_w and s to maximize the following in the first stage.

$$\underset{f_w, s}{Max} \left\{ \left(\lambda_c U(f_w + z + s) + (1-\lambda_c) U(w+s) \right) \overline{L} + NU(y) \right\},$$

$$\text{where } y = \frac{Z_P - \phi M - \lambda_c f_w \overline{L} - (1-\lambda_c)\overline{L} w - s\overline{L}}{N}.$$

In the second stage the firms choose λ_c, L, and w to do the following maximization.

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

subject to

$$\lambda_c U(f_w + z + s) + (1-\lambda_c) U(w+s) \geq W.$$

In addition, the equilibrium condition $L = (1-\lambda_c)\overline{L}$ must be satisfied.

Recall that the social planner makes a transfer of b' to unemployed workers and w' to employed workers in the planner's welfare maximizing solution in the first-best case discussed earlier. It is proved in the appendix that there exists a pair of f_w and s that replicates the first-best outcome derived in the previous sub-section. This gives us the following important result.

Proposition 7: *If the planner can mandate severance payments and redistribute income between workers and profit owners, then the decentralized outcome corresponds to the welfare maximizing outcome obtained by the social planner.*

Therefore, if the planner has an instrument of redistribution, then mandated severance payments in combination with redistribution not only guarantee production-efficiency but maximize social welfare as well.[18] Given the lack of a trade-off between equity and efficiency this result is not surprising.

We showed earlier that the planner can choose a level of unemployment insurance that will achieve the efficient level of λ_c. However, this necessarily involves incomplete insurance for workers. Complete insurance via unemployment insurance is incompatible with efficiency, as was shown earlier. Therefore, unemployment insurance combined with redistribution cannot achieve the welfare maximizing outcome obtained in the first-best case. In other words, the planner's outcome for welfare maximization cannot be decentralized using unemployment insurance and a redistributive transfer.

4.3 Globalization and Welfare with optimal policy

What is the impact of offshoring on welfare when optimal social insurance and redistributive policies are in place? Recall that social welfare is given by

$$SWF = (\lambda_c U(f_w + z + s) + (1 - \lambda_c) U(w + s)) \overline{L} + NU(y).$$

It is shown in the appendix that

$$\frac{d(SWF)}{d\phi} = -U'(y)M < 0. \tag{30}$$

This gives us the following result.

Proposition 8: *Globalization necessarily increases social welfare when optimal policies (severance payments and redistribution) are in place.*

The result above is not surprising in light of the welfare results mentioned in proposition 3 for risk neutral agents. In fact, notice the similarity between (30) and (24). Just as offshoring yielded social welfare gains in the case of risk neutral agents, it does so for risk averse agents when optimal policies (insurance and redistribution) are in place. While at a deeper level the results are not surprising, our

[18] It is straightforward to verify that redistribution alone cannot achieve the first-best welfare maximization. That is, proposition 7 requires a strictly positive f_w.

contribution lies in showing that severance payments can act as an instrument for insurance and play an important role in ensuring welfare gains from offshoring.

The result that redistribution may be required to ensure social welfare improvement from globalization gives justification to the redistributive programs like the Trade Adjustment Assistance programs in the U.S. and the European Globalization Adjustment Fund which provide assistance to workers adversely affected by trade using revenue from general funds.

Next, we show the robustness of qualitative results to the presence of search frictions in hiring.

5 Extension With Search Frictions

In this extension we introduce search frictions in hiring and show that in the absence of any policy intervention offshoring can still reduce the welfare of workers and social welfare. As well, labor market interventions can restore efficiency and make offshoring social welfare improving.

5.1 Decentralized Equilibrium

Suppose there is a cost of posting vacancies and there are matching frictions as in the standard Pissarides (2000) model. Denote the cost of posting a vacancy by c. Assume a constant returns to scale matching function such that the probability of a vacancy being filled is $\mu\theta^{\delta-1}$, while the probability of an applicant finding a job is $\mu\theta^{\delta}$ where $0 < \delta < 1$ and θ is the market tightness defined as the ratio of the number of vacancies to the number of workers searching for a job. Since the probability of a vacancy being filled is $\mu\theta^{\delta-1}$, if a firm posts v vacancies, using the law of large numbers we can say that it ends up with $L_h = \mu\theta^{\delta-1}v$ matched workers. Therefore, a firm wanting to be matched with L_h workers must post $\frac{L_h}{\mu\theta^{\delta-1}}$ vacancies. Given the uniform distribution of match-specific productivity, if a firm chooses a productivity cutoff of λ_c, it fires a fraction λ_c of matched workers and therefore, retains $L = (1-\lambda_c)L_h = (1-\lambda_c)\mu\theta^{\delta-1}v$ workers. Therefore, a firm wanting to retain L workers must post $v = \frac{L}{\mu\theta^{\delta-1}(1-\lambda_c)}$ vacancies.

Now a firm announces a wage, w, a rate of firing, λ_c, and decides to post its vacancies in a market with tightness, θ, to ensure that worker's reservation utility is satisfied. Workers find themselves in one of three states: unmatched, matched and fired, matched and retained. For simplicity we assume that they get z in both of the two unemployed states: unmatched, and matched and fired. Allowing their income to be different in the state when they are fired compared to when they are unmatched yields qualitatively similar results.

The firm's maximization problem is given by

$$\underset{L,M,w,\lambda_c,\theta}{Max} \left\{ Z - wL - \phi M - \frac{c}{\mu\theta^{\delta-1}} \frac{L}{(1-\lambda_c)} \right\},$$

subject to the constraint

$$\mu\theta^{\delta}\left((1-\lambda_c)U(w) + \lambda U(z)\right) + \left(1-\mu\theta^{\delta}\right)U(z) \geq W. \tag{31}$$

The aggregate labor market constraint now is given by

$$L = \mu\theta^{\delta}(1-\lambda_c)\overline{L}. \tag{32}$$

Therefore, the fraction of workers who are unemployed is given by

$$u = \left(1-\mu\theta^{\delta}\right) + \mu\theta^{\delta}\lambda_c. \tag{33}$$

That is, there are two sources of unemployment now: workers who do not get matched $\left(1-\mu\theta^{\delta}\right)$ and those who get matched but are fired $(\mu\theta^{\delta}\lambda_c)$.

We derive the following three equations determining the three key endogenous variables of interest in the decentralized equilibrium: w, λ_c, and θ.

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

$$\gamma A\left(1+\left(\frac{\lambda_c\phi}{w-\psi}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma}\left(\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} = w\left(1-\lambda_c\right)+\frac{c}{\mu\theta^{\delta-1}}; \tag{35}$$

$$(1-\lambda_c)\psi = \frac{(1-\delta)c}{\delta\mu\theta^{\delta-1}}; \tag{36}$$

where $\psi \equiv \frac{U(w)-U(z)}{U'(w)}$ as was defined earlier.

Again, we can compare the decentralized equilibrium with the planner's problem.

5.2 Planner's problem

In the absence of search frictions, the planner simply hires every worker and retaines a fraction of them. That is, the planner simply chose λ_c, the fraction of workers to fire. Now, however, the planner also faces the same matching function as the one faced by firms and has to bear the cost of posting a vacancy. Therefore, the planner has to decide how many vacancies to post and what fraction of matched workers to fire. If v is the number of vacancies posted by the planner, then it results in a market tightness of $\theta = \frac{v}{\overline{L}}$. If the planner posts v vacancies, then $\mu\theta^{\delta-1}v$ vacancies are filled, given the matching function described earlier. Therefore, the number of workers retained will be $(1-\lambda_c)\,\mu\theta^{\delta-1}v$. Since $v = \theta\overline{L}$ by definition, the planner effectively chooses θ and the number of workers retained is $(1-\lambda_c)\,\mu\theta^{\delta}\overline{L}$. Therefore, the planner's maximization problem can be written as

$$\underset{\theta,M,\lambda_c}{Max}\left\{A\left(\left(\left(\frac{1-\lambda_c^2}{2}\right)\mu\theta^{\delta}\overline{L}\right)^{\frac{\sigma-1}{\sigma}}+M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\gamma}{\sigma-1}}-\phi M-c\theta\overline{L}+z(\lambda_c\mu\theta^{\delta}+1-\mu\theta^{\delta})\overline{L},\right\}$$

where the last term is the home production by unemployed workers.

It is shown in the appendix that the equations characterizing the efficient values of θ, and λ_c are given by

$$\gamma A\lambda_c\left(1+\left(\frac{\lambda_c\phi}{z}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma-1}\left(\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} = z \tag{37}$$

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

Comparing the planner's problem with the decentralized equilibrium in the risk neutral case, we can verify that by substituting (36) into (35) and noting that $\psi = w - z$ in the risk neutral case, (34) and (35) become identical to (37) and (38). That is:

Lemma 3: *If workers are risk neutral, then the decentralized equilibrium is efficient, but if workers are risk averse, then the decentralized equilibrium is inefficient.*

Despite search frictions, the only distortion (from the production efficiency point of view) is the missing insurance market for risk averse workers. Search frictions do not introduce any search externalities in our framework because we use a competitive search framework (a la Moen (1997)) for wage setting.[19]

Having identified the distortion in the extended model, which is exactly the same as the distortion in the baseline model without search frictions, below we study the implications of globalization.

[19] As expected, Lemma 3 can be easily verified if workers have identical productivities and the only source of unemployment is search frictions.

5.3 Globalization, unemployment, and welfare

The key difference in the results from the baseline model is that now offshoring affects unemployment and welfare through both job creation and job destruction. That is, in addition to changing λ_c offshoring also affects θ which affects the job finding rate $\mu\theta^{\delta}$ for workers. Since the algebra is tedious in this case, we present numerical examples.

Figures 5 and 6 illustrate the impact of offshoring for the case of high elasticity of substitution between domestic labor and offshored inputs ($\sigma > \frac{1}{1-\gamma}$). The two figures differ with respect to the degree of risk aversion: it being low ($\rho = 1.5$) in figure 5 and high in figure 6 ($\rho = 3$). In both cases offshoring increases job destruction (figures 5a and 6a) same as in the benchmark model without matching frictions (figures 1a and 2a). In the presence of matching frictions offshoring also reduces the job finding rate or job creation in both cases reflected in a positive relationship between the cost of offshoring and the job finding rate (figures 5b and 6b). Therefore, offshoring increases unemployment in both cases (figures 5c and 6c). The increase in unemployment happens due to both increased job destruction and reduced job creation. The wages (figures 5d and 6d) and the welfare of workers (figures 5e and 6e) decrease. However, the impact on social welfare is different in the two cases. Similar to figures 1d and 2d, social welfare increases when the degree of risk aversion is low (figure 5f) but decreases when the degree of risk aversion is high (figure 6f).[20]

5.4 Policies with search frictions

How can the efficient levels of θ and λ_c be achieved in a decentralized equilibrium? Note from (31) that in the extended model with search frictions, workers find themselves in one of three states now: unmatched, matched and fired, and matched and employed.[21] The first two groups constitute the

[20] It is also worth pointing out that if all workers have identical match-specifi productivities and the only source of unemployment is search frictions, the results above go through. That is, it would still be the case that offshoring would increase unemployment and reduce worker welfare for high elasticity of substitution and reduce unemployment and increase worker welfare for low elasticity of substitution. As well, in the former case, social welfare decreases if the degree of risk aversion is high.

[21] In dynamic models of unemployment with search frictions some unemployed workers stay unemployed because they couldn't find a match, some leave unemployment because they find a match, and some join unemployment because they have been fired. Our static model roughly captures these phenomena by putting workers in one of the three states

unemployed. Since severance payments can only be paid upon separation, they cannot insure workers who fail to match. One way to insure them in this case is via unemployment benefits. Therefore, we discuss two policies: One, a combination of severance payments and unemployment benefits such that fired workers get severance payments while unmatched workers get unemployment benefits; two, both fired and unmatched workers are given unemployment benefits of equal amount. In both cases unemployment benefits are financed by a tax on employed workers with the government maintaining a balanced budget.

When the policy involves a combination of severance payments and unemployment benefits, firms do the following maximization in the decentralized case taking f_w, b, and τ as given:

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

subject to the constraint

$$\mu\theta^{\delta}\left((1-\lambda_c)U(w-\tau) + \lambda_c U(f_w+z)\right) + \left(1-\mu\theta^{\delta}\right)U(z+b) \geq W \tag{39}$$

where the tax τ equals $\tau = \frac{\left(1-\mu\theta^{\delta}\right)}{\mu\theta^{\delta}(1-\lambda_c)} b$.

For a given f_w, b, and τ, the following three equations (derived in the appendix) determine the values of λ, θ, and w.

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_{c1} - f_w}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} = w - \psi_{c1} - f_w, \tag{40}$$

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_{c1} - f_w}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\right)^{\gamma} \left(\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} = w(1-\lambda_c) + \lambda_c f_w + \frac{c}{\mu\theta^{\delta-1}}, \tag{41}$$

$$\psi_{c2} - \lambda_c \psi_{c1} = \frac{(1-\delta)c}{\delta\mu\theta^{\delta-1}}, \tag{42}$$

where $\psi_{c1} \equiv \frac{U(w-\tau)-U(f_w+z)}{U'(w-\tau)}$, $\psi_{c2} \equiv \frac{U(w-\tau)-U(b+z)}{U'(w-\tau)}$.

By comparing the above with equations (37) and (38) it is verified in the appendix that the decentralized equilibrium values of λ_c and θ coincide with the planner's solution (or are efficient) if f_w and b satisfy the following two conditions.

$$\psi_{c1} = w - f_w - z, \tag{43}$$

$$\psi_{c2} - \psi_{c1} = f_w. \tag{44}$$

mentioned here.

To obtain the values of f_w and b that give the efficient levels of λ_c and θ in the decentralized case, solve equations (40)-(44) for λ_c, θ, f_w, w, and b.

The efficient outcome can also be decentralized using unemployment benefits alone. In this case, both fired and unmatched workers will get unemployment benefits. The firms maximize the following.

$$\underset{L,M,w,\lambda_c}{Max}\left\{Z - wL - \phi M - \frac{c}{\mu\theta^{\delta-1}}\frac{L}{(1-\lambda_c)}\right\}$$

subject to the constraint

$$\mu\theta^{\delta}(1-\lambda_c)U(w-\tau) + \Big(1-\mu\theta^{\delta}(1-\lambda_c)\Big)U(b+z) \geq W, \tag{45}$$

and $\tau = \frac{(1-\mu\theta^{\delta})+\lambda_c\mu\theta^{\delta}}{\mu\theta^{\delta}(1-\lambda_c)}b$.[22]

It is shown in the appendix that the following 4 equations yield the efficient values of λ_c and θ, and the required b and associated w.

$$\begin{aligned}
\gamma A\lambda_c\left(1+\left(\frac{\lambda_c\phi}{w-\psi_{ub}}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} &= w-\psi_{ub}; &(46)\\
\gamma A\left(1+\left(\frac{\lambda_c\phi}{w-\psi_{ub}}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma}\left(\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} &= w\left(1-\lambda_c\right)+\frac{c}{\mu\theta^{\delta-1}}; &(47)\\
(1-\lambda_c)\psi_{ub} &= \frac{(1-\delta)c}{\delta\mu\theta^{\delta-1}}; &(48)\\
\psi_{ub} &= w-z, &(49)
\end{aligned}$$

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

While both these policies achieve efficiency, we numerically verify that the worker welfare as well as social welfare is higher in the case of a combination of severance payments and unemployment benefits than unemployment benefits alone. Figure 7 provides a numerical example where the red line represents the value of a variable for the combination policy, the black line represents the value for unemployment benefits alone, and the green line for the case of no intervention. Each policy is chosen so that λ_c and θ are at the production-efficient level. Figures 7a and 7b are for the case of low risk aversion ($\rho = 1.5$) while figures 7c and 7d are for the case of high risk aversion ($\rho = 3$). Looking at figures 7a and 7c

[22] In writing the constraint above we have assumed that the same unemployment benefit is paid to fired and unmatched workers. In principle, unemployment benefits could be different for fired and unmatched workers, however, it is easily verified that efficiency requires the unemployment benefits to be the same for the two types of unemployed workers.

note that the worker welfare is higher with the combination policy than with unemployment benefits which in turn is higher than the worker welfare without policy intervention. Similarly, figures 7b and 7d verify that social welfare is higher with the combination policy than with unemployment benefits alone which in turn is higher than the social welfare in the absence of any interventions. Note also from figure 7b that social welfare increases as the cost of offshoring decreases when the degree of risk aversion is low as was the case in the absence of search frictions shown in figure 1d . Similarly, figure 7d shows that social welfare decreases as the cost of offshoring decreases when the risk aversion is high similar to the result in figure 2d in the absence of search frictions.

As mentioned earlier, in the model without search frictions severance payments did a better of job of insuring workers than unemployment benefits. When unemployment is caused by both matching frictions and job destruction, a combination of severance payments and unemployment benefits does better because the former is better suited for unemployment arising from job destruction while the latter is better suited for unmatched workers. Therefore, while severance payments and unemployment benefits are generally thought of as alternative ways of insuring risk averse workers, the two can be used in combination when unemployment is caused by both job destruction and matching frictions, which is the case in reality.

The result that welfare with intervention is higher than the welfare without intervention at all levels of offshoring cost (red and black lines lie above the green line) highlights one of the key themes of the paper. Policy interventions such as severance payments or unemployment benefits may increase unemployment in an open economy as they do in a closed economy, however, they increase worker welfare as well as social welfare by providing social protection to workers.

It is worth mentioning that while the numerical exercises in the paper were performed using a CRRA utility function, all the numerical results were verified for many other commonly used utility functions exhibiting risk aversion such as logarithmic utility function, CARA utility function etc.

6 Discussions

In the model we have assumed that there is a unit measure of firms and the production function exhibits diminishing returns. We mentioned earlier that diminishing returns 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

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

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. It is straightforward to verify that the profit of our baseline model given in (15) would exactly equal rH, the total income going to this factor of production. Therefore, all the results in the paper will go through with this alternative production function.

The presence of diminishing returns to the composite input of L and M is essential to get some of the key results in the paper. If the production function has constant returns ($\gamma = 1$) to this composite input, one can easily see that we will always be in the case of $\sigma < \frac{1}{1-\gamma}$, and therefore, domestic labor and offshored inputs will become gross complements and offshoring will always increase the welfare of workers. This would also be the case if 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 offshoring 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. Even though we have written a one sector model, it is easy to see that the results can be obtained in a two sector Heckscher-Ohlin type model if the scarce factor is subject to unemployment and the owners of this scarce factor are risk averse.

In the paper we have used offshored input and imported input interchangeably. There is some confusion about the meaning of offshoring in the literature. 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 task as offshoring.[23] While the approach in the present paper is closer to the traditional concept of offshoring viewed as input trade, it can be easily adapted to the trade in task view of 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.

[23] See Feenstra (2008) for an excellent discussion of older and newer concepts of offshoring.

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 offshored input, we could think of it is 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 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.

Our model can also be used to analyze the consequences of routine-task replacing technical change (see Autor and Dorn(2013)) on the welfare of workers. We can think of the two inputs in the production as labor performing routine tasks and computers. Our current model has only one sector and therefore, the alternative for workers is unemployment (or home production). One could think of the outside option for these workers to be low-paying service occupations that are difficult to computerize as in the models of routine-task replacing technical change. Now a decrease in the price of computers would destroy routine jobs (provided the elasticity of substitution between computers and routine jobs is high) leading to a decrease in employment and wages of these workers. In the absence of any policy intervention, the welfare of workers would decrease and social welfare could decrease as well if workers are highly risk averse.

7 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 offshoring. In this setting, a decrease in the cost of offshoring leads to greater job destruction and lower wages if the elasticity of substitution between domestic labor and offshored inputs is high. This causes welfare losses for workers and potential social welfare losses. In the absence of any instrument of social protection or redistribution there would be a case for creating barriers to offshoring.

Looking at policies, it is shown that from the point of view of production-efficiency there is a distortion in the economy arising from the missing market for insurance against labor income risk.

Common labor market policies such as severance payments and unemployment benefits can address this distortion by providing insurance. Imposing administrative burden on firing, on the other hand, makes things worse. While both unemployment benefits and severance payments can alleviate the distortion, 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 unemployment 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.

From the point of view of social welfare, there is an additional distortion arising from an inequality in the distribution of income which can be addressed through redistribution. When both distortions are addressed (say through severance payments and redistribution), offshoring necessarily improves welfare.

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8 Appendix A

8.1 The Baseline Model

8.1.1 Derivation of key equations (13) and (14)

Using (10) in (11) obtain

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

Next, substitute (8) in (50) and simplify to obtain (13). Next, note that equations (8) and (9) imply

$$M^{\frac{\sigma-1}{\sigma}} = \omega^{\sigma-1} L^{\frac{\sigma-1}{\sigma}} \left(\frac{1+\lambda_c}{2}\right)^{-\frac{(\sigma-1)^2}{\sigma}}. \tag{51}$$

Using (51) and (12) in (8) obtain (14).

8.1.2 The Planner's problem

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

$$\begin{aligned} \lambda_c \gamma A F_{\overline{L}} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\frac{-1}{\sigma}} &= z; & (52)\\ \gamma A F_{\overline{L}} M^{\frac{-1}{\sigma}} &= \phi. & (53) \end{aligned}$$

From the above two f.o.c obtain

$$M = \left(\frac{\lambda_c \phi}{z}\right)^{-\sigma} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right). \tag{54}$$

Substitute the above in (52) to eliminate M and obtain

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{z}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\right)^{\gamma-1} \overline{L}^{\gamma-1} = z. \tag{55}$$

Re-write (55) as

$$\Gamma(\lambda_c, z) = 1, \tag{56}$$

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 $\Gamma(\lambda_c^e, z) = 1$.

8.1.3 Equations for Decentralized equilibrium with and without policies

In the decentralized equilibrium firms maximize

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

The f.o.c are given by

$$\begin{aligned}
L &: \gamma A \digamma_L \left(\frac{1+\lambda_c}{2}\right)^{\frac{\sigma-1}{\sigma}} L^{-\frac{1}{\sigma}} = w + \frac{\lambda_c}{1-\lambda_c}\left(f_w + f_t\right); && (57)\\
M &: \gamma A \digamma_L M^{\frac{-1}{\sigma}} = \phi; && (58)\\
w &: -L + \varrho(1-\lambda_c)U'(w-\tau) = 0; && (59)\\
\lambda_c &: \gamma A \digamma_L \left(\frac{1+\lambda_c}{2}L\right)^{\frac{-1}{\sigma}} \frac{L}{2} + \varrho(U(b+f_w+z) - U(w-\tau)) - \frac{1}{(1-\lambda_c)^2}\left(f_t + f_w\right)L = 0. && (60)
\end{aligned}$$

Using (59) write (60) as

$$\gamma A \digamma_L \left(\frac{1+\lambda_c}{2}L\right)^{\frac{-1}{\sigma}} \left(\frac{1-\lambda_c}{2}\right) = \psi_p + \frac{(f_t + f_w)}{1-\lambda_c}, \tag{61}$$

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

Next, subtract (61) from (57) to obtain

$$\gamma A \digamma_L L^{-\frac{1}{\sigma}} \left(\frac{1+\lambda_c}{2}\right)^{\frac{-1}{\sigma}} \lambda_c = w - \psi_p - \left(f_t + f_w\right). \tag{62}$$

Use (61) and (58) to obtain

$$M = \left(\frac{\lambda_c \phi}{w - \psi_p - (f_t + f_w)}\right)^{-\sigma} \left(\frac{1+\lambda_c}{2}\right) L. \tag{63}$$

Now, substitute out M in (62) using (63) to obtain

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p - (f_t + f_w)}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\gamma-1} \lambda_c = w - \psi_p - \left(f_t + f_w\right). \tag{64}$$

This is the equation (26) in the text.

The expression for λ_c in the decentralized equilibrium without intervention is obtained by setting $f_t = f_w = b = \tau = 0$ in the above, which yields

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{z'}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\gamma-1} = z', \tag{65}$$

where $z' = w - \psi$ (recall that $\psi \equiv \frac{U(w)-U(z)}{U'(w)}$).

8.1.4 Expression for Change in Profits

Taking the total derivative of (15) in the text obtain

$$d\Pi = \left(-2\lambda_c A \gamma F_{\overline{L}} \left(\frac{\overline{L}}{2}\right)^{\frac{\sigma-1}{\sigma}} \left(1-\lambda_c^2\right)^{\frac{-1}{\sigma}} + w\overline{L}\right) d\lambda_c - (1-\lambda_c)\overline{L}dw - M d\phi. \tag{66}$$

Using the equilibrium condition, $L = (1-\lambda_c)\overline{L}$, re-write the first-order condition for the optimal choice of L, (8), as

$$\gamma A F_{\overline{L}} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\frac{\sigma-1}{\sigma}} = w(1-\lambda_c)\overline{L}. \tag{67}$$

Using (67) above in (66) obtain

$$d\Pi = \left(\frac{1-\lambda_c}{1+\lambda_c}\right) w\overline{L}d\lambda_c - (1-\lambda_c)\overline{L}dw - M d\phi. \tag{68}$$

Next, note from (13) that $\frac{1-\lambda_c}{1+\lambda_c} w = \psi$. Therefore, the above can be written as

$$d\Pi = \overline{L}\left(\psi d\lambda_c - (1-\lambda_c)dw - \frac{M}{\overline{L}}d\phi\right). \tag{69}$$

8.1.5 Expression for change in welfare of workers

Totally differentiating (16) in the text obtain

$$dW = (1-\lambda_c)U'(w)dw - (U(w) - U(z))d\lambda_c. \tag{70}$$

Using the definition of ψ ($= \frac{U(w)-U(z)}{U'(w)}$) re-write above as

$$dW = U'(w)((1-\lambda_c)dw - \psi d\lambda_c). \tag{71}$$

8.1.6 Expression for change in social welfare

The social welfare, given by the sum of the welfare of workers and profit owners is given by $NU(\pi)+\overline{L}W$. The change in welfare can be written, using (71) and (69), as

$$NU'(\pi)d\pi + \overline{L}dW = \overline{L}U'(\pi)\left(\psi d\lambda_c - (1-\lambda_c)dw - \frac{M}{\overline{L}}d\phi\right) + \overline{L}U'(w)\left((1-\lambda_c)dw - \psi d\lambda_c\right). \quad (72)$$

8.2 Offshoring and Welfare

8.2.1 Welfare of workers

It follows from (71) that the change in the welfare of workers in response to offshoring is

$$\frac{dW}{d\phi} = U'(w)\left((1-\lambda_c)\frac{dw}{d\phi} - \psi\frac{d\lambda_c}{d\phi}\right). \quad (73)$$

8.2.2 Profits

It follows from (69) that

$$\frac{d\Pi}{d\phi} = \overline{L}\left(\psi\frac{d\lambda_c}{d\phi} - (1-\lambda_c)\frac{dw}{d\phi}\right) - M. \quad (74)$$

8.2.3 Social Welfare

It follows from (72) that the change in social welfare in response to offshoring is given by

$$NU'(\pi)\frac{d\pi}{d\phi} + \overline{L}\frac{dW}{d\phi} = (U'(w) - U'(\pi))\overline{L}\left((1-\lambda_c)\frac{dw}{d\phi} - \psi\frac{d\lambda_c}{d\phi}\right) - U'(\pi)M. \quad (75)$$

8.2.4 Welfare maximization by the planner

$$\underset{\lambda_c, M, b', w'}{Max}\left(\lambda_c U(b'+z) + (1-\lambda_c)U(w')\right)\overline{L} + NU(y)$$

where

$$y = \frac{Z_P - \phi M - \lambda_c \overline{L}b' - (1-\lambda_c)\overline{L}w'}{N},$$

where Z_P is given by (20). The first order conditions are

$$\begin{aligned}
b' &: \; U'(b'+z) = U'(y); \\
\lambda_c &: \; \left(U(b'+z) - U(w')\right)\overline{L} + U'(y)\left(\frac{\partial Z_P}{\partial \lambda_c} + \left(w' - b'\right)\right)\overline{L} = 0; \\
w' &: \; U'(w') = U'(y); \\
M &: \; \frac{\partial Y}{\partial M} = \phi.
\end{aligned}$$

The f.o.c with respect to b' and w' imply that

$$U'(b'+z) = U'(y) = U'(w').$$

Above implies that $w' - b' = z$ and hence, it is easily verified from the f.o.c. with respect to λ_c and M that the choice of the choice of λ_c is efficient. (Note that they become the same as the f.o.c for the planner's problem in (52) and (53).

8.3 Model with matching frictions

8.3.1 Decentralized equilibrium

Below we write down a model with two policies in place: severance payments, f_w, going to fired workers and unemployment benefits, b, paid to unmatched workers. b, in turn, is financed by a payroll tax on employed workers. The equations for the model without any policy intervention can be simply obtained by setting $f_w = b = \tau = 0$.

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

subject to the constraint

$$\mu\theta^{\delta}\left((1-\lambda_c)U(w-\tau) + \lambda_c U(f_w + z)\right) + \left(1 - \mu\theta^{\delta}\right) U(z+b) \geq W. \tag{76}$$

The first order conditions for the above maximization are given by

$$L \ : \ \gamma A F_L \left(\frac{1+\lambda_c}{2}\right)^{\frac{\sigma-1}{\sigma}} L^{\frac{-1}{\sigma}} = w + \frac{\lambda_c}{1-\lambda_c} f_w + \frac{c}{(1-\lambda_c)\mu\theta^{\delta-1}}; \tag{77}$$

$$M \ : \ \gamma A F_L M^{\frac{-1}{\sigma}} = \phi; \tag{78}$$

$$w \ : \ -L + \varrho\mu\theta^{\delta}(1-\lambda_c)U'(w-\tau) = 0; \tag{79}$$

$$\lambda_c \ : \ \gamma A F_L (1+\lambda_c)^{\frac{-1}{\sigma}} \left(\frac{L}{2}\right)^{\frac{\sigma-1}{\sigma}} = \varrho\mu\theta^{\delta}\left(U(w-\tau) - U(f_w+z)\right)) + \frac{f_w L}{(1-\lambda_c)^2} + \frac{cL}{\mu\theta^{\delta-1}(1-\lambda_c)^2} \tag{80}$$

$$\theta \ : \ \varrho\delta\mu\theta^{\delta-1}\left((1-\lambda_c)U(w-\tau) + \lambda_c U(f_w+z) - U(b+z)\right) = (1-\delta)\frac{c\theta^{-\delta}}{\mu}\frac{L}{(1-\lambda_c)}. \tag{81}$$

In addition, the labor market equilibrium condition is

$$L = \mu\theta^{\delta}(1-\lambda_c)\overline{L}. \tag{82}$$

Using the definition $\psi_{c1} \equiv \frac{U(w-\tau)-U(f_w+z)}{U'(w-\tau)}$ and using (79) in (80) obtain

$$\gamma A F_L (1+\lambda_c)^{\frac{-1}{\sigma}} (1-\lambda_c) \left(\frac{1}{2}\right)^{\frac{\sigma-1}{\sigma}} L^{-\frac{1}{\sigma}} = \psi_{c1} + \frac{1}{(1-\lambda_c)} f_w + \frac{c}{(1-\lambda_c)\mu\theta^{\delta-1}}. \tag{83}$$

Next, using (79) write (81) as

$$\frac{(1-\lambda_c)U(w-\tau) + \lambda_c U(f_w+z) - U(b+z)}{U'(w-\tau)} = \frac{(1-\delta)c}{\delta\mu\theta^{\delta-1}}. \tag{84}$$

Equations (77), (78), (82), (83), and (84) determine the equilibrium values of w, λ_c, θ, L, and M.

We eliminate M and derive the three key equations in w, λ_c, and θ.

Subtract (83) from (77) to get

$$\gamma A F_L L^{\frac{-1}{\sigma}} \left(\frac{1+\lambda_c}{2}\right)^{\frac{-1}{\sigma}} \lambda_c = w - \psi_{c1} - f_w. \tag{85}$$

Use above along with (78) to obtain

$$M = \left(\frac{\lambda_c \phi}{w-\psi_{c1}-f_w}\right)^{-\sigma} \left(\frac{1+\lambda_c}{2}\right) L. \tag{86}$$

Eliminate M in (85) using (86) and use (82) to obtain

$$\gamma A \lambda_c \left(1 + \left(\frac{\lambda_c \phi}{w-\psi_{c1}-f_w}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} = w - \psi_{c1} - f_w. \tag{87}$$

Substitute out M in (77) using using (86) and use (82) to obtain

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w-\psi_{c1}-f_w}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\right)^{\gamma} \left(\mu\theta^{\delta}\overline{L}\right)^{\gamma-1} = w\left(1-\lambda_c\right) + \lambda_c f_w + \frac{c}{\mu\theta^{\delta-1}}. \tag{88}$$

Equations (84),(87), and (88) are the 3 equations giving w, λ_c, and θ in the model with search frictions. Also,

$$\tau = \frac{\left(1-\mu\theta^{\delta}\right)}{\mu\theta^{\delta}(1-\lambda_c)} b,$$

in this case.

When the policy intervention is unemployment benefits alone, then the above maximization changes as follows. Set the $f_w = 0$ in the objective function and modify the budget constraint to

$$\mu\theta^{\delta}\left((1-\lambda_c)U(w-\tau) + \lambda_c U(b+z)\right) + \left(1-\mu\theta^{\delta}\right) U(z+b) \geq W.$$

Now, the three key equations determining w, λ_c, and θ are as follows.

$$\begin{aligned}
\gamma A\lambda_c\left(1+\left(\frac{\lambda_c\phi}{w-\psi_{ub}}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\mu\theta^\delta\overline{L}\right)^{\gamma-1} &= w-\psi_{ub}; &(89)\\
\gamma A\left(1+\left(\frac{\lambda_c\phi}{w-\psi_{ub}}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma}\left(\mu\theta^\delta\overline{L}\right)^{\gamma-1} &= w\left(1-\lambda_c\right)+\frac{c}{\mu\theta^{\delta-1}}; &(90)\\
(1-\lambda_c)\psi_{ub} &= \frac{(1-\delta)c}{\delta\mu\theta^{\delta-1}}; &(91)
\end{aligned}$$

where $\psi_{ub}\equiv\frac{U(w-\tau)-U(b+z)}{U'(w-\tau)}$; $\tau=\frac{\left(1-\mu\theta^\delta\right)+\lambda_c\mu\theta^\delta}{\mu\theta^\delta(1-\lambda_c)}b$.

8.3.2 Planner's Problem with Search Frictions

Use the following definition: $F_{\overline{L}\theta}=\left(\left(\left(\frac{1-\lambda_c^2}{2}\right)\mu\theta^\delta\overline{L}\right)^{\frac{\sigma-1}{\sigma}}+M^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}$. Now the first order conditions for the planner's problem are

$$\begin{aligned}
M &: \gamma AF_{\overline{L}\theta}M^{\frac{-1}{\sigma}}=\phi, &(92)\\
\lambda_c &: \lambda_c\gamma F_{\overline{L}\theta}\left(\frac{1-\lambda_c^2}{2}\mu\theta^\delta\overline{L}\right)^{\frac{-1}{\sigma}}=z, &(93)\\
\theta &: \gamma AF_{\overline{L}\theta}\left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\frac{\sigma-1}{\sigma}}\left(\mu\theta^\delta\right)^{-\frac{1}{\sigma}}\delta\mu\theta^{\delta-1}=c\overline{L}+\delta\left(1-\lambda_c\right)z\mu\theta^{\delta-1}\overline{L}. &(94)
\end{aligned}$$

The above 3 equations determine λ_c, M, θ. From the above 3 equations we can eliminate M and obtain the following two equations in λ_c and θ.

$$\begin{aligned}
\gamma A\lambda_c\left(1+\left(\frac{\lambda_c\phi}{z}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma-1}\left(\mu\theta^\delta\overline{L}\right)^{\gamma-1} &= z; &(95)\\
\gamma A\left(1+\left(\frac{\lambda_c\phi}{z}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1}\left(\frac{1-\lambda_c^2}{2}\right)^{\gamma}\left(\mu\theta^\delta\overline{L}\right)^{\gamma-1} &= \frac{c}{\delta\mu\theta^{\delta-1}}+z\left(1-\lambda_c\right). &(96)
\end{aligned}$$

8.3.3 Efficient Policies with search frictions

Combination of severance payments and unemployment benefits Comparing (95) and (96) with (87) and (88) note that the decentralized outcome is same as planner's if $w-\psi_{c1}-f_w=z$ and if

$$w\left(1-\lambda_c\right)+\lambda_c f_w+\frac{c}{\mu\theta^{\delta-1}}=\frac{c}{\delta\mu\theta^{\delta-1}}+z\left(1-\lambda_c\right). \tag{97}$$

To show this, using the definition $\psi_{c2} \equiv \frac{U(w-\tau)-U(b+z)}{U'(w-\tau)}$ re-write (84) as

$$\psi_{c2} - \lambda_c \psi_{c1} = \frac{(1-\delta)c}{\delta \mu \theta^{\delta-1}}. \tag{98}$$

Next, when $w - \psi_{c1} - f_w = z$,we can write $w\,(1-\lambda_c) + \lambda_c f_w$ as

$$z\,(1-\lambda_c) + \psi_{c1} + f_w - \lambda_c \psi_{c1}.$$

Next, using (98) and the expression above, re-write the l.h.s of (97) as

$$z\,(1-\lambda_c) + \psi_{c1} + f_w - \psi_{c2} + \frac{c}{\delta \mu \theta^{\delta-1}}.$$

Therefore, (97) is satisfied if $\psi_{c1} + f_w - \psi_{c2} = 0$. Therefore, the two conditions required for the decentralized outcome to be efficient with the combination policy are:

$$w - \psi_{c1} - f_w = z; \psi_{c2} - \psi_{c1} = f_w.$$

If workers are risk neutral then $\psi_{c1} + f_w - \psi_{c2}$ becomes b, and therefore, (97) is satisfied for $b = 0$. Therefore, in the risk neutral case, the decentralized outcome is efficient without any policy intervention and independent of f_w as was the case earlier.

Also, f_w alone without a $b > 0$ cannot achieve efficiency because $w - \psi_{c1} - f_w = z$ can be satisfied only for $\psi_{c1} = 0$. In this case, the second condition requires $f_w = \psi_{c2}$ or $\frac{U(w)-U(z)}{U'(w)} = f_w$. Since the first condition requires $f_w = w - z$, the two together require $\frac{U(w)-U(z)}{U'(w)} = w - z$, which is not possible given the risk aversion and $w > z$.

Finally, note that full insurance is not compatible with efficiency. Full insurance implies $\psi_{c1} = \psi_{c2} = 0$. Now, at full insurance $\psi_{c2} - \psi_{c1} = f_w$ is satisfied only if $f_w = 0$. At $f_w = 0$ and $\psi_{c1} = 0$, the first condition $w - \psi_{c1} - f_w = z$ cannot be satisfied for any $w > z$.

Unemployment benefits alone Comparing (89) and (90) with (95) and (96) note that the decentralized outcome with unemployment benefits alone is efficient if

$$w - z = \psi_{ub}.$$

In deriving the condition for the efficient level of unemployment benefits we have imposed the condition that the same level of unemployment benefit is paid to both unmatched and fired workers. It is easy to verify that efficiency requires this to be the case.

9 Appendix B

9.1 Proof of Proposition 1

Totally differentiating (13) 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 the above as

$$C_{1w}dw + C_{1\lambda}d\lambda_c = 0, \tag{99}$$

where

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

Re–arrange the key equation (14) as

$$\frac{\gamma A}{2^\gamma}\overline{L}^{\gamma-1}\left(1+\left(\omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}\right)\right)^{\frac{\sigma\gamma}{\sigma-1}-1}(1-\lambda_c)^{\gamma-1}(1+\lambda_c)^\gamma = w. \tag{100}$$

Use the following compact notation.

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

Now, totally differentiate (100) to obtain

$$(\sigma-1)\,d\Lambda\left(\omega^{\sigma-2}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}d\omega - \frac{\omega^{\sigma-1}}{2}\left(\frac{1+\lambda_c}{2}\right)^{-\sigma}d\lambda_c\right)\frac{\left(1-\lambda_c^2\right)^\gamma}{1-\lambda_c} + \left(\frac{1+\lambda_c-2\lambda\gamma}{1-\lambda_c^2}\right)wd\lambda_c = dw. \tag{101}$$

Next, from the definition of ω obtain

$$d\omega = \frac{1}{\phi}dw - \omega\frac{d\phi}{\phi}. \tag{102}$$

Using the above expression for ω in (101) obtain

$$(\sigma-1)\,d\Lambda\left(\begin{array}{c}\omega^{\sigma-2}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}\left(\frac{1}{\phi}dw - \omega\frac{d\phi}{\phi}\right) - \\ \frac{\omega^{\sigma-1}}{2}\left(\frac{1+\lambda_c}{2}\right)^{-\sigma}d\lambda_c\end{array}\right)\frac{\left(1-\lambda_c^2\right)^\gamma}{1-\lambda_c} + \left(\frac{1+\lambda_c-2\lambda\gamma}{1-\lambda_c^2}\right)wd\lambda_c = dw,$$

where the last term on the left uses (100). Collect the terms and re-write the above as

$$C_{2w}dw + C_{2\lambda}d\lambda_c + C_{2\phi}d\phi = 0, \tag{103}$$

where

$$C_{2\phi} = -(\sigma-1)\frac{\left(1-\lambda_c^2\right)^{\gamma}}{1-\lambda_c}\left(\omega^{\sigma-1}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}\right)\frac{d\Lambda}{\phi}; \tag{104}$$

$$C_{2w} = \left(\frac{(\sigma-1)\,\omega^{\sigma-2}}{\phi}\left(\frac{1+\lambda_c}{2}\right)^{-(\sigma-1)}\frac{\left(1-\lambda_c^2\right)^{\gamma}}{1-\lambda_c}d\Lambda - 1\right); \tag{105}$$

$$C_{2\lambda} = -(\sigma-1)\,d\Lambda\left(\frac{\omega^{\sigma-1}}{2}\left(\frac{1+\lambda_c}{2}\right)^{-\sigma}\right)\frac{\left(1-\lambda_c^2\right)^{\gamma}}{1-\lambda_c} + \left(\frac{1+\lambda_c-2\lambda\gamma}{1-\lambda_c^2}\right)w. \tag{106}$$

Using (100) re-write $C_{2\phi}$ in the following convenient form.

$$C_{2\phi} = -(\sigma\gamma-\sigma+1)\,\omega\Omega. \tag{107}$$

Next, using the definition of $d\Lambda$ and (100) to re-write C_{2w} as

$$C_{2w} = -(\sigma(1-\gamma)-1)\,\Omega - 1 < 0. \tag{108}$$

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

Finally, let us simplify $C_{2\lambda}$. First, re-organize terms in (106) to obtain

$$C_{2\lambda} = -(\sigma-1)\,d\Lambda\frac{\omega^{\sigma-1}}{2}\left(\frac{1+\lambda_c}{2}\right)^{-\sigma}\frac{\left(1-\lambda_c^2\right)^{\gamma}}{1-\lambda_c} + \left(\frac{1+\lambda_c-2\lambda\gamma}{1-\lambda_c^2}\right)w. \tag{109}$$

Next, substitute out $d\Lambda$ and obtain

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

Finally, use (100) to re-write above as

$$C_{2\lambda} = \frac{w}{1+\lambda_c}\left(\frac{2\lambda_c(1-\gamma)}{1-\lambda_c} - C_{2w}\right) > 0. \tag{110}$$

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

Therefore, the coefficients of (103) 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 (100) 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 (99) that (13) 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 $w_2 = \psi$.

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 $w_2 > w_1$. A sufficient condition is that parameter are such that $w_1 < z$. Recall that w_1 is the solution to (100) when $\lambda_c = 0$. Essentially, it is the marginal product of labor at full employment. A sufficiently large $\overline{L}$ or small A will ensure that $w_1 < z$. If $w_1 > w_2$ then we get a corner solution with $\lambda_c = 0$ (full employment). Irrespective of the type of equilibrium, $w > z$ is always true.

9.2 Proof of Lemma 1

When workers are risk neutral $\psi = w - z$, therefore, $w - \psi = z$, and hence, (65) is exactly the same as (55). Therefore, the decentralized outcome is efficient if workers are risk neutral.

9.3 Proof of Lemma 2

Verify from (56) 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 (65) 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, $\lambda_c^r < \lambda_c^e$.

9.4 Proof of Proposition 2

From (99) and (103) obtain the following expressions for the impact of offshoring on w and λ_c.

$$\frac{dw}{d\phi} = -\frac{C_{2\phi}}{\left(C_{2w} - \frac{C_{2\lambda}}{C_{1\lambda}} C_{1w}\right)}; \frac{d\lambda_c}{d\phi} = -\frac{C_{2\phi}}{\left(C_{2\lambda} - \frac{C_{2w}}{C_{1w}} C_{1\lambda}\right)}. \tag{111}$$

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 offshoring. Since the sign of $C_{2\phi}$ is ambiguous, we have two relevant cases to discuss.

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

In this case, $C_{2\phi} < 0$, therefore, (111) 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, (111) implies $\frac{dw}{d\phi} > 0$, $\frac{d\lambda_c}{d\phi} < 0$.

9.5 Proof of proposition 5

Denote the wage with efficient unemployment insurance by w_b and the wage with efficient severance payments by w_{fw}. Note from (28) and (29) 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 $w_b = w_{fw} + \frac{\lambda_c}{1-\lambda_c} f_w$. This can be done as follows. From (63) above verify that the value of M in both cases is identical. It follows from (57) and (58) that $w_b = w_{fw} + \frac{\lambda_c}{1-\lambda_c} f_w$. And hence, the profits in the case of efficient severance payments, $Z - \left(w_{fw} + \frac{\lambda_c}{1-\lambda_c} f_w\right) L - \phi M$, are identical to the profits with efficient unemployment insurance, $Z - w_b L - \phi M$. Next, verify that the expected income with unemployment insurance is same as the expected income with severance payments:

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

Next, use $w_b = w_{fw} + \frac{\lambda_c}{1-\lambda_c} f_w$ to get

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

where the last equality follows from the fact that $z = w_{fw} - f_w$. It follows from the concavity of U that

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

9.6 Proof of Proposition 7

Start with a pair of f_w and s and look at the firm's problem in the second stage. The only difference from the decentralized equilibrium with severance payments discussed earlier is the presence of the transfer, s. Following the same steps as earlier, it can be verified that for a given f_w and s, the optimal choice of λ_c in a decentralized equilibrium is given by

$$\gamma A \left(1 + \left(\frac{\lambda_c \phi}{w - \psi_p - f_w}\right)^{1-\sigma}\right)^{\frac{\sigma\gamma}{\sigma-1}-1} \left(\frac{1-\lambda_c^2}{2}\overline{L}\right)^{\gamma-1} \lambda_c = w - \psi_p - f_w, \tag{112}$$

where $\psi_p \equiv \frac{U(w+s)-U(f_w+z+s)}{U'(w+s)}$. A comparison with (21) makes it clear that to achieve efficient λ_c, we need $w - \psi_p - f_w = z$. Since $\psi_p > w - f_w - z$ for any $w > f_w + z$, efficiency requires $\psi_p = 0$ or

$w - f_w = z$. That is, for any s, if f_w satisfies $f_w = w(f_w, s) - z$, where $w(f_w, s)$ is the equilibrium w for a given f_w and s, then that (f_w, s) pair yields efficient λ_c. Denote this f_w by $f_w(s)$. Now suppose the planner chooses s that solves the following equation: $s = b' - f_w(s)$ where b' is obtained from the planner's problem solved for the first-best case earlier. Next, verify that the resulting $w(f_w, s)$ must satisfy $w(f_w, s) = w' - s$ because $w' - b' = w(f_w, s) - f_w = z$.

Essentially what we have shown is that a combination of f_w and s satisfying $b' = f_w(s) + s$ which results in $w' = w(f_w, s) + s$ leads to efficient choice of λ_c, and therefore, the planner can replicate the first-best outcome in the decentralized case by choosing f_w and s satisfying $b' = f_w(s) + s$.

9.7 Proof of Proposition 8

$$SWF = \lambda_c U(f_w + z + s) + (1 - \lambda_c) U(w + s)\overline{L} + NU(y)$$

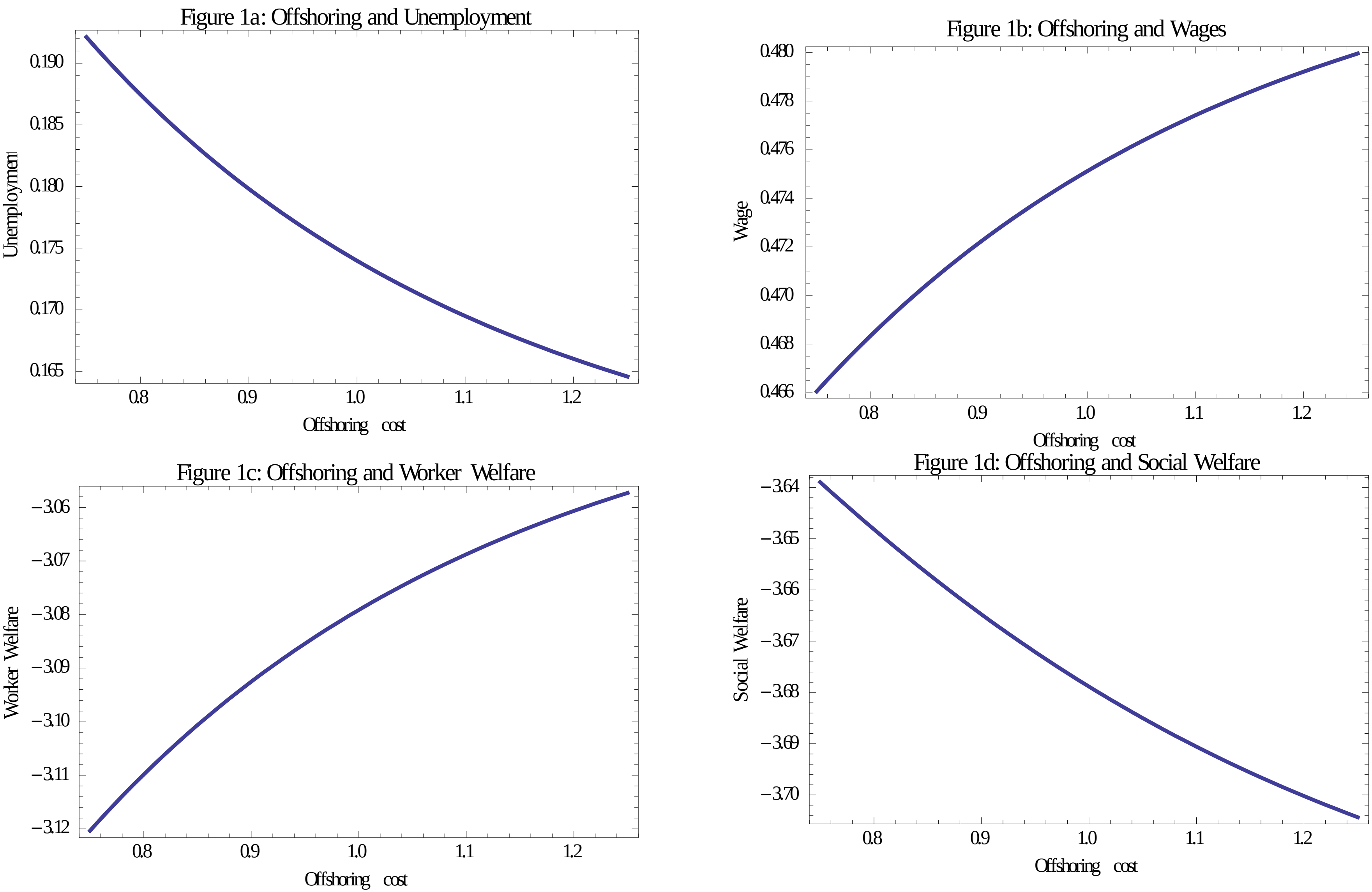
where

$$y = \frac{Z_P - \phi M - \lambda_c f_w \overline{L} - (1 - \lambda_c)\overline{L}w - s\overline{L}}{N}.$$

Since λ_c, f_w, w, y, M, and s are chosen optimally, it follows from envelope theorem that

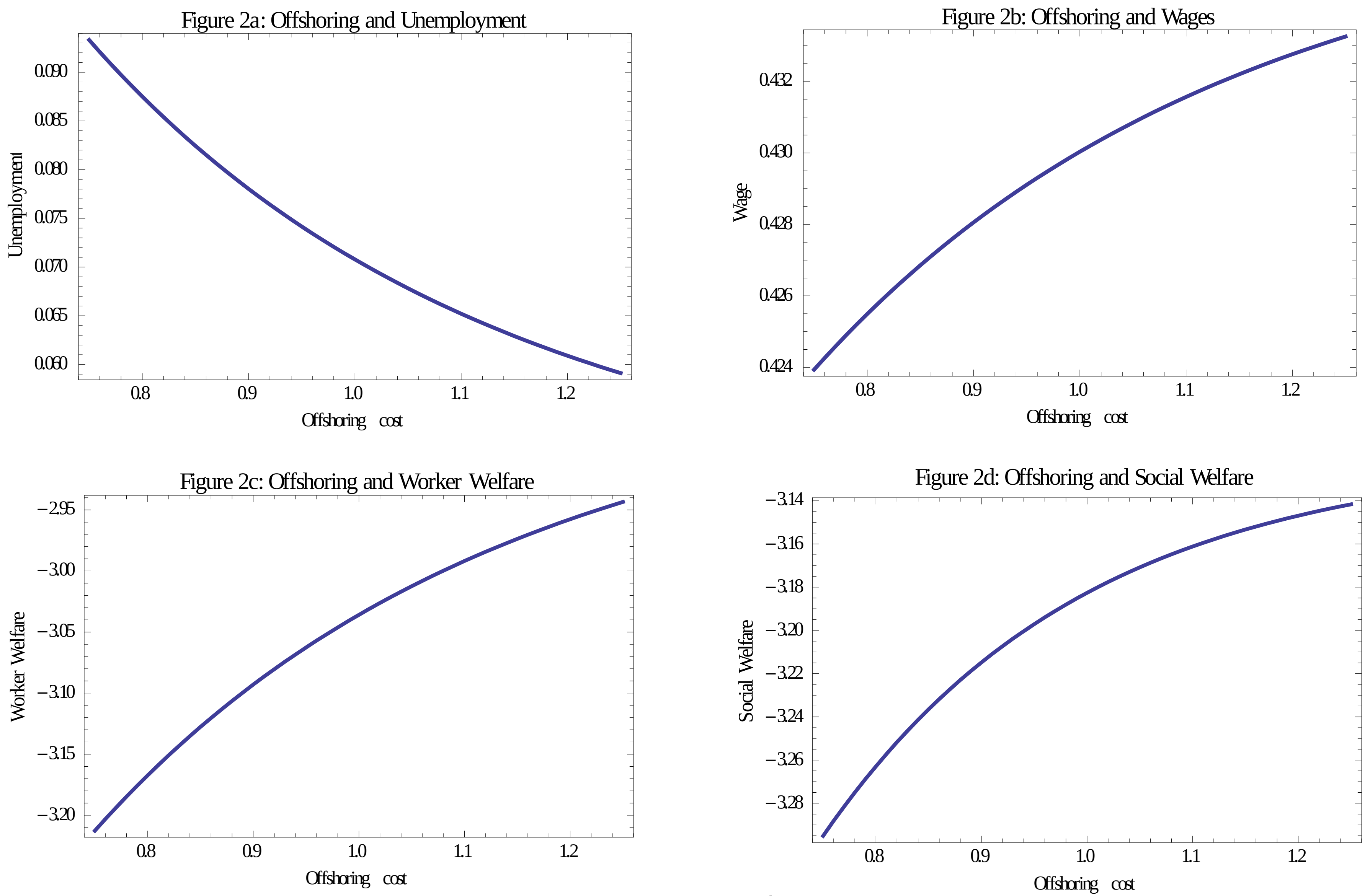
$$\frac{dSW}{d\phi} = -U'(y)\, M < 0.$$

Figure 1: Globalization and Welfare (low risk aversion: ρ= 1.5)



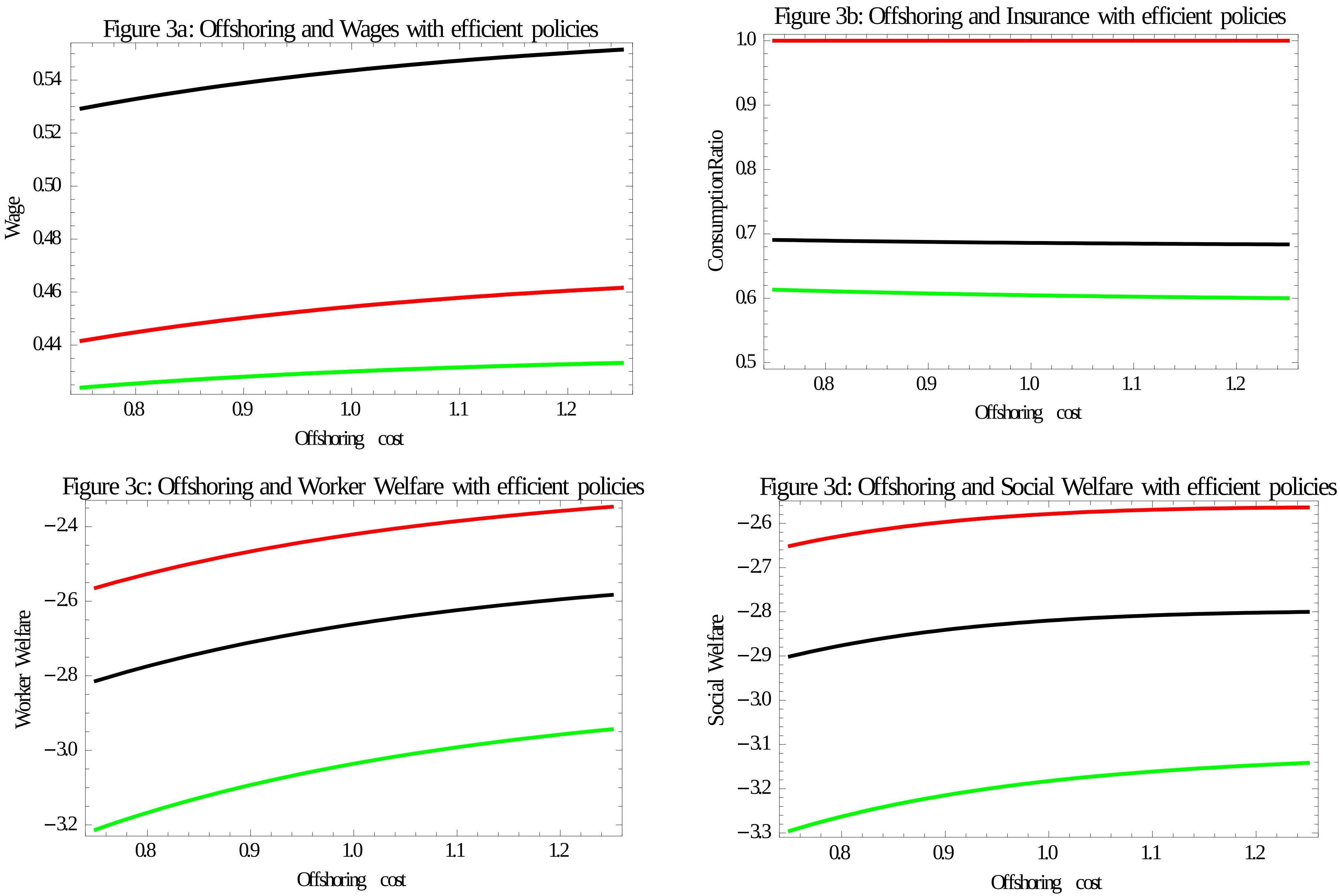
A=1,L=1,N=.3,σ=4,γ=2/3,z=.26

Figure 2: Globalization and Welfare (high risk aversion: ρ= 3)



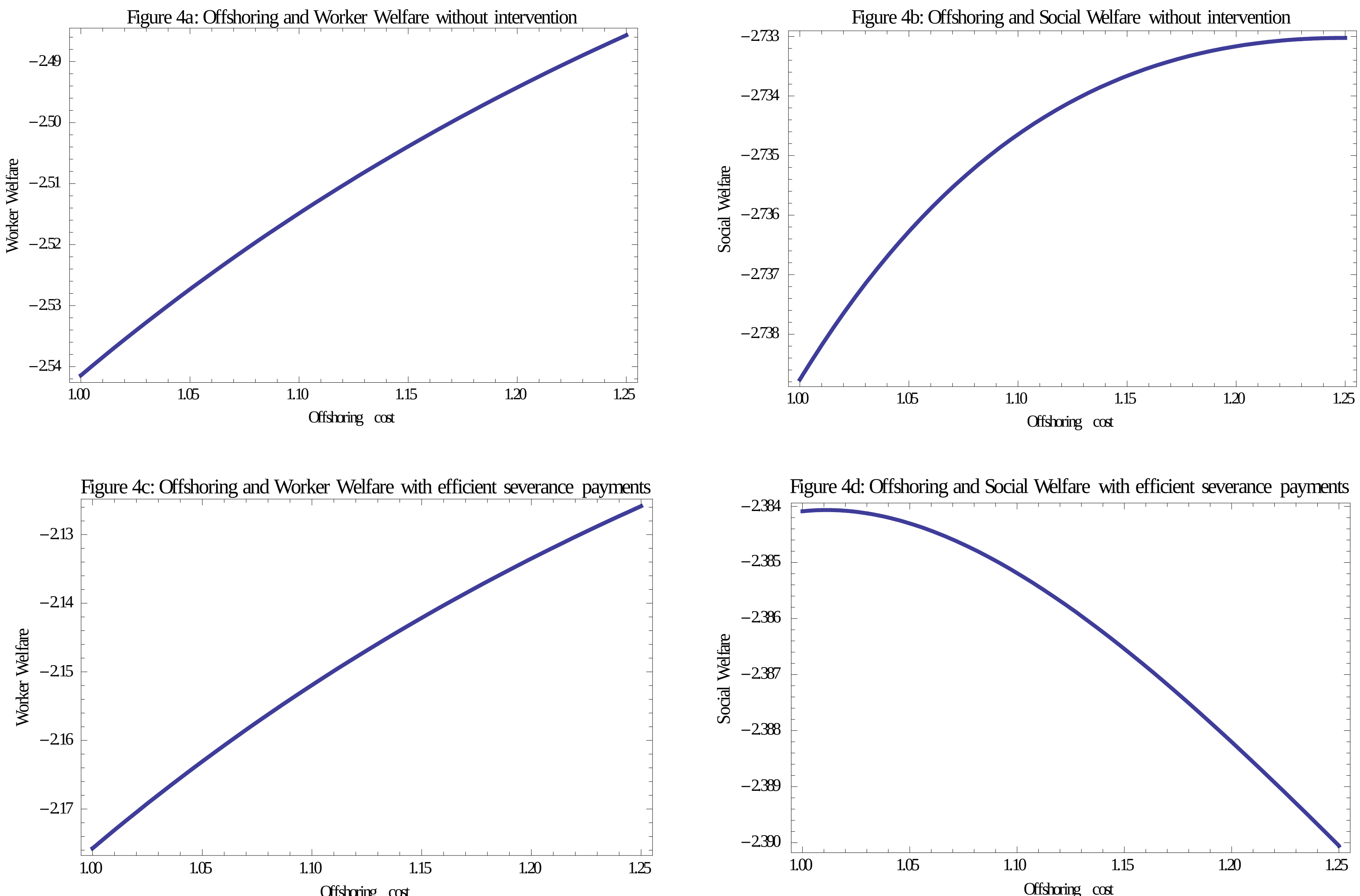
A=1,L=1,N=.3,σ=4,γ=2/3,z=.26, ρ= 3,

Figure 3: Globalization and Welfare with efficient policies (ρ= 3)



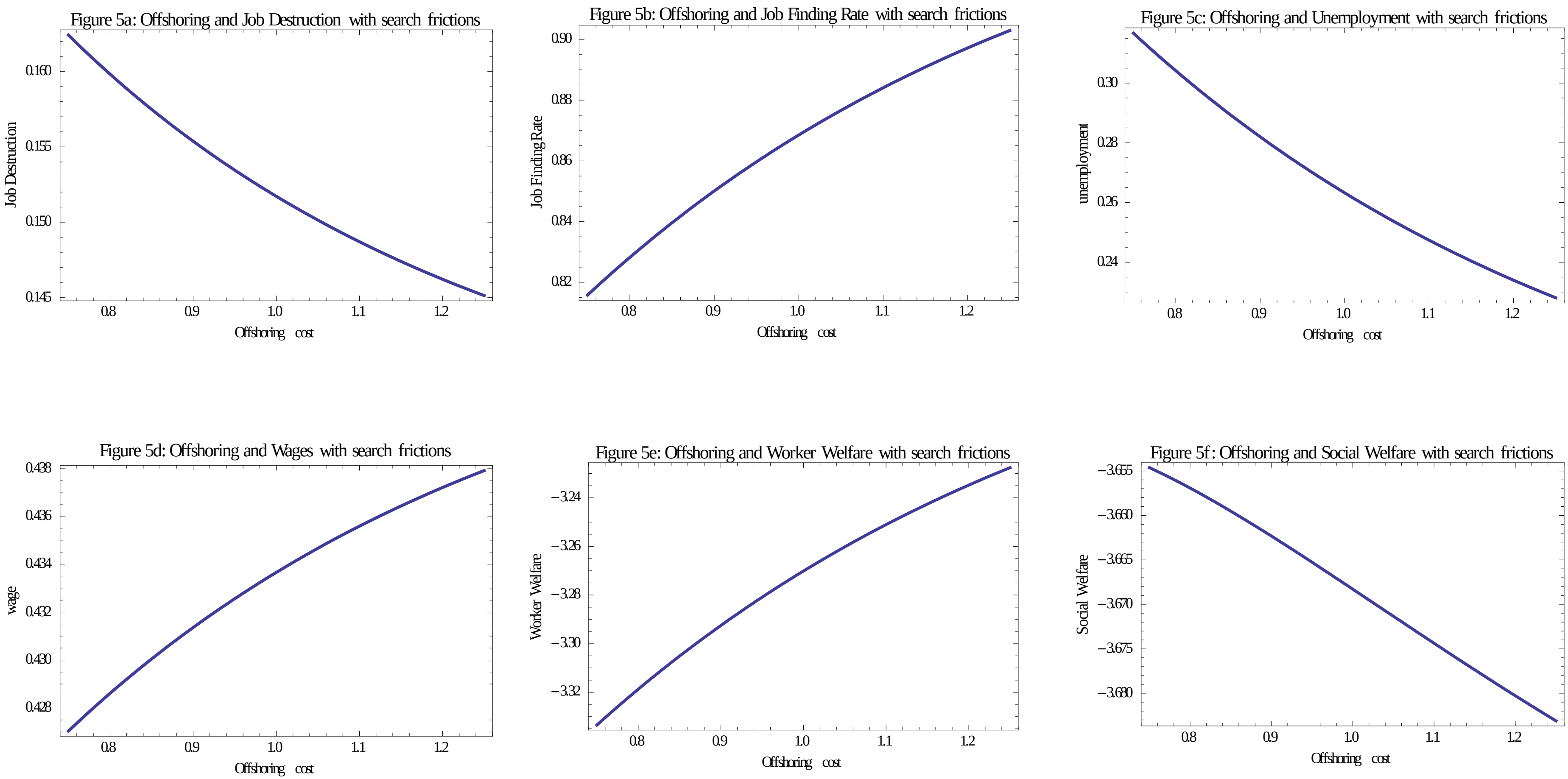
A=1,L=1,N=.3,σ=4,γ=2/3,z=.26

Figure 4: Globalization and Welfare with and without intervention (ρ= 2.5)



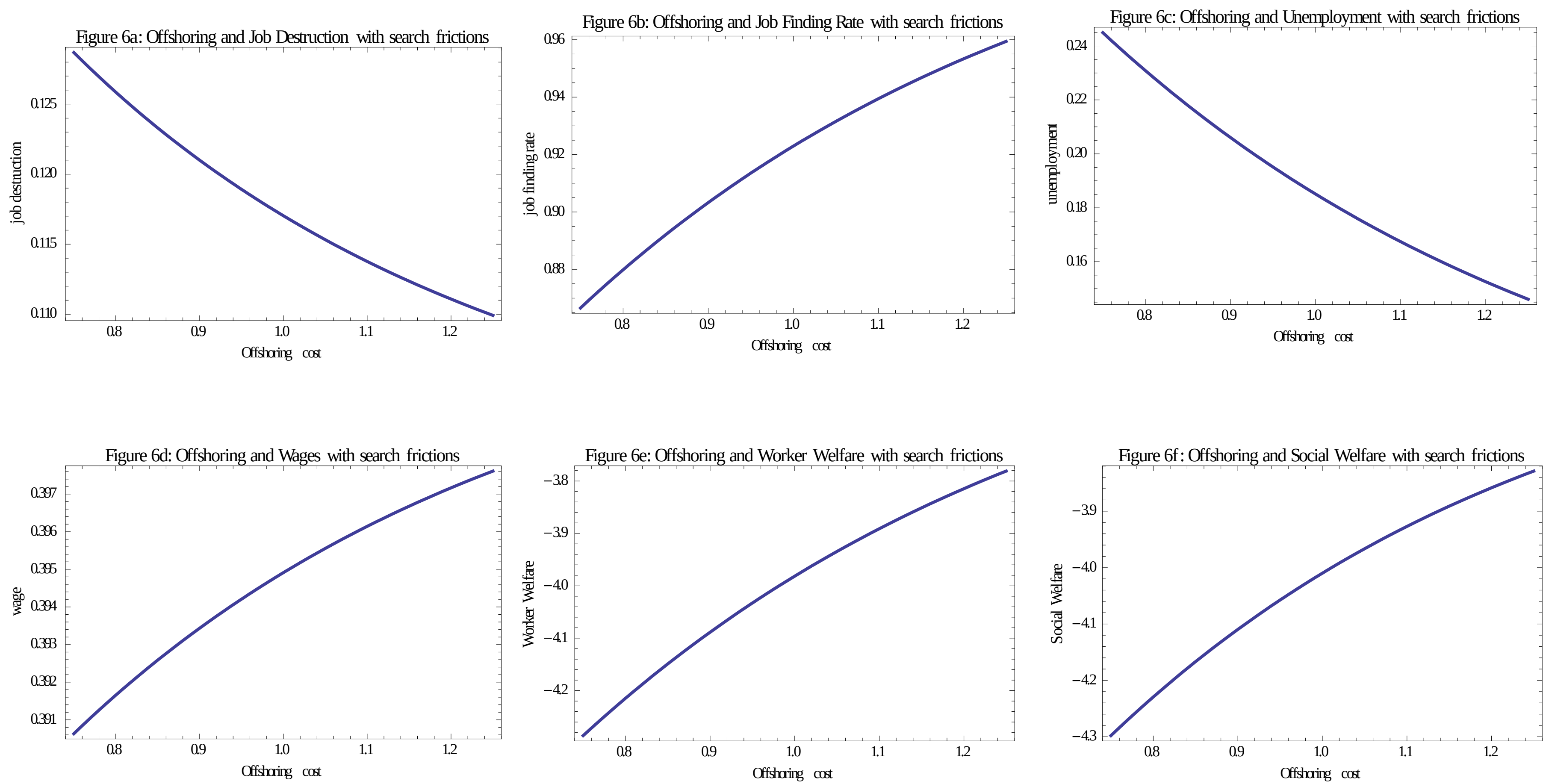
A=1,L=1,N=.3,σ=4,γ=2/3,z=.26, ρ= 2.5,

Figure 5: Globalization and Welfare with search frictions (ρ= 1.5)



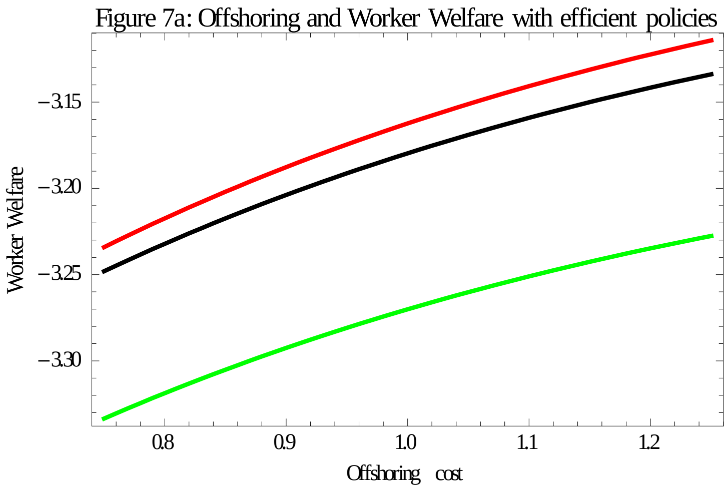
$A=1.5, L=1, N=.3, \gamma=2/3, z=.26, c=.05, \mu=.45, \delta=.5; \rho=1.5$

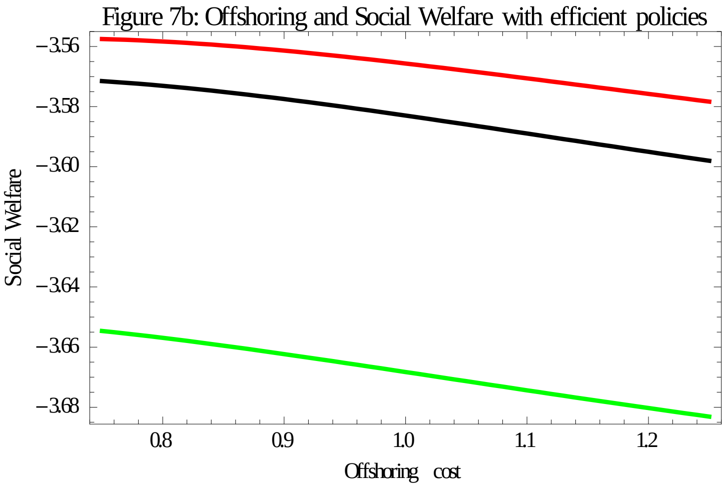
Figure 6: Globalization and Welfare with search frictions (ρ= 3)



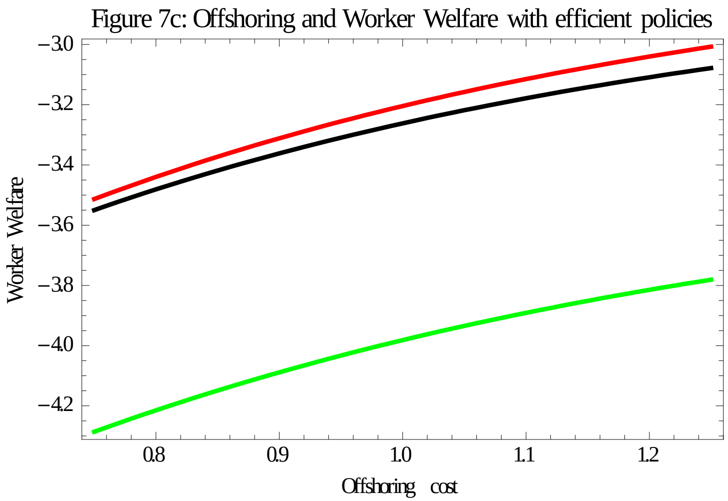
A=1.5,L=1, σ=4, N=.3, γ=2/3,z=.26,c=.05 ,μ=.45,δ=.5; ρ=3

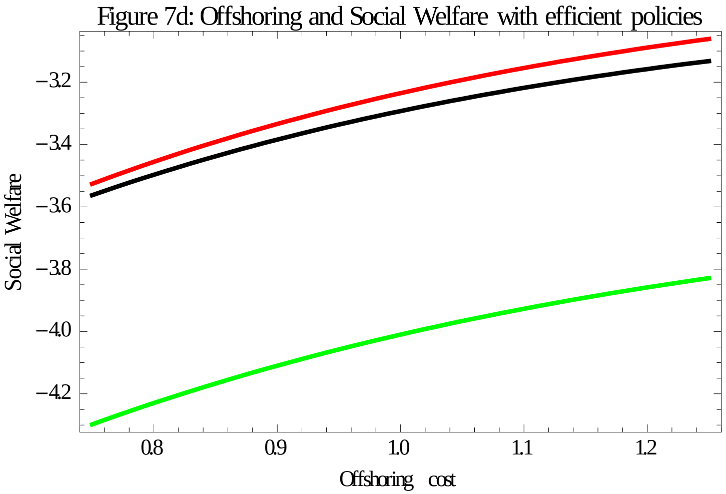
Figure 7: Globalization and Welfare with search frictions and efficient policies





A=1.5,L=1, γ=2/3,z=.26, c=.05,μ=.45,δ=.5; ρ=1.5





A=1.5,L=1, σ=4, N=.3, γ=2/3,z=.26,c=.05 ,μ=.45,δ=.5; ρ=3