Offshoring, Unemployment, and Welfare with Risk Averse Workers

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Abstract

This paper studies the welfare and policy implications of offshoring when risk averse workers face the risk of unemployment. If offshored inputs can be easily substituted for domestic workers, then offshoring reduces wages and increases unemployment. In this situation, in the absence of any government intervention offshoring not only reduces the welfare of workers but could reduce aggregate welfare as well if workers are highly risk averse and the markets for insurance against unemployment risk are missing. In addition to unemployment insurance, the role of employment protection policies- severance payments and administrative cost of firing -in protecting workers against the adverse consequences of globalization is studied. An administrative cost of firing reduces job destruction, however it ends up reducing the welfare of workers. Mandated severance payments and unemployment insurance can both protect workers against the adverse effects of offshoring and have the potential to make offshoring aggregate welfare improving. When unemployment arises due to both job destruction and matching frictions, a combination of severance payments and unemployment benefits is a better policy to shield workers from the adverse consequences of offshoring than either of them alone.

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

JEL Codes: F16, F66, F68

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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 (both quantity and quality). This has given rise to a recent surge in works studying the implications of globalization for jobs. The empirical literature using datasets from various countries and industries finds mixed results. Dutt, Mitra, and Ranjan (2009) find trade liberalization to be associated with lower unemployment at longer intervals in a cross-country study, however, there is a spike in unemployment in the immediate aftermath of trade liberalization. A recent influential study by Autor, Dorn, and Hanson (forthcoming, AER) 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. 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 focus on a particular aspect of globalization- offshoring- which has been increasing in importance in recent times. By offshoring we mean the fragmentation and relocation of a part of production process abroad undertaken both within the firm boundary and outside the firm boundary.

We construct a theoretical model with risk averse workers which is a key departure from the standard models of globalization and labor market. In our model a single good is produced using domestic labor and offshored inputs with a constant elasticity of substitution production function. While all workers are \textit{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. 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 not only improves the welfare of workers by lowering unemployment and increasing wages but increases aggregate welfare 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.\(^1\) In the latter case, there is an increase in inequality in the distribution of income since profits rise and wages fall. More importantly, if workers are sufficiently risk averse, then offshoring not only reduces the welfare of workers, but reduces aggregate 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 aggregate 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 aggregate welfare.

Risk aversion of workers and missing market for insurance against labor income risk creates a role for social protection. 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. Social protection programs protect workers from shocks irrespective of whether the shock originates within a country or has its origins abroad. However, providing protection against external shocks acquires salience due to political economy reasons.

We study the roles of unemployment insurance (UI) and employment protection (EP) legislation in protecting workers against the possible adverse consequences of offshoring. Both UI and EP are common in developed countries, but EP seems to be more common in developing countries probably because setting up UI programs requires considerable administrative expertise. For example, during the East Asian crisis of the late 1990s, South Korea was the only country that had any kind of unemployment insurance, but all East Asian countries had employment protection policies in place. Not only were there restrictions on firing, but firms were required to make severance payments upon dismissal as well.\(^2\)

\(^1\) 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.

\(^2\) see Mitra and Ranjan (2011) for details.
While the role of unemployment insurance as an instrument of social protection is relatively well known, it is less clear how some elements of employment protection programs can act as an instrument of social protection and hence can play a crucial role in protecting workers against the potentially adverse consequences of globalization. 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 which is a transfer from firms to workers and an administrative cost borne by employers which does not accrue to employees directly.

Focusing on the case where offshoring adversely affects workers (high elasticity of substitution between domestic labor and offshored inputs), it is shown that severance payments have the potential to offset the adverse welfare effects of offshoring on workers. More precisely, when the cost of offshoring goes down a level of severance payments that keeps the welfare of workers unchanged, allows the aggregate welfare to be higher than before the decrease in the cost of offshoring. Therefore, severance payments can be used as a policy tool to compensate the workers and make offshoring potentially Pareto improving. As well, the greater the decrease in the cost of offshoring the larger is the increase in severance payments required to keep the welfare of workers unchanged implying an expansion in the role of the welfare state with further globalization.

We also study the welfare implications of offshoring when severance payments are always set at the socially optimal level. It is shown that the socially optimal level of severance payments fully insure workers against labor market risk. However, offshoring can reduce the welfare of workers as well as aggregate welfare even if severance payments are always set at socially optimal level. The reason is that there are two distortions in the model: one arising from a lack of insurance and the other from a lack of instrument for redistribution. While severance payments correct the distortion from lack of insurance, when offshoring redistributes income from workers to profit owners it causes welfare losses by aggravating social inequality. It is shown that if a sufficiently large share of profits is distributed to workers, then offshoring increases both the welfare of workers as well as aggregate welfare in the presence of optimal severance payments.

Looking at the pure administrative cost component of employment protection, it is shown that an increase in this cost reduces job destruction by firms and thereby reduces unemployment, however, it ends up reducing the welfare of workers. Therefore, this component of the standard employment protection program protects employment but fails to improve the welfare of workers. What this suggests
is that not all components of employment protection are equal in terms of their welfare implications. 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.

An alternative policy to insure workers is publicly provided unemployment benefits which is like a self insurance program where employed workers pay a payroll tax to fund the unemployment benefits. Comparing optimal severance payments with optimal unemployment benefits, we find that the former leads to greater aggregate welfare. Intuitively, since workers are risk averse and firms are risk neutral, optimal risk sharing requires firms to bear the risk. Since severance payments allow firms to bear the risk while unemployment benefits are a form of self insurance for workers, the former yields greater aggregate welfare.

The baseline model discussed above abstracts from matching frictions to focus on job destruction and severance payments. As a result, unemployment is determined solely by job destruction which is not consistent with reality. In reality, and in the workhorse Pissarides (2000) model, the pool of unemployed in any period consists of workers who fail to match and those whose jobs have been terminated. To capture this additional source of unemployment, 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 domestic labor can be easily substituted by offshored inputs, offshoring increases unemployment by increasing job destruction as well as reducing job creation. The latter happens through a reduction in the market tightness.

Looking at policies in the extended model, since severance payments are targeted towards fired workers, they cannot be used to insure workers who fail to match. However, unemployment benefits can be used to insure unmatched workers. In this setting, a policy that uses a combination of severance payments and unemployment benefits is a better tool for insuring workers than just unemployment benefits. That is, severance payments can complement unemployment benefits when unemployment is caused by both job destruction and matching frictions.

1.1 Related Literature

While much work in labor/macro economics focuses on the administrative cost aspect of employment protection, Pissarides (2001) constructs a model to highlight the insurance motive for severance payments. In his setting, firms can provide insurance to workers through severance payments. Essentially,
firms reduce the wages of employed workers and make a payment to them when the workers are fired. Now, if firms can do this, then there won’t be a need for government intervention. However, there are reasons why firms may not be willing or able to offer insurance through severance payments. One possible reason is wage rigidity as highlighted in a model by Garibaldi and Violante (2005). 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, severance payments rely on a contract that a firm has to enter into with the workers whereby workers agree to a lower wage so that they can get severance payments when they are fired. However, a firm may renegade on its severance payments obligations later. In this case, a worker may be forced to take the defaulting firm to the court. Getting the contract enforced may be costly for an individual worker. A legislation requiring severance payments may be easier to enforce than an individual contract.

There is a large literature on globalization and labor markets using search models of unemployment. While much of this literature uses a dynamic framework, Keuschnigg and Ribi (2009) and Helpman and Itskhoki (2010) showed that the key insights can be as easily generated using a static framework, which is the approach taken in the present paper as well. Helpman and Itskhoki (2010) also provide an extension where they study the role of firing cost in a setting where firms fire an exogenous fraction of matched workers. This extension is closer to our set up, however, in our case the fraction fired is endogenous. Also, since workers are risk neutral in Helpman and Itskhoki (2010), firing cost does not have the insurance role which is a key feature of our model.

Our production structure with heterogeneous match specific productivity of workers is 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 aim is to derive policy implications when the cost of offshoring decreases, we create a simpler framework with homogeneous firms where the match specific productivities are observed costlessly and firms retain only workers above the pre-announced level of productivity and all the retained workers are paid the same wage. Given our aim to study offshoring, our production function also includes an input which is offshored, and domestic labor and offshored inputs are combined using a CES production function.
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, 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 aggregate welfare. However, they do not discuss the role of social protection in protecting workers.

Among other related papers, Brander and Spencer (1994), Feenstra and Lewis (1994), and Davidson and Matusz (2006) study various policies to compensate the workers who lose from trade. However, workers are risk neutral in these papers. Closer to our approach is the paper by Brecher and Chaudhuri (1994) which examines the issue of Pareto superiority of free trade over autarky through Dixit-Norman compensation schemes when there is unemployment in the economy caused by efficiency wage considerations and unemployed workers get an 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.

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 offshoring in a model with search frictions and risk averse workers. Our model differs from their model in several respects. While they assume domestic labor and offshored inputs to be perfect substitutes, we work with a CES production function which allows us to study cases when offshored inputs are complementary to domestic labor as in the seminal paper by Grossman and Rossi-Hansberg (2008) where this raises the possibility of wages increasing for workers whose jobs are offshored. In fact, we get a cutoff value of the elasticity of substitution parameter such that if the elasticity of substitution is higher than the cutoff then the workers are hurt by offshoring, but gain otherwise. Additionally, while in Keuschnigg and Ribi (2009) unemployment arises solely because some workers are unmatched, in our baseline model unemploy-
ment arises solely from the firing of workers while in the extension unemployment arises due to both matching frictions and endogenous job destruction. As well, while Keuschnigg and Ribi (2009) focus on unemployment benefits, we focus on employment protection policies as an alternative way to provide social protection, and in this sense the two papers are complementary. More substantively, 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 unmatched workers, a policy that combines severance payments and unemployment benefits can be superior to unemployment benefits only.

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 concluding remarks.

2 The Model

The production function is given by

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

(1)

where \( L^e \) is the domestic labor in efficiency units and \( M \) denotes foreign produced inputs. \( \sigma \) captures the elasticity of substitution between domestic labor and foreign produced inputs and \( \gamma \) captures the diminishing returns and is useful in making the firm size determinate. Also, there is a continuum of domestic firms of unit mass so there is no distinction between a firm level variable and an economy level variable.

Workers are identical \textit{ex ante} but their match specific productivity, denoted by \( \lambda \), is drawn from a distribution \( G(\lambda) \). 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. There are two costs of firing workers: \( f_t \) is the administrative cost while \( f_w \) is the mandated severance payment that goes to fired workers. If firms use a cutoff rule whereby they retain workers with productivity above \( \lambda_c \) and fire others, then the average productivity of retained workers is

\[ \overline{\lambda} \equiv \frac{1}{1 - G(\lambda_c)} \int_{\lambda_c}^{\infty} \lambda dG(\lambda) \]  

(2)
If they hire $L_h$ workers then they retain $(1 - G(\lambda_c)) L_h$ of them, and hence the amount of labor in efficiency units that is used in production is

$$L^e = \bar{\lambda} (1 - G(\lambda_c)) L_h = \bar{\lambda} L,$$

where $L$ is the number of workers retained by the firm. 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.

Denote the aggregate profit of firms by $\Pi$. The total number of workers in the economy is denoted by $\bar{L}$. A fraction $t \in [0, 1]$ of the profits could go to workers where $t$ could either be based on their ownership of firms or it could be an instrument of redistributive taxation by the government. Therefore, each worker has a possible non-wage income given by

$$\pi = \frac{t\Pi}{\bar{L}}$$

In the benchmark case we are going to assume $t = 0$, that is, workers do not get any share of profits and hence $\pi = 0$. Later while discussing policy we will discuss the case of $t > 0$.

Workers are risk averse. Their utility function is given by

$$U(x); \ U' > 0, U'' < 0$$

where $x$ is their income in a particular state: employed or unemployed. 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 $x = w + \pi$, where $w$ is the wage and $\pi$ is their share of profits, while the income when they are fired is $x = f_w + z + \pi$ where $z$ is the value of leisure/home production, and $f_w$ is the severance payment.

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 $\lambda_{ci}$. Workers direct their applications to the firm whose $(w_i, \lambda_{ci})$ pair gives them the highest expected utility. Suppose $W$ is the highest utility that a worker can expect from a job at another firm. Now, in order to attract workers, $(w_i, \lambda_{ci})$ must satisfy

$$(1 - G(\lambda_{ci}))U(w_i + \pi) + G(\lambda_{ci})U(f_w + z + \pi) \geq W$$

Effectively, for any firing rate that the firm posts, (6) determines the wage that the firm has to offer.\(^3\) If a firm wants to raise the average productivity of its workforce by being more selective (higher $\lambda_{ci}$) then

\(^3\) Note that this way of modeling labor market is similar in spirit to the competitive search framework of Moen (1997)
it will have to offer higher wages. Even though looking at (6) one gets the impression that firms can choose different pairs of \((w, \lambda_c)\) to satisfy (6), it can be shown from the firm’s maximization exercise that all firms end up posting the same wage rate \(^4\). Therefore, in the analysis below we drop the firm subscript \(i\).

Given the above description of the model, one can raise the question that why don’t the firm and the worker renegotiate wages once the match specific productivity is realized as happens in the standard Mortensen-Pissarides (1994) set up after the realization of a shock. One way to justify our set up would be to assume that firms get a noisy signal of a worker’s match specific productivity as in Helpman, Itskhoki, and Redding (2010). That is, if a firm chooses a cutoff \(\lambda_c\), it only knows whether the worker’s productivity is above \(\lambda_c\) or below \(\lambda_c\). In Helpman, Itskhoki, and Redding (2010) if firms incur a screening cost of \(c(\lambda_c)\) they learn whether the worker’s productivity is above \(\lambda_c\) or below \(\lambda_c\), where \(c'(\lambda_c) > 0\). Since their aim is to derive wage heterogeneity in a model with firm heterogeneity, this is an essential component of their model. We work with a representative firm model, and since there are already costs associated with firing workers discussed above, the introduction of screening cost just adds to those costs and does not change our qualitative results. Therefore, our set up can be thought of as one where \(c(\lambda_c) = 0\).

Denote the per unit price of the imported/offshored input by \(\phi\). Now, firms perform the following profit maximization exercise.

\[
\max_{L,M,w,\lambda_c} \left\{ A\left(\bar{L}^{\alpha L} \frac{w}{\bar{w}} + M^{\alpha M} \frac{w}{\bar{w}}\right)^{\frac{\alpha}{\alpha - 1}} - wL - \frac{G(\lambda_c)}{1 - G(\lambda_c)} (f_w + f_t) L - \phi M \right\}
\]

subject to the constraint

\[
(1 - G(\lambda_c))U(w + \pi) + G(\lambda_c)U(f_w + z + \pi) \geq W \tag{7}
\]

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 \((w_i, \lambda_{ci})\) to ensure that the worker gets a utility of \(W\).

\[^4\text{This can be accomplished by noting that the wage rate can be expressed as a function of } W \text{ and } \lambda_c \text{ in the firm’s maximization exercise. Since each firm takes } W \text{ as given, it ends up choosing the same } \lambda_c, \text{ which implies the same wage rate.}\]
Using $\phi$ to denote the Lagrangian multiplier on the constraint above, the first order conditions for the above maximization are given by

$$
L : \quad \gamma A((\bar{\lambda}L)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma-1}{\sigma-1}} - \frac{1}{\sigma-1} L^{\frac{\sigma-1}{\sigma-1}} = w + \frac{G(\lambda_c)}{1 - G(\lambda_c)} (f_w + f_t) 
$$

(8)

$$
M : \quad \gamma A((\bar{\lambda}L)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma-1}{\sigma-1}} - \frac{1}{\sigma-1} M^{\frac{\sigma-1}{\sigma-1}} = \phi 
$$

(9)

$$
w : \quad -L + g(1 - G(\lambda_c))U'(w + \pi) = 0 
$$

(10)

$$
\lambda_c : \quad \frac{\gamma A (\bar{\lambda} - \lambda_c)}{1 - G(\lambda_c)} (\bar{\lambda}L)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma-1}{\sigma-1}} - \frac{1}{\sigma-1} \bar{\lambda}^{\frac{\sigma-1}{\sigma-1}} L^{\frac{\sigma-1}{\sigma-1}} = \frac{(f_w + f_t) L}{(1 - G(\lambda_c))^2} + gU((w + \pi) - U(f_w + z + \pi)) 
$$

(11)

Intuitively, the l.h.s of (8) is the marginal product of an additional retained worker while the r.h.s is the expected cost of a retained worker: wage plus the separation cost (for each retained worker the firm hires $\frac{1}{1-G(\lambda_c)}$ workers, a fraction $G(\lambda_c)$ of whom is fired resulting in a separation cost of $\frac{G(\lambda_c)}{1-G(\lambda_c)} (f_w + f_t)$).

Similarly, the l.h.s of (11) is the benefit of a higher $\lambda_c$, which for a given $L$ results in higher average productivity of these workers. The r.h.s is the cost of a higher $\lambda_c$ resulting from greater separation cost paid to workers who are not retained (for each retained worker, the number fired is $\frac{G(\lambda_c)}{1-G(\lambda_c)}$; an increase in $\lambda_c$ increases the number of workers fired per retained worker by $\frac{g(\lambda_c)}{(1-G(\lambda_c))^2}$) and higher wages to satisfy the wage constraint because the probability of getting fired is higher which must be offset by a higher wage. The last component 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. Also, while $f_w$ and $f_t$ affect the cost of an extra retained worker symmetrically, they have different effects on the determination of $\lambda_c$. While an increase in $f_t$ makes going for higher $\lambda_c$ more expensive, an increase in $f_w$ has two opposing effects: The separation cost paid by the firms increases but the reservation wage constraint is relaxed. The latter arises due to the insurance role of severance payments and therefore is stronger the more risk averse the worker.

Since all workers are matched, the number employed simply equals the number fired and therefore, the aggregate labor market equilibrium condition is given by

$$
L = \bar{L}(1 - G(\lambda_c)) 
$$

(12)

Upon using (12) the expression for aggregate profits is given by

$$
\Pi = A((\bar{\lambda}(1 - G(\lambda_c))\bar{L})^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma-1}{\sigma-1}} - w(1 - G(\lambda_c))\bar{L} - G(\lambda_c) (f_w + f_t) \bar{L} - \phi M. 
$$

(13)
Therefore, $\pi$ is given by

$$\pi = t \frac{A((\bar{x}(1 - G(\lambda_c))L)^{\frac{1}{\lambda - \lambda_c}} + M^{\frac{1}{\lambda - \lambda_c}} - w(1 - G(\lambda_c))L - G(\lambda_c) (f_w + f_t) L - \phi M}{L}.$$  \hspace{1cm} (14)

The 6 equations (8)-(11), (12) and (14) determine $w, L, M, \lambda_c, \varrho$ and $\pi$.

It is shown in the appendix that using (8)-(11) and (12) we can obtain the following two key equations in $w$ and $\lambda_c$ which are useful for proving the existence of equilibrium as well as comparative statics.

$$w = \left( \frac{\bar{x}}{\lambda - \lambda_c} - G(\lambda_c) \right) \frac{(f_w + f_t)}{1 - G(\lambda_c)} + \frac{\bar{x}}{\lambda - \lambda_c} \psi$$  \hspace{1cm} (15)

$$\gamma A(1 + \omega^{\sigma - 1} \bar{x}^{-(\sigma - 1)} \frac{G(\lambda_c)}{\lambda - \lambda_c}) \gamma^{-1} (\bar{x}(1 - G(\lambda_c)))^\gamma = w (1 - G(\lambda_c)) + G(\lambda_c) (f_w + f_t)$$  \hspace{1cm} (16)

where we use the following compact notation.

$$\psi \equiv \frac{U(w + \pi) - U(f_w + z + \pi)}{U'(w + \pi)}; \quad \omega \equiv \frac{w + \frac{G(\lambda_c)}{1 - G(\lambda_c)} (f_w + f_t)}{\phi}$$

In rest of the paper we make the following two functional form assumptions for analytical tractability.

Assumption 1: $G(\lambda)$ is Uniformly distributed over $[0, 1]$.

This is a standard distributional assumption in the literature on endogenous job destruction (e.g. Mortensen and Pissarides (1994)).

Assumption 2: Utility function $U(x)$ is of CRRA type, that is $\rho \equiv -x \frac{t''(x)}{U'(x)}$ is constant.

The existence of equilibrium for the baseline case of $t = 0$ is proved in the appendix. In the analysis below the default is the $t = 0$ case unless indicated otherwise.

### 3 Offshoring, Unemployment and Welfare

Now we are ready to analyze the impact of offshoring on the labor market, the welfare of workers, and aggregate welfare. The impact of offshoring is going to be captured by a decrease in the cost of offshored inputs, $\phi$. The following proposition is easily proved in the appendix.

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5 All the analytical and numerical results in the paper have been derived for Pareto distribution as well. They are available upon request.
**Proposition 1:** 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 \( \phi \) 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. As firms reduce their demand for domestic labor, the expected reward of labor, \( W \), decreases. This decrease in \( W \) allows firms to raise \( \lambda_c \). More mechanically, at the aggregate level the amount of labor employed in efficiency units is \( L^e = \frac{(1-\lambda^2_c)}{2} L \). Therefore, the only way the amount of labor employed in efficiency units can decrease is through an increase in \( \lambda_c \).

The measure of welfare of workers is simply \( W \) which for uniform distribution of \( \lambda \) can be written as

\[
W = (1 - \lambda_c)U(w + \pi) + \lambda_c U(f_w + z + \pi).
\] (17)

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

\[
SW = \Pi + \bar{L} W
\]

The expressions for the impact of offshoring on the welfare of workers and aggregate welfare for the case of \( t = 0 \) (derived in the appendix) are given by

\[
\frac{dW}{d\phi} = U'(w) \left( (1 - \lambda_c) \frac{dw}{d\phi} - \psi \frac{d\lambda_c}{d\phi} \right)
\] (18)

\[
\frac{d\Pi}{d\phi} + L \frac{dW}{d\phi} = (U'(w) - 1)\bar{L} \left( (1 - \lambda_c) \frac{dw}{d\phi} - \psi \frac{d\lambda_c}{d\phi} \right) - M
\] (19)

Before discussing the welfare implications of offshoring further for the case of risk averse workers, it is useful to note the results for the case of risk neutral workers: \( U(w) = w \). The following result is easily verified from (18), (19), and proposition 1.

**Proposition 2:** When workers 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 aggregate welfare.

The result above shows that if there are no distortions in the economy arising from either the risk aversion of workers or redistributive considerations, then 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 workers, there are two relevant cases for the welfare implications of offshoring.

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 increases the welfare of workers as well as aggregate welfare as long as \( U'(w) > 1 \). In addition to the direct productivity enhancing benefits of offshoring, it interacts with the two distortions present in a positive way. If \( U'(w) > 1 \), then a shift of income in favor of workers is welfare improving. Therefore, offshoring induced rise in wage and decline in \( \lambda_c \) shifts income away from profits towards workers. This redistributive effect is welfare improving because workers are poorer than profit owners (\( U'(w) > 1 \)). Offshoring also increases the welfare of risk averse workers by mitigating the risk through a decrease in \( \lambda_c \).

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

Since \( U'(w) > 1 \), the redistribution of income away from workers and towards profits is welfare reducing. Also, the offshoring induced increase in \( \lambda_c \) is bad for workers because the probability of low income state is rising. This effect is stronger the more risk averse the worker. If the insurance market was complete, this adverse effect through a rise in \( \lambda_c \) would be absent.

The profits increase unambiguously. Therefore, the impact on aggregate welfare is theoretically ambiguous. Numerical simulations reveal that when the degree of risk aversion is high, aggregate 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 \( \rho \) is the coefficient of risk aversion. In figure 1 \( \rho = 1.5 \) (low risk aversion) and in figure 2 \( \rho = 3 \) (high risk aversion). In both cases as the cost of offshoring decreases unemployment (\( \lambda_c \)) 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 aggregate welfare. While in panel 1d aggregate welfare increases when the degree of risk aversion is low, in panel 2d aggregate welfare decreases with a higher degree of risk aversion.\(^6\)

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 are summarized in the proposition below.

\(^6\)In all figures the numbers for welfare are negative. The negative sign is not obvious in the figures because of the conversion from powerpoint to pdf.
Proposition 3: When $\sigma < \frac{1}{1-\gamma}$, offshoring reduces unemployment and increases wages, thereby, increasing the welfare of workers as well as the aggregate welfare. When $\sigma > \frac{1}{1-\gamma}$, not only does the welfare of workers decrease but the aggregate 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 3 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 aggregate welfare when $\sigma > \frac{1}{1-\gamma}$, our discussion of various policies below focuses on this case.

3.1 Change in the administrative cost of firing

The first policy that we consider is the change in the administrative cost of firing. Since offshoring increases unemployment in the relevant case ($\sigma > \frac{1}{1-\gamma}$), it is tempting to argue that an increase in the administrative cost of firing can increase the welfare of workers by reducing unemployment. We show below that even though an increase in $f_t$ is likely to reduce unemployment, it ends up reducing the welfare of workers. The following lemma summarizes the impact of offshoring on wages and unemployment.

Lemma 1: An increase in $f_t$ reduces wages and is likely to reduce unemployment for reasonable parameter values.

Intuitively, at the firm level an increase in $f_t$ induces firms to lower the productivity cutoff because firing workers is costlier. For a given $W$, if they go for lower $\lambda_c$ they can satisfy the worker’s outside option constraint with a lower $w$. Therefore, at the firm level, for a given $W$, there is a decrease in $w$ and $\lambda_c$. As firms reduce $\lambda_c$, the amount of labor employed by firms increases which puts a downward pressure on the reward of labor reflected in $W$. The decrease in $W$ has a feedback effect on the firms’ choices of $w$ and $\lambda_c$. A lower $W$ implies that firms can satisfy the constraint with a higher $\lambda_c$ or a lower $w$. Therefore, the feedback effect on $w$ is in the same direction as the original effect of an increase in $f_t$, however, the feedback effect on $\lambda_c$ is in the opposite direction, creating the theoretical ambiguity.

For reasonable parameter values\(^7\) the direct effect on $\lambda_c$ dominates the feedback general equilibrium effect, leading to a decrease in $\lambda_c$. A lower $\lambda_c$ implies less job destruction and lower unemployment at

\(^7\)A sufficient condition for $\lambda_c$ to be decreasing in $f_t$ is $\rho < \frac{1+\lambda_c}{\lambda_c}$. 

15
the aggregate level. That is, in the equilibrium with higher firing costs the amount of labor employed by firms increases.

The impact of a change \( f_t \) on the welfare of workers is given by

\[
\frac{dW}{df_t} = (1 - \lambda_c)U'(w)\frac{dw}{df_t} - (U(w) - U(f_w + z))\frac{d\lambda_c}{df_t}
\]

Lemma 1 implies that the impact of an increase in \( f_t \) on the welfare of workers is ambiguous because workers gain from a lower \( \lambda_c \) but lose from a lower wage. However, a little bit of algebra shows that the wage effect always dominates and therefore, an increase in \( f_t \) reduces the welfare of workers. This gives us an important result.

**Proposition 4:** An increase in the administrative cost of firing decreases wages and is likely to decrease unemployment by reducing job destruction. However, it unambiguously reduces the welfare of workers.

With risk averse workers, the level of firing is sub-optimal in our set up. Increased administrative burden of firing makes it costlier for firms to fire, therefore, it worsens the existing distortion and ends up making the workers worse off. That is, this is a policy which is going to hurt the intended beneficiaries. Therefore, greater administrative burden of firing cannot be used to shield workers from the adverse consequences of offshoring.

### 3.2 Change in Severance Payments

Before studying the impact of a change in \( f_w \) when workers are risk averse, it is useful to study the impact of a change in \( f_w \) when workers are risk neutral. The following lemma is easily proved in the appendix.

**Lemma 2:** When workers are risk neutral, an increase in severance payments has no impact on unemployment. Firms adjust wages by an amount that leaves the welfare of workers as well as profits unchanged.

The above neutrality result of severance payments in the risk neutral worker case is important in understanding its role in providing insurance and distinguishing it from unemployment benefits. Intuitively, in the absence of insurance needs for risk neutral workers, severance payments just make firing more costly for firms, which the firms offset by lowering wages, thereby leaving the rate of firing and worker welfare unchanged.
Moving to the case of risk averse workers, we obtain the following results on the impact of a change in $f_w$.

**Lemma 3**: *When workers are risk averse, an increase in severance payments increases job destruction ($\lambda_c$) but has a non-monotonic effect on wages.*

When workers are risk averse and the market for insurance against labor income risk is missing, it is costly for firms to fire workers. Since severance payments provide insurance to workers, it allows firms to go for higher quality workers by choosing a higher $\lambda_c$. The impact on wages is theoretically ambiguous but numerical simulations reveal the following pattern. Starting from no severance payments, an increase in severance payments increases wages initially, but beyond a point wages start decreasing. The reason is the general equilibrium effect of an increase in $\lambda_c$ induced by the increase in $f_w$. The lower employment of workers at the aggregate level implies higher $W$ given diminishing returns to labor. The higher $W$, in turn, requires higher wages when $f_w$ is low, but at higher levels of $f_w$ firms can afford to pay lower wages and still meet the reservation utility of workers. In all cases, however, the welfare of workers, $W$, increases. It is this feature of severance payments that makes it a candidate for a policy to protect workers against the possible adverse effects of offshoring.

### 3.2.1 Severance payments in response to offshoring

Suppose the level of severance payments is sub-optimal to begin with. The question is can an increase in severance payments allow offshoring to increase aggregate welfare without reducing the welfare of workers. That is, can severance payments be used to soften the blow of offshoring on workers without causing aggregate welfare losses.

From (17) note that the change in the welfare of workers in response to offshoring and change in severance payments is

$$dW = (1 - \lambda_c)U'(w)dw + \lambda_c U'(f_w + z)df_w - (U(w) - U(f_w + z))d\lambda_c$$

(20)

Since at $df_w = 0$ offshoring causes a decrease in welfare (when $\sigma > \frac{1}{1-\gamma}$), to compensate the losses of workers we must have $df_w > 0$. The level of $f_w$ that keeps the worker welfare unchanged in response to an offshoring shock is obtained by setting $dW = 0$ above and is given by

$$df_w = \frac{1}{\lambda_c(1 + \rho\varphi)}(\psi d\lambda - (1 - \lambda_c)dw)$$

(21)
where $\psi = \frac{U'(w)-U'(f_w+z)}{U'(w)}$ since $\pi = 0$ and using linear approximation $\frac{U'(f_w+z)}{U'(w)} \approx (1 + \rho \varphi)$ where

$$\varphi \equiv \frac{w-z-f_w}{w}.$$

What is the impact of this change in $f_w$ on profits? From the expression for change in profits derived in the appendix, note that

$$d\Pi = L(\psi d\lambda - (1 - \lambda_c)dw) - \lambda_c L df_w - M d\phi$$

(22)

Using (21) in (22) we get

$$d\Pi = \lambda \rho \varphi L df_w - M d\phi$$

(23)

Since $df_w > 0$, the compensating change in $f_w$ in response to a decrease in $\phi$ increases profits. That is, a compensating increase in severance payments leaves profits higher than before the change in $\phi$. Therefore, the aggregate welfare ($\Pi + LW$) is higher as well. This gives us the following result.

**Proposition 5:** When offshoring causes welfare losses for workers ($\sigma > \frac{1}{1+\rho}$) an increase in severance payments that keeps the welfare of workers unchanged allows the profits to be higher than the pre-offshoring profits.

The above result is also verified numerically. An example is included in figure 3 which is constructed for the case of $\rho = 3$. As shown in figure 2d, a decrease in the offshoring cost leads to a decrease in aggregate welfare in this case. Figure 3 is constructed by setting $f_w$ such that the welfare of workers is held constant at the initial value of $\phi = 1.5$. Again, a reduction in offshoring cost increases unemployment as shown in figure 3a. Figure 3b shows that the level of severance payments required to keep the welfare of workers constant increases as $\phi$ decreases. Figure 3c shows that the profits still increase as $\phi$ decreases, and most importantly, figure 3d shows that the aggregate welfare increases as $\phi$ decreases. This should be contrasted with figure 2d where the aggregate welfare decreases as $\phi$ decreases.

Therefore, an increase in severance payments offsets the losses of workers from offshoring without making profit owners worse off. This obviously leads to an increase in aggregate welfare. Therefore, if severance payments are sub-optimal to begin with, an increase in severance payments is a way to redistribute some of the gains of offshoring to workers when they lose from it.
3.3 Optimal Severance payment and offshoring

We are going to talk about the role of redistribution in this section, therefore, we derive results for \( t \geq 0 \) and consequently, \( \pi \geq 0 \).

Since workers are risk averse while profit owners are risk neutral, the optimal severance payment in the model (both from the worker’s point of view and the aggregate welfare point of view) is full insurance for any given level of offshoring cost \( \phi \). The following lemma is proved formally in the appendix.

**Lemma 4**: For all \( t \in [0, 1] \), the level of severance payments that maximizes the welfare of workers as well as aggregate welfare is full insurance given by \( f_w = w - z \).

Recall that proposition 1 was proved for the case of \( t = 0 \). We could not prove it analytically for \( t > 0 \). However, when \( \sigma > \frac{1}{1-\gamma} \), we can prove the following useful lemma.

**Lemma 5**: For all \( t \in [0, 1] \), \( \frac{dw}{d\phi} > 0 \) when \( \sigma > \frac{1}{1-\gamma} \).

That is, irrespective of the level of \( t \), a decrease in the cost of offshoring reduces wages when offshored inputs can be easily substituted for domestic workers.

Now, the impact of offshoring on the welfare of workers when severance payments are optimally chosen is given by (shown in appendix)

\[
\frac{dW}{d\phi} = U'(w + \pi) \left( (1 - t) (1 - \lambda_c) \frac{\partial w}{\partial \phi} - t \frac{M}{L} \right)
\]

where \( \frac{\partial w}{\partial \phi} \) is the change in wage with respect to change \( \phi \) holding severance payments constant.\(^8\) It follows from lemma 5 that \( \frac{dW}{d\phi} > 0 \) for \( t = 0 \) and \( \sigma > \frac{1}{1-\gamma} \). That is, if workers do not get any share of profits, then offshoring reduces their welfare in the relevant case even if severance payments are chosen to maximize their welfare.

The impact of offshoring on aggregate welfare in the presence of optimal severance payments is given by

\[
(1 - t) \frac{d\Pi}{d\phi} + L \frac{dW}{d\phi} = (U'(w + \pi) - 1) L (1 - t)(1 - \lambda_c) \frac{\partial w}{\partial \phi} - M (1 + t (U'(w + \pi) - 1))
\]

Therefore, when \( t = 0 \) and \( U'(w + \pi) > 1 \), offshoring can reduce aggregate welfare as well. This gives us the following result.

---

\(^8\)We are using partial derivative here because \( f_w \) is an endogenous variable in the present case. Therefore, \( \frac{dw}{d\phi} = \frac{\partial w}{\partial \phi} + \frac{\partial w}{\partial f_w} \frac{df_w}{d\phi} \), and \( \frac{\partial w}{\partial \phi} \) is same as \( \frac{dw}{d\phi} \) in lemma 5 because lemma 5 was derived for the case of exogenous \( f_w \).
**Proposition 6:** When $\sigma > \frac{1}{1-\gamma}$, even when severance payments are optimally chosen, offshoring reduces the welfare of workers and can reduce aggregate welfare as well. The aggregate welfare loss in this case arises purely because of the adverse distributional effects of offshoring.

The reason that even in the presence of socially optimal severance payments, offshoring does not necessarily improve welfare is because the economy has two distortions. While the optimal severance payment addresses the distortion arising from lack of insurance, it cannot address the distortion arising from distributional issues.

To clearly see the role of redistribution, note from (24) that if all profits are redistributed to workers ($t = 1$), then offshoring is necessarily welfare improving in the presence of optimal severance payments.

In fact, we don’t need all profits to be distributed to workers. From (24) verify that there exists a level of $t_w$ such that if $t > t_w$, then workers gain from offshoring in the presence of optimal severance payment. The level of $t_w$ is given by

$$t_w = \frac{(1 - \lambda_c) \frac{\partial w}{\partial \phi}}{(1 - \lambda_c) \frac{\partial w}{\partial \phi} + \frac{M}{T}} \in (0, 1) \quad (26)$$

As well, verify from (25) that there exists a $t_{sw}$ such that if $t > t_{sw}$, then offshoring increases aggregate welfare where

$$t_{sw} = \frac{(1 - \lambda_c) \frac{\partial w}{\partial \phi} - \frac{M}{T(U'(w+\pi)-1)}}{(1 - \lambda_c) \frac{\partial w}{\partial \phi} + \frac{M}{T}} \quad (27)$$

Visual inspection of (26) and (27) suggests that $t_w > t_{sw}$; however, the r.h.s in both the expressions also depends on the level of $t$. Therefore, we cannot claim that $t_w > t_{sw}$. However, we verify numerically that indeed $t_w > t_{sw}$. That is, the share of profits going to workers that makes offshoring aggregate welfare improving is smaller than the one that makes offshoring worker welfare improving.

A sufficiently high $t$ alleviates the welfare loss from inequality in the distribution of income, and therefore ensures that offshoring is welfare improving. The results above were derived for the case of $\sigma > \frac{1}{1-\gamma}$ in which case $\frac{\partial w}{\partial \phi} > 0$. It is easy to verify from (24) and (25) that if $\frac{\partial w}{\partial \phi} < 0$ then $\frac{dW}{d\phi} < 0$ and $(1 - t) \frac{dW}{d\phi} + T \frac{dW}{d\phi} < 0$ irrespective of the value of $t$. Therefore, the results are true for any $\sigma$ and are summarized below.

**Proposition 7:** When severance payments are optimally chosen and workers get a sufficiently large share of profits, offshoring improves workers’ welfare and aggregate welfare irrespective of the elasticity of substitution between domestic workers and offshored inputs.
3.4 Other Policies

3.4.1 Unemployment benefits

While we have focused on severance payments in this paper which are paid by firms, it is also possible to insure workers against labor market risk through publicly provided unemployment benefits. Countries use different methods to fund unemployment benefits. In most cases it is funded by contributions from both employers and employees with some exceptions. In Iceland, Italy and the U.S. only employers contribute while in Luxembourg only employees contribute. Below we discuss two alternative cases depending on the financing of unemployment benefits.

Case I: unemployment benefits financed by a tax on firms

Suppose unemployment benefits are financed by a tax on employers, as is the case in the U.S. Suppose the unemployment benefits are set at $b$ per worker, and the government requires firms to contribute exactly $b$ per worker fired by the firm. Then the unemployment benefit of this kind is exactly like the severance payment in our model. However, in practice, the amount that firms contribute in the U.S. is only imperfectly related to the number of workers they fire in which case they are not going to fully internalize the cost of firing. Also, the experience rating based funding of unemployment benefits in the U.S. is an exception rather than the rule.

Case II: unemployment benefits financed by a tax on workers

The tax on workers could either be a lump sum tax paid by both employed and unemployed workers as in Acemoglu and Shimer (1999) or it could be a payroll tax on only employed workers as in Keuschnigg and Ribi (2009). In the former case, the constraint facing the firms is given by

$$ (1 - \lambda_c)U(w - \tau) + \lambda_c U(b + z - \tau) \geq W $$

where $\tau = \lambda_c b$ is the balanced budget condition. In the latter case, the constraint facing firms is given by

$$ (1 - \lambda_c)U(w - \tau) + \lambda_c U(b + z) \geq W $$

where $\tau = \frac{\lambda_c}{1 - \lambda_c} b$.

The key equations for the determination of key endogenous variables are given in the appendix. It is also verified from the key equations that when unemployment benefits are chosen optimally, the equilibrium labor market outcomes are independent of the mode of funding unemployment benefits.
Given this, in the comparison of severance payments with unemployment benefits, we focus on the case where unemployment benefits are paid by a payroll tax as in Keuschnigg and Ribi (2009).

It is clear that both unemployment benefits and severance payments can be used to insure workers against labor market risk. The question is which policy is better. We attempt to answer this by comparing aggregate welfare under optimal unemployment benefits and optimal severance payments. Since deriving analytical result is hard, we provide numerical examples.

Figure 4 is constructed to compare the outcomes for aggregate welfare maximizing unemployment benefits with optimal severance payments. Figure 4a shows that unemployment is higher under unemployment benefits (red line) than under severance payments (black line). In figure 4b the vertical axis is the ratio of the consumption in unemployment state to the consumption in employment state. There is full insurance under severance payments as shown in the ratio of 1 by the black line. The red line showing the ratio for unemployment benefits is always less than one showing incomplete insurance. Figures 4c and 4d show the worker welfare and the aggregate welfare, respectively. The black line for severance payments is always above the red line for unemployment benefits in both figures. That is, both the worker welfare and the aggregate welfare are higher with optimal severance payments than with optimal unemployment benefits.

Intuitively, both unemployment benefits and severance payments reduce the cost of firing workers for firms leading to greater firing in both cases. However, in the case of severance payments, the cost is borne by the firm itself, while in the case of unemployment insurance workers are bearing the cost (an individual firm treats $\tau$ and $b$ in (28) and (29) as given). As a result, there is greater firing in the case of unemployment insurance which leads to lower welfare. More generally, since workers are risk averse while firms are risk neutral, the optimal risk sharing arrangement involves firms bearing the risk. Severance payments allow firms to bear the risk while unemployment insurance makes workers bear the risk. Therefore, the former yields greater aggregate welfare than the latter.

Therefore, if unemployment is caused by job destruction, then severance payments can be a better tool for insuring workers than unemployment insurance. Note, however, that severance payments cannot be used to insure workers when unemployment is caused by the failure of a worker to match. In the next section we extend the model to include matching frictions and let unemployment be determined by both endogenous job destruction and matching frictions. In this case there is a role for both severance payments and unemployment benefits.
4 Extension With Search Frictions

Suppose that 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 $\mu \theta^{\delta-1}$, where $0 < \delta < 1$ and $\theta$ 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 $\lambda_c$, it fires $(1 - \lambda_c)$ 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. The firm’s maximization problem is given by

$$
\max_{L, M, \lambda_c, \theta} \left\{ A\left(\frac{1 + \lambda_c}{2}L\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} - wL - \frac{\lambda_c}{1 - \lambda_c} (f_w + f_t) L - \phi M - \frac{c}{\mu \theta^{\delta-1}} \frac{L}{(1 - \lambda_c)} \right\}
$$

subject to the constraint

$$
\mu \theta^{\delta} \left( (1 - \lambda_c)U(w) + \lambda U(f_w + z) \right) + \left( 1 - \mu \theta^{\delta} \right) U(z) \geq W \tag{30}
$$

The aggregate labor market constraint is given by

$$
L = \mu \theta^{\delta}(1 - \lambda_c)\bar{L}
$$

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

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

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

The key equations for this case are derived in the appendix. The key difference in the results is that now offshoring affects unemployment and welfare through both job creation and job destruction. That is, in addition to changing $\lambda_c$, offshoring also affects $\theta$. Figures 5 and 6 illustrate the impact of offshoring for the case of high elasticity of substitution between domestic labor and offshored inputs.
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 5b and 6b) 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 market tightness (figures 5a and 6a). 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 aggregate welfare is different. Similar to figures 1d and 2d, aggregate welfare increases when the degree of risk aversion is low (figure 5f) but decreases when the degree of risk aversion is high (figure 6f).

For the sake of completeness we also verify in figure 7 that when the elasticity of substitution is low \((\sigma < \frac{1}{1-\gamma})\), offshoring reduces unemployment and increases worker welfare even in the presence of matching frictions. Figures 7a and 7c show a positive relationship between the cost of offshoring and unemployment for \(\rho = 1.5\) and \(\rho = 3\), respectively. Figures 7b and 7d show that the welfare of workers increases as the cost of offshoring decreases.

Looking at policies, the first thing to note is that workers find themselves in one of three states now: matched and fired, matched and employed, and unmatched. Since severance payments are not paid to unmatched workers, they cannot insure them when workers fail to match. One way to insure them in this case is via unemployment benefits. With this in mind we first explore the analogue of proposition 5 for the extended model with matching frictions. In particular, we find a level of severance payments and unemployment benefits of equal amount (the latter financed by a payroll tax) that keeps the welfare of workers unchanged at the initial level of offshoring cost. Recall from figure 6f that (for \(\rho = 3\) and \(\sigma > \frac{1}{1-\gamma}\)) in the absence of any intervention, aggregate welfare decreases as offshoring cost decreases. Figure 8 shows that an intervention (a combination of unemployment benefits and severance payments) that keeps the welfare of workers unchanged leads to an increase in aggregate welfare as offshoring cost decreases. Figure 8a shows that a reduction in offshoring cost requires an increase in severance payments (and unemployment benefits) to keep the welfare of workers constant. Figure 8b shows that unemployment increases (due to both increased job destruction and reduced job creation). Figure 8c shows that profits increase despite the policy intervention and figure 8d shows an increase in aggregate welfare. Therefore, severance payments can shield workers from the adverse consequences of
offshoring even in the presence of search frictions.

Just as we derived optimal severance payments and unemployment benefits in the baseline model, we can do the same in the presence of search frictions and compare the two policies in terms of overall welfare implications. To be precise, we make the following policy comparison: Compare a policy that provides severance payments to fired workers and unemployment benefits to unmatched workers with a policy that provides unemployment benefits to both fired and unmatched workers. In both cases unemployment benefits are financed by a payroll tax.\(^9\)

Numerical simulations reveal that a combination of severance payments and unemployment benefits dominates unemployment benefits alone in terms of aggregate welfare when policies are chosen to maximize aggregate welfare. Figure 9 provides numerical illustration of this result. The black line represents the case of severance payments and unemployment benefits combination while the red line is for unemployment benefits only. Unemployment (figure 9a) and wages (figure 9b) both are higher in the case of unemployment benefits only compared to the case when both severance payments and unemployment benefits are used. Both the worker welfare (figure 9c) and aggregate welfare (figure 9d) are higher with the combination policy than with unemployment benefits alone.

As mentioned earlier, in the model without search frictions severance payments did a better 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.

Before concluding, 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.

\(^9\)The results are unchanged when unemployment benefits are financed by a lump sum tax on all workers.
5 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 large welfare losses for workers and potential aggregate welfare losses. In the absence of any instrument of social protection there would be a case for creating barriers to offshoring. Both unemployment benefits and severance payments can alleviate the adverse consequences of offshoring for workers, and have the potential to make offshoring aggregate welfare improving. When unemployment arises solely due to endogenous job destruction, severance payments turn out to be a better tool for insuring workers than unemployment benefits. When unemployment is caused by both matching frictions and endogenous job destruction, a combination of severance payments and unemployment benefits dominates unemployment benefits alone. 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 possible adverse consequence of offshoring. The administrative costs of firing, which are not a transfer to workers, do reduce job destruction but end up reducing the welfare of workers. Therefore, there is no case on welfare grounds for creating greater administrative barriers to the firing of workers.

References


Appendix

6.1 Derivation of (15) and (16)

Using (10) in (11) obtain

$$\gamma A((\lambda L)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}L^{\frac{1}{\sigma}}(\lambda - \lambda_c) = \frac{(f_w + f_t)}{(1 - G(\lambda_c))} + \psi$$

Next, substitute (8) in (31) and simplify to obtain (15). Next, note that equations (8) and (9) imply

$$M^{\frac{\sigma-1}{\sigma}} = \omega^{\sigma-1}L^{-\frac{\sigma-1}{\sigma}}\lambda^{(\frac{\sigma-1)^2}{\sigma}}$$

Using (32) and (12) in (8) obtain (16).

6.2 Existence Proof and Comparative Statics

In the derivations below we are going to make use of the following linear approximation.

$$U(f_w + z + \pi) \approx U(w + \pi) + (f_w + z - w)U'(w + \pi)$$

Similarly,

$$U'(f_w + z + \pi) \approx U'(w + \pi) + (f_w + z - w)U''(w + \pi)$$
Next, define \( \varphi \equiv \frac{u - z - f_w}{u + \pi} \) and recall that \( \rho = -x \frac{U''(x)}{U'(x)} \) is the coefficient of relative risk aversion. Now re-write (34) as

\[
U'(f_w + z + \pi) \approx (1 + \rho \varphi) U'(w + \pi)
\]  

(35)

The comparative statics are based on equations (15), (16), and (14) with the additional assumption of uniform distribution of productivity.

Totally differentiating (15) after assuming uniform distribution obtain

\[
dw = \frac{(1 + \lambda_c)}{(1 - \lambda_c)} \left( dw - \frac{(U(w + \pi) - U(f_w + z + \pi))}{(U'(w + \pi))^2} U''(w + \pi) dw - \frac{U'(f_w + z + \pi)}{U'(w + \pi)} df_w \right) + \\
2 \frac{(1 + \lambda_c)^2}{(1 - \lambda_c)^2} \left( \frac{f_w + f_t}{(1 + \lambda_c)^2} + \frac{(1 + \lambda_c)(U(w + \pi) - U(f_w + z + \pi))}{U'(w + \pi)} \right) d\lambda_c + \\
\frac{(1 + \lambda_c^2)}{(1 - \lambda_c)^2} (df_w + df_t) + \\
\frac{(1 + \lambda_c)}{(1 - \lambda_c)} \left( U'(w + \pi) (U'(w + \pi) - U'(f_w + z + \pi)) - U''(w + \pi) (U(w + \pi) - U(f_w + z + \pi)) \right) d\pi
\]

Using the linear approximation in (35) above and the definitions \( \varphi, \rho, \) and \( \psi, \) and simplifying, obtain

\[
\left( \frac{2\lambda_c(1 - \lambda_c)(w + \pi) + (1 - \lambda_c^2) \rho \psi}{w + \pi} \right) dw + (1 + \lambda_c^2) df_t + (2\lambda^2 - (1 - \lambda_c^2) \rho \varphi) df_w + \\
2 \left( \psi + \frac{1 + \lambda_c}{1 - \lambda_c} (f_w + f_t) \right) d\lambda_c + (1 - \lambda_c^2) \left( \frac{\rho \psi}{w + \pi} - \rho \varphi \right) d\pi = 0
\]

Re-write the above as

\[
C_{1w} dw + C_{1f_w} df_w + C_{1f_t} df_t + C_{1\lambda} d\lambda_c + C_{1\pi} d\pi = 0
\]  

(36)

where

\[
C_{1w} \equiv \left( \frac{2\lambda(1 - \lambda_c)(w + \pi) + (1 - \lambda_c^2) \rho \psi}{w + \pi} \right) > 0;
\]

\[
C_{1f_w} \equiv (2\lambda^2 - (1 - \lambda_c^2) \rho \varphi) \leq 0; C_{1f_t} \equiv (1 + \lambda_c^2) > 0;
\]

\[
C_{1\lambda} \equiv 2 \left( \psi + \frac{1 + \lambda_c}{1 - \lambda_c} (f_w + f_t) \right) > 0; C_{1\pi} = (1 - \lambda_c^2) \left( \frac{\rho \psi}{w + \pi} - \rho \varphi \right) > 0
\]

Upon using uniform distribution, re-write the key equation (16) as

\[
\frac{\lambda}{2\gamma} L^{\gamma - 1} \left( 1 + \left( \omega^{-1} \left( \frac{1 + \lambda_c}{2} \right)^{(\sigma - 1)} \right) \right)^{\frac{\sigma - 1}{\sigma - 1}} (1 - \lambda_c)^{\gamma - 1} (1 + \lambda_c)^\gamma = w + \frac{\lambda_c}{1 - \lambda_c} (f_w + f_t)
\]  

(37)
Use the following compact notation.

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

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

Now, totally differentiate (37) to obtain

\[
(\sigma - 1) d\Lambda \left(\omega^{\sigma-2} \left(1+\lambda_c \frac{1}{2}\right)^{-(\sigma-1)} \right) dw - \omega^{\sigma-1} \left(1+\lambda_c \frac{1}{2}\right)^{-\sigma} d\lambda_c \left(1 - \frac{\lambda_c^2}{1 - \lambda_c}\right) + \frac{w (1 - \lambda_c) + \lambda_c (f_w + f_t)}{1 - \lambda_c^2} \left[\frac{1 + \lambda_c - 2\lambda_\gamma}{(1 - \lambda_c)}\right] d\lambda_c = dw \left(\frac{f_w + f_t}{(1 - \lambda_c)^2}\right) d\lambda_c + \frac{\lambda_c}{1 - \lambda_c} (df_w + df_t) \quad (38)
\]

Next, from the definition of \(\omega\) obtain

\[
d\omega = \frac{1}{\phi} \left(dw + \frac{\lambda_c}{1 - \lambda_c} (df_w + df_t) + \frac{(f_w + f_t)}{(1 - \lambda_c)^2} d\lambda_c\right) - \omega \frac{d\phi}{\phi} \quad (39)
\]

Using the above expression for \(\omega\) in (38) obtain

\[
(\sigma - 1) d\Lambda \left(\omega^{\sigma-2} \left(1+\lambda_c \frac{1}{2}\right)^{-(\sigma-1)} \right) \left(\frac{1}{\phi} \left(dw + \frac{f_w + f_t}{(1 - \lambda_c)} d\lambda_c + \frac{\lambda_c}{1 - \lambda_c} (df_w + df_t)\right) - \omega \frac{d\phi}{\phi}\right) - \omega^{\sigma-1} \left(1+\lambda_c \frac{1}{2}\right)^{-\sigma} d\lambda_c \left(1 - \frac{\lambda_c^2}{1 - \lambda_c}\right) + \frac{w (1 - \lambda_c) + \lambda_c (f_w + f_t)}{1 - \lambda_c^2} \left[\frac{1 + \lambda_c - 2\lambda_\gamma}{(1 - \lambda_c)}\right] d\lambda_c = dw + \frac{(f_w + f_t)}{(1 - \lambda_c)^2} d\lambda_c + \frac{\lambda_c}{1 - \lambda_c} (df_w + df_t)
\]

where the last term on the left uses (37). Collect the terms and re-write the above as

\[
C_{2w} dw + C_{2\lambda} d\lambda_c + C_{2f_w} df_w + C_{2f_t} df_t + C_{2\phi} d\phi = 0 \quad (40)
\]

where

\[
C_{2\phi} = - (\sigma - 1) \frac{(1 - \frac{\lambda_c^2}{1 - \lambda_c})^\gamma}{1 - \lambda_c} \left(\omega^{\sigma-1} \left(1+\lambda_c \frac{1}{2}\right)^{-(\sigma-1)}\right) \frac{d\Lambda}{\phi} \quad (41)
\]

\[
C_{2w} = \frac{(\sigma - 1) \omega^{\sigma-2} \left(1+\lambda_c \frac{1}{2}\right)^{-(\sigma-1)} \left(1 - \frac{\lambda_c^2}{1 - \lambda_c}\right)^\gamma}{\phi} - (\sigma - 1) \frac{(1 - \frac{\lambda_c^2}{1 - \lambda_c})^\gamma}{1 - \lambda_c} d\Lambda - 1 \quad (42)
\]

\[
C_{2f_t} = C_{2f_w} = \frac{\lambda_c C_{2w}}{(1 - \lambda_c)} \quad (43)
\]
\[ C_{2\lambda} = (\sigma - 1) d\Lambda \left( \omega^{\sigma-2} \left( \frac{1 + \lambda_c}{2} \right)^{-\sigma} \frac{(f_w + f_t)}{z \phi (1 - \lambda_c)^2} - \frac{\omega^{\sigma-1}}{2} \left( \frac{1 + \lambda_c}{2} \right)^{-\sigma} \right) \left( \frac{1 - \lambda_c^2}{1 - \lambda_c} \right)^{\gamma} + (44) \]

Using (37) re-write \( C_{2\phi} \) in the following convenient form.

\[ C_{2\phi} = - (\sigma \gamma - \sigma + 1) \omega \Omega \]  
(45)

Next, using the definition of \( d\Lambda \) and (37) to re-write \( C_{2w} \) as

\[ C_{2w} = - (\sigma (1 - \gamma) - 1) \Omega - 1 < 0 \]  
(46)

The inequality above follows from the fact that \(- (\sigma (1 - \gamma) - 1) < 1\). Therefore, \( C_{2ft} = C_{2fw} < 0 \) as well.

Finally, let us simplify \( C_{2\lambda} \). First, re-organize terms in (44) to obtain

\[ C_{2\lambda} = (\sigma - 1) d\Lambda \left( \omega^{\sigma-2} \left( \frac{1 + \lambda_c}{2} \right)^{-\sigma} \frac{(f_w + f_t)}{z \phi (1 - \lambda_c)^2} - \frac{\omega^{\sigma-1}}{2} \left( \frac{1 + \lambda_c}{2} \right)^{-\sigma} \right) \left( \frac{1 - \lambda_c^2}{1 - \lambda_c} \right)^{\gamma} + (47) \]

Next, substitute out \( d\Lambda \) and obtain

\[ C_{2\lambda} = -\Lambda (\sigma \gamma - \sigma + 1) \Omega \left( \frac{1 - \lambda_c^2}{1 - \lambda_c} \right)^{\gamma-1} + \frac{w (1 - \lambda_c) + \lambda_c (f_w + f_t)}{1 - \lambda_c^2} \left[ 1 + \frac{1 + \lambda_c - 2\lambda_c \gamma}{(1 - \lambda_c)} \right] + (48) \]

Finally, use (37) to re-write above as

\[ C_{2\lambda} = \frac{w (1 - \lambda_c) + \lambda_c (f_w + f_t)}{1 - \lambda_c^2} \left[ 2\lambda_c (1 - \gamma) \frac{(f_w + f_t)}{1 - \lambda_c} - C_{2w} \right] + \left( f_w + f_t \right) C_{2w} \]  
(49)

Since \( C_{2w} < 0 \), a sufficient condition for \( C_{2\lambda} > 0 \) is

\[ \frac{w (1 - \lambda_c) + \lambda_c (f_w + f_t)}{1 - \lambda_c^2} > \frac{(f_w + f_t)}{(1 - \lambda_c)^2} \]  
(50)

which can be re-written as

\[ w > \left( \frac{1 + \lambda_c^2}{(1 - \lambda_c)^2} \right) (f_w + f_t) \]  
(51)
Note from (15) that the above inequality is always true in the relevant case of \( w > z + f_w \), that is when there is incomplete insurance. Therefore, the coefficients of (40) are

\[
C_{2w} = -((\sigma(1 - \gamma) - 1) \Omega + 1) < 0; \\
C_{2\lambda} = \frac{w(1 - \lambda_c) + \lambda_c(f_w + f_t)}{1 - \lambda_c^2} \left[ \frac{2\lambda_c(1 - \gamma)}{1 - \lambda_c} - C_{2w} \right] + \frac{(f_w + f_t)}{(1 - \lambda_c)^2} C_{2w} > 0 \\
C_{2fw} = C_{2ft} = \frac{\lambda_c C_{2w}}{(1 - \lambda_c)} < 0; C_{2\phi} = \sigma(1 - \gamma) - 1) \Omega \omega
\]

The coefficients above imply that there is a positive relationship between \( \lambda_c \) and \( w \) in the \( (\lambda_c, w) \) space.
Verify from the coefficients in (36) that (15) gives a negative relationship between \( \lambda_c \) and \( w \) in the \( (\lambda_c, w) \) space when \( t = 0 \). Therefore, in the benchmark case of \( t = 0 \) and hence \( \pi = 0 \) there exists a unique equilibrium.

### 6.3 Proof of Proposition 1

For a given \( f_w \) and \( f_t \), from (36) and (40) obtain the following expressions for the impact of offshoring on \( w \) and \( \lambda_c \).

\[
\frac{dw}{d\phi} = -\frac{C_{2\phi}}{C_{2w} - \frac{C_{2\lambda}}{C_{1w}} C_{1w}}; \frac{d\lambda_c}{d\phi} = -\frac{C_{2\phi}}{C_{2\lambda} - \frac{C_{2w}}{C_{1w}} C_{1\lambda}} \quad (52)
\]

Note from the signs of the coefficients defined earlier that \( C_{2w} - \frac{C_{2\lambda}}{C_{1w}} C_{1w} < 0 \) and \( C_{2\lambda} - \frac{C_{2w}}{C_{1w}} C_{1\lambda} > 0 \). Therefore, \( w \) and \( \lambda_c \) 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, (52) 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, (52) implies \( \frac{dw}{d\phi} > 0, \frac{d\lambda_c}{d\phi} < 0 \).
6.4 Expression for Change in Profits

The final equation for comparative statics is derived as follows. Using the assumption of uniform distribution, and taking the total derivative of (13) in the text obtain

\[
d\Pi = \left( -2\lambda_c A \gamma \left( \frac{1 - \lambda_c^2}{2} \frac{\sigma - 1}{\sigma} + M \frac{\sigma - 1}{\sigma - 1}\right)^{\frac{\sigma - 1}{\sigma}} \frac{1 - \lambda_c^2}{2} \frac{\sigma - 1}{\sigma - 1} - wL + (f_w + f_t) L \right) d\lambda_c \tag{53}
\]

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

\[
\gamma A \left( \frac{1 - \lambda_c^2}{2} \frac{\sigma - 1}{\sigma} + M \frac{\sigma - 1}{\sigma - 1}\right)^{\frac{\sigma - 1}{\sigma}} \frac{1 - \lambda_c^2}{2} \frac{\sigma - 1}{\sigma - 1} = w(1 - \lambda_c) L + \lambda_c (f_w + f_t) L \tag{54}
\]

Using (54) above in (53) obtain

\[
d\Pi = \left( \left(-\frac{2\lambda_c}{1 + \lambda_c} \frac{w}{1 - \lambda_c^2} - \frac{2\lambda_c^2}{1 - \lambda_c^2} (f_w + f_t) \right) + w - (f_w + f_t) \right) \tilde{L} d\lambda_c - (1 - \lambda_c) \tilde{L} dw - \lambda_c L df_w - \lambda_c L df_t - M d\phi \tag{55}
\]

The above can be simplified as

\[
d\Pi = \left( \left(-\frac{1 - \lambda_c}{1 + \lambda_c} w - \frac{1 + \lambda_c^2}{1 - \lambda_c^2} (f_w + f_t) \right) \right) \tilde{L} d\lambda_c - (1 - \lambda_c) \tilde{L} dw - \lambda_c L df_w - \lambda_c L df_t - M d\phi \tag{56}
\]

Next, note from (15) that \( (1 - \lambda_c) \frac{w}{1 + \lambda_c} (f_w + f_t) - \psi = 0 \). Therefore, the above can be written as

\[
d\Pi = \psi \tilde{L} d\lambda_c - (1 - \lambda_c) \tilde{L} dw - \lambda_c L df_w - \lambda_c L df_t - M d\phi \tag{57}
\]

It follows that

\[
d\pi = \left( \psi d\lambda_c - (1 - \lambda_c) dw - \lambda_c df_w - \lambda_c df_t - \frac{M}{L} d\phi \right) \tag{58}
\]

6.5 Expression for change in welfare of workers

Totally differentiating (17) in the text obtain

\[
dW = (1 - \lambda_c) U'(w + \pi) dw + \lambda_c U'(f_w + z + \pi) df_w - (U(w + \pi) - U(f_w + z + \pi)) d\lambda_c \tag{59}
\]
Using the expression for $d\pi$ from (58) above obtain

\[
dW = (1 - \lambda_c)U'(w + \pi)dw + \lambda_cU'(f_w + z + \pi)df_w - \psi U'(w + \pi)d\lambda_c +
\]
\[
+ ((1 - \lambda_c)U'(w + \pi) + \lambda_cU'(f_w + z + \pi)) t \left( \psi d\lambda_c - (1 - \lambda_c)dw - \lambda_c df_w - \frac{M}{L} d\phi \right)
\]

Combining terms in the above expression obtain

\[
dW = U'(w + \pi) \left\{ [1 - (1 + \lambda_c \rho \psi) t] ((1 - \lambda_c)dw - \psi d\lambda_c) + [(1 + \rho \varphi) - (1 + \lambda_c \rho \varphi) t] \lambda_c df_w - (1 + \lambda_c \rho \varphi) t \frac{M}{L} d\phi \right\}
\]

The change in the welfare of workers in the case of $t = 0$ which is our baseline case discussed in the text is

\[
dW = U'(w) ((1 - \lambda_c)dw - \psi d\lambda_c) + U'(w) (1 + \rho \varphi) \lambda_c df_w
\]

where $\psi$ and $\varphi$ are obtained in this case by setting $\pi = 0$.

Similarly, the change in the welfare of workers when all profits go to workers, $t = 1$, is given by

\[
dW = U'(w + \pi) \left\{ -\lambda_c \rho \varphi ((1 - \lambda_c)dw - \psi d\lambda_c) + \lambda_c (1 - \lambda_c) \rho \varphi df_w - (1 + \lambda_c \rho \varphi) \frac{M}{L} d\phi \right\}
\]

### 6.6 Expression for change in aggregate welfare

The aggregate welfare, given by the sum of the welfare of workers and the component of profits not going to workers is given by $(1 - t)\Pi + LW$. The change in welfare can be written, using (61) and (57), as

\[
(1 - t)d\Pi + LW = (1 - t)L \left[ \psi d\lambda_c - (1 - \lambda_c)dw - \lambda_c df_w - \lambda_c df_t - \frac{M}{L} d\phi \right] + \frac{M}{L} d\phi
\]

\[
U'(w + \pi) \left[ [1 - (1 + \lambda_c \rho \varphi) t] ((1 - \lambda_c)dw - \psi d\lambda_c) + [(1 + \rho \varphi) - (1 + \lambda_c \rho \varphi) t] \lambda_c df_w - (1 + \lambda_c \rho \varphi) t \frac{M}{L} d\phi \right]
\]

### 6.7 Offshoring and Welfare

#### 6.7.1 Welfare of workers

It follows from (61) that the change in the welfare of workers in response to offshoring is

\[
\frac{dW}{d\phi} = U'(w + \pi) \left\{ [1 - (1 + \lambda_c \rho \varphi) t] ((1 - \lambda_c)\frac{dw}{d\phi} - \psi \frac{d\lambda_c}{d\phi}) - (1 + \lambda_c \rho \varphi) t \frac{M}{L} \right\}
\]

where $\frac{dw}{d\phi}$ and $\frac{d\lambda_c}{d\phi}$ are given in (52). For $t = 0$ the above becomes

\[
\frac{dW}{d\phi} = U'(w) \left( (1 - \lambda_c)\frac{dw}{d\phi} - \psi \frac{d\lambda_c}{d\phi} \right)
\]
For $t = 1$, the change in the welfare of workers is given by

$$\frac{dW}{d\phi} = U'(w + \pi) \left[ -\lambda_c \rho \varphi ((1 - \lambda_c) \frac{dw}{d\phi} - \psi \frac{d\lambda_c}{d\phi}) - (1 + \lambda_c \rho \varphi) \frac{M}{L} \right]$$

(67)

### 6.7.2 Profits

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

(68)

It is clear from proposition 1 that $\frac{d\Pi}{d\phi} < 0$ when $\sigma > \frac{1}{1-\gamma}$, but it is ambiguous when $\sigma < \frac{1}{1-\gamma}$.

### 6.7.3 Aggregate Welfare

It follows from (64) that the change in aggregate welfare in response to offshoring in the baseline case of $t = 0$ is given by

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

(69)

When $t = 1$, the change in aggregate welfare is same as the change in worker welfare given by (67).

### 6.8 Proof of Lemma 1

From (36) and (40) obtain the following.

$$\frac{dw}{df_t} = -\frac{C_{2ft} - \frac{C_{2w}}{C_{1w}} C_{1ft}}{C_{2w} - \frac{C_{2w}}{C_{1w}} C_{1w}}; \frac{d\lambda_c}{df_t} = -\frac{C_{2ft} - \frac{C_{2w}}{C_{1w}} C_{1ft}}{C_{2\lambda} - \frac{C_{2w}}{C_{1w}} C_{1\lambda}}.$$  

(70)

It is easy to verify that $C_{2fw} - \frac{C_{2w}}{C_{1w}} C_{1fw} < 0$ and $C_{2ft} - \frac{C_{2w}}{C_{1w}} C_{1ft} < 0$. Therefore, $\frac{dw}{df_t} < 0$. That is, an increase in $f_t$ reduces wages. The sign of $C_{2ft} - \frac{C_{2w}}{C_{1w}} C_{1ft}$ is same as the sign of $w - \frac{\lambda_c \rho \psi}{1-\lambda_c}$. Verify from (15) that $w > \frac{(1+\lambda_c)}{(1-\lambda_c)} \psi$. Therefore, a sufficient condition for $w > \frac{\lambda_c \rho \psi}{1-\lambda_c}$ is

$$\rho < \frac{1 + \lambda_c}{\lambda_c}$$

Since $\lambda_c$ is the job destruction rate as well as the unemployment rate in our model, it is small, and hence the above condition is easily satisfied for reasonable values of the risk aversion parameter $\rho$.  

35
6.9 Proof of proposition 4

Note from (59) that the impact of a change in \( f_t \) on the welfare of workers is given by

\[
\frac{dW}{df_t} = U'(w) \left( (1 - \lambda_c) \frac{dw}{df_t} - \psi \frac{d\lambda_c}{df_t} \right)
\]

Next, using (40) obtain (setting \( df_w = d\phi = 0 \))

\[
\left( (1 - \lambda_c) \frac{dw}{df_t} - \psi \frac{d\lambda_c}{df_t} \right) = \left( \frac{(1 - \lambda_c)C_{2\lambda} + \psi C_{2w}}{C_{2\lambda}} \right) \frac{dw}{df_t} + \psi \frac{\lambda_c C_{2w}}{C_{2\lambda} (1 - \lambda_c)}
\]

Verify from the coefficients \( C_{ij} \) that \((1 - \lambda_c)C_{2\lambda} + \psi C_{2w} > 0 \). Recall from lemma 1 that \( \frac{dw}{df_t} < 0 \). Therefore, \( \frac{dW}{df_t} < 0 \).

6.10 Proof of lemma 2

The three equations determining \( w, \lambda_c \), and \( W \) in the risk neutral case are given by

\[
w = \frac{(1 + \lambda_c^2) (f_w + f_t)}{(1 - \lambda_c)^2} + \frac{(1 + \lambda_c)}{(1 - \lambda_c)} (w - f_w - z)
\]

\[
W = (1 - \lambda_c) w + \lambda_c (f_w + z)
\]

\[
\gamma A(1 + \omega^{\sigma - 1} \bar{\lambda}^{-(\sigma - 1)}) \pi^{-1} \bar{\lambda}^{\gamma - 1} (\bar{\lambda} (1 - \lambda_c))^{\gamma} = w (1 - \lambda_c) + \lambda_c (f_w + f_t)
\]

Next, denote \( w + \frac{\lambda_c}{1 - \lambda_c} f_w \) by \( w' \) and re-write the above 3 equations as

\[
\frac{(1 + \lambda_c)}{2\lambda_c z} - \frac{(1 + \lambda_c^2)}{2\lambda_c (1 - \lambda_c)} f_t = w'
\]

\[
\frac{W}{(1 - \lambda_c)} = w' + \frac{\lambda_c}{1 - \lambda_c} z
\]

\[
\gamma A \left( 1 + \left( \frac{w' + \frac{\lambda_c}{(1 - \lambda_c)} f_t}{\psi} \right) \right)^{\sigma - 1} \bar{\lambda}^{-(\sigma - 1)} \pi^{-1} \bar{\lambda}^{\gamma - 1} (\bar{\lambda} (1 - \lambda_c))^{\gamma} = w' + \frac{\lambda_c}{(1 - \lambda_c)} f_t
\]

Since \( f_w \) appears in the above 3 equations only in the \( w' \) term, it is clear that any change in \( f_w \) does not affect \( W \) and \( \lambda_c \). The only impact of \( f_w \) is on the wage rate \( w \). That is, an increase in \( f_w \) leads to a reduction in \( w \) such that \( w' \) remains unchanged.

6.11 Proof of lemma 3

From (36) and (40) obtain the following.

\[
\frac{dw}{df_w} = - \left( \frac{C_{2f_w} - C_{1\lambda} C_{1f_w}}{C_{2w} - C_{1\lambda} C_{1w}} \right) \frac{d\lambda_c}{df_w} = - \left( \frac{C_{2f_w} - C_{1\omega} C_{1f_w}}{C_{2\lambda} - C_{1\omega} C_{1\lambda}} \right)
\]

(71)
As mentioned in the proof of proposition 1, $C_{2\lambda} - \frac{C_{2w}}{C_{1\lambda}} C_{1\lambda} > 0$. It is easily verified from $C_{ij}$ above that $C_{2w} - \frac{C_{2w}}{C_{1\lambda}} C_{1w} < 0$. Therefore, $\frac{d\lambda}{df} > 0$. For the sign of $\frac{dw}{df}$ recall that $C_{2w} - \frac{C_{2w}}{C_{1\lambda}} C_{1w} < 0$, however, the sign of $C_{2w} - \frac{C_{2w}}{C_{1\lambda}} C_{1w}$ is ambiguous.

6.12 Worker welfare maximizing severance payment

From (61) the equation determining the level of severance payment that maximizes the welfare of workers is given by

$$\frac{dW}{df} = U'(w + \pi) \left(1 - (1 + \lambda_c \rho \varphi) t\right) \left((1 - \lambda_c) \frac{dw}{df} - \psi \frac{d\lambda_c}{df} \right) + [(1 + \rho \varphi) - (1 + \lambda_c \rho \varphi)t] \lambda_c = 0$$  (72)

At full insurance $\varphi = \psi = 0$. It is straightforward to verify from (36), (40), and (58) that at $\varphi = \psi = 0$, $\frac{dw}{df} = -\frac{\lambda_c}{1 - \lambda_c}$. Therefore, $f_w = w - z$ is a solution to the above equation for all $t$ and hence, full insurance is optimal irrespective of the value of $t$. We verify numerically that $\frac{d^2W}{df^2} < 0$, therefore, $W$ is maximized at the solution to (72).

6.13 Social welfare maximizing severance payment

From (64) note that the social welfare maximizing severance payment is characterized by

$$(1 - t) \frac{d\Pi}{df} + \mathcal{L} \frac{dW}{df} = \mathcal{L} \left[U'(w + \pi) \left(1 - (1 + \lambda_c \rho \varphi) t\right) - (1 - t)\right] \left((1 - \lambda_c) \frac{dw}{df} + \psi \frac{d\lambda_c}{df}\right) + U'(w + \pi) \mathcal{L} [(1 + \rho \varphi) - (1 + \lambda_c \rho \varphi)t] \lambda_c - \lambda_c (1 - t) \mathcal{L} = 0$$  (73)

At full insurance $\varphi = \psi = 0$ the above reduces to

$$(1 - t) \frac{d\Pi}{df} + \mathcal{L} \frac{dW}{df} = \mathcal{L} \left(U'(w + \pi) - 1\right) \left((1 - \lambda_c) \frac{dw}{df} + \lambda_c\right) = 0$$

As verified earlier, $\frac{dw}{df} = -\frac{\lambda_c}{1 - \lambda_c}$ at $\varphi = \psi = 0$, therefore, $f_w = w - z$ maximizes aggregate welfare as well.

6.14 Impact of offshoring on optimal severance payment

Since the optimal level of severance payments (both worker welfare maximizing and aggregate welfare maximizing) is characterized by $f_w = w - z$, we get

$$\frac{df_w}{df} = \frac{dw}{df}$$

Therefore, if offshoring reduces wages it also reduces optimal severance payment and vice-versa.
6.15 Proof of lemma 4

From (36), (40), (58) obtain

\[ \frac{dw}{d\phi} = - \frac{C_{2\phi} + \frac{C_{2\lambda}C_{1\pi t}}{(C_{1\lambda}+tC_{1\pi})L}}{C_{2w} - \frac{C_{2\lambda}(C_{1w} - t(1-\lambda_c)C_{1\pi})}{(C_{1\lambda}+tC_{1\pi})L}} \]

It is easy to verify from the signs of coefficients \( C_{ij} \) that \( C_{1w} > t(1-\lambda_c)C_{1\pi} \), therefore, the denominator is always negative. Since the second term in the numerator is always positive, a sufficient condition for \( \frac{dw}{d\phi} > 0 \) is \( C_{2\phi} > 0 \) which is true since \( \sigma > \frac{1}{1-\gamma} \).

6.16 Offshoring and welfare with optimal severance payment

As derived earlier, optimal severance payment (both worker welfare maximizing and aggregate welfare maximizing) is characterized by \( f_w = w - z \) in which case \( \varphi = \psi = 0 \). Using these in (61) obtain the following expression for the impact of of offshoring on workers’ welfare when severance payments are optimally chosen.

\[ \frac{dW}{d\phi} = U'(w + \pi) \left( (1 - t)(1 - \lambda_c) \frac{\partial w}{\partial \phi} - t \frac{M}{L} \right) \]  

(74)

where \( \frac{\partial w}{\partial \phi} \) is the change in wage with respect to a change in \( \phi \) for an exogenous \( f_w \). In deriving (74) we have used the envelope theorem: since \( f_w \) is chosen to maximize \( W \) for each level of \( \phi \), the impact of a change in \( f_w \) on \( W \) can be ignored. Above is the expression reported in the text. Since the aggregate welfare maximizing severance payments coincides with the worker welfare maximizing severance payments, using same steps as in the derivation of (74) obtain the following expression for the change in aggregate welfare

\[ (1 - t) \frac{d\Pi}{d\phi} + L \frac{dW}{d\phi} = (U'(w + \pi) - 1)(1 - t)(1 - \lambda_c) \frac{L}{\partial w} \frac{\partial w}{\partial \phi} - M(1 + t(U'(w + \pi) - 1)) \]  

(75)

6.17 Offshoring and Welfare with Unemployment Insurance

The key equations for the case when unemployment benefits are paid by a lump sum tax are

\[ \frac{(1 + \lambda_c^2)}{(1 - \lambda_c)^2} f_t + \frac{(1 + \lambda_c)}{(1 - \lambda_c)} \frac{U(w - \tau) - U(b + z - \tau)}{U'(w - \tau)} = w \]  

(66)

\[ \frac{\gamma A}{2\gamma} \frac{1}{L} \left( 1 + \left( \frac{\omega}{2} \right)^{-(\sigma-1)} \right)^{\frac{2}{\sigma-1}} (1 - \lambda_c^2)^{\gamma} = (1 - \lambda_c)w + \lambda_c f_t \]  

(77)

\[ (1 - \lambda_c)U(w - \tau) + \lambda_c U(b + z - \tau) = W \]  

(78)
where $\omega \equiv \frac{w + \frac{\lambda_c}{\phi} f_t}{\phi}$.

When unemployment benefits are funded by a payroll tax, then equation (77) remains unchanged. (76) and (78) are modified slightly and are given by

$$\frac{(1 + \lambda_c^2) f_t}{(1 - \lambda_c)^2} + \frac{(1 + \lambda_c) U(w - \tau) - U(b + z)}{U'(w - \tau)} = w$$  \hspace{1cm} (79)

$$(1 - \lambda_c) U(w - \tau) + \lambda_c U(b + z) = W$$  \hspace{1cm} (80)

Suppose for any level of offshoring cost, $\phi$, the optimal unemployment benefits, equilibrium $\lambda_c$, and the equilibrium wage in the case when unemployment benefits are paid by a payroll tax are given by $b^l$, $\lambda_c^l$, and $w^l$. The balanced budget condition implies $\tau^l = \lambda_c^l b^l$. Next, define $b^p = (1 - \lambda_c^l) b^l$ and $\tau^p = \frac{\lambda_c^l b^p}{1 - \lambda_c^l} = \lambda_c^l b^l = \tau^l$. It can be easily verified that $b^p, \tau^p, \lambda_c^l$, and $w^l$ satisfy (77) and (79). This simply follows from the fact that $b^l - \tau^l = b^p$.

7 Model with matching frictions

$$\max_{L, M, w, \lambda_c} \left\{ A\left(\frac{1 + \lambda_c}{2} L\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} \left(1 + \lambda_c\right) \left(1 - \lambda_c\right) - w L - \left(f_w + f_t\right) - \frac{\lambda_c}{1 - \lambda_c} L - \phi M - \frac{c}{\mu \theta^{\delta-1} \left(1 - \lambda_c\right)} L \right\}$$

subject to the constraint

$$\mu \theta^\delta \left( (1 - \lambda_c) U(w) + \lambda_c (f_w + z) \right) + \left(1 - \mu \theta^\delta\right) U(z) \geq W$$  \hspace{1cm} (81)

$$L : \gamma A\left(\frac{1 + \lambda_c}{2} L\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} \left(1 + \lambda_c\right) \left(1 - \lambda_c\right) = w + \frac{\lambda_c}{1 - \lambda_c} \left(f_w + f_t\right) + \frac{c}{\mu \theta^{\delta-1} \left(1 - \lambda_c\right) \mu \theta^{\delta-1}}$$  \hspace{1cm} (82)

$$M : \gamma A\left(\frac{1 + \lambda_c}{2} L\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} = \phi$$  \hspace{1cm} (83)

$$w : -L + \mu \theta^\delta (1 - \lambda_c) U'(w) = 0$$  \hspace{1cm} (84)

$$\lambda_c : \gamma A\left(\frac{1 + \lambda_c}{2} L\right)^{\frac{\sigma-1}{\sigma}} + M^{\frac{\sigma-1}{\sigma}} =$$  \hspace{1cm} (85)

$$\mu \theta^\delta \left( U(w) - U(f_w + z) \right) + \frac{1}{\left(1 - \lambda_c\right)^2} \left(f_w + f_t\right) L + \frac{c L}{\mu \theta^{\delta-1} \left(1 - \lambda_c\right)^2}$$

$$\theta : \mu \theta^{\delta-1} \left( (1 - \lambda_c) U(w) + \lambda_c (f_w + z) - U(z) \right) = \left(1 - \delta\right) \frac{c \theta^{-\delta}}{\mu} \frac{L}{\left(1 - \lambda_c\right)}$$  \hspace{1cm} (86)
From the first order conditions above derive the following key equations.

\[
\gamma AL^{\gamma-1} \left( 1 + \left( \omega^{\sigma-1} \left( \frac{1 + \lambda_c}{2} \right)^{-1} \right) \right)^{\frac{\sigma-1}{\sigma-1}} (1 - \lambda_c)^{\gamma-1} \left( \frac{1 + \lambda_c}{2} \right)^{\gamma} \left( \mu \theta^{\delta} \right)^{\gamma-1} = \phi \omega \tag{88}
\]

\[
\frac{(1 + \lambda_c) U(w) - U(fw + z)}{(1 - \lambda_c) U'(w)} + \frac{1 + \lambda_c^2}{(1 - \lambda_c)^2} (fw + f_t) + \frac{c}{\mu \theta^{\delta-1}} \frac{2\lambda_c}{(1 - \lambda_c)^2} = w \tag{89}
\]

where

\[
\omega = \frac{w + \frac{\lambda_c}{1 - \lambda_c} (fw + f_t) + \frac{c}{\phi (1 - \lambda_c) \mu \theta^{\delta-1}}}{\phi}
\]

The aggregate labor market clearing condition is given by

\[
L = \mu \theta^{\delta} (1 - \lambda_c) \bar{L} \tag{90}
\]

Equations (87)-(90) determine \( w, \lambda_c, \theta, \) and \( L. \) The welfare of workers, \( W, \) is obtained from (81).

For policy exercise, equation (81) is modified as follows. When the policy involves a combination of severance payments and unemployment benefits, then the constraint is given by

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

where the balanced budget condition is

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

When the policy involves only unemployment benefits, the constraint is given by

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

where the balanced budget condition is

\[
\tau = \frac{(1 - \mu \theta^{\delta}) + \lambda_c \mu \theta^{\delta}}{\mu \theta^{\delta} (1 - \lambda_c)} b.
\]
Figure 1: Offshoring and Welfare (low risk aversion: $\rho = 1.5$)

$A=1,L=1,\sigma=4,\gamma=2/3,z=.26,ft=.05$
Figure 2: Offshoring and Welfare (high risk aversion: $\rho = 3$)

\[ A=1, L=1, \sigma=4, \gamma=2/3, z=.26, ft=.05 \]
Figure 3: Offshoring with Compensating Severance Payments

Figure 3a: Offshoring and Unemployment

Figure 3b: Offshoring and Severance Payments

Figure 3c: Offshoring and Profits

Figure 3d: Offshoring and Aggregate Welfare

\[ A=1, L=1, \sigma=4, \gamma=\frac{2}{3}, z=0.26, \rho=3, f_t=0.05 \]
Figure 4: Offshoring and Welfare with alternative policies

A=1, L=1, σ=4, γ=2/3, z=.26, ρ=3, ft=.05; Aggregate Welfare Maximizing Policy
Figure 5: Offshoring and Welfare with search frictions ($\rho = 1.5$, $\sigma = 4$)

$A=1, L=1, \gamma=2/3, z=.2, ft=.1, c=.1, \mu=.85, \delta=.5$
Figure 6: Offshoring and Welfare with search frictions ($\rho = 3, \sigma = 4$)

$A=1,L=1, \gamma=2/3,z=0.2,ft=0.1,c=0.1,\mu=0.85,\delta=0.5$
Figure 7: Offshoring and Welfare with search frictions ($\sigma = 2.5$)

A=1, L=1, $\gamma = 2/3, z = 0.2, f_t = 0.1, c = 0.1, \mu = 0.85, \delta = 0.5; \rho = 1.5$

A=1, L=1, $\gamma = 2/3, z = 0.2, f_t = 0.1, c = 0.1, \mu = 0.85, \delta = 0.5; \rho = 3$
Figure 8: Offshoring and welfare with Compensating Policies

\[ A=1, L=1, \gamma=\frac{2}{3}, z=.2, ft=.1, c=.1, \mu=.85, \delta=.5, \rho=3, \sigma=4, W=-6.53 \]
Figure 9: Offshoring and Welfare with alternative policies

Figure 9a: Offshoring and Unemployment

Figure 9b: Offshoring and Wages

Figure 9c: Offshoring and Worker Welfare

Figure 9d: Offshoring and Aggregate Welfare

A=1,L=1,σ=4,γ=2/3,z=.2, p=3,ft=.1,c=.1,μ=.85,δ=.5;Aggregate Welfare Maximizing Policy