Threatening to Offshore in a Search Model of the Labor Market

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Abstract

We develop a two-country labor search model in which a multinational firm engages in production sharing by hiring both domestic and foreign labor in order to produce. The key innovation is the sequential nature of wage bargaining which allows the multinational to use the possibility of shifting production overseas as part of its outside option in wage negotiations. Within this environment, we derive a model-based estimate of the aggregate effect of the threat of offshoring on global wages and labor market allocations. We find that while the threat of offshoring lowers wages by as much as 6.5 percent in the source country, this lower wage reduces the unemployment rate by 4.5 percentage points. In constrast, the threat of offshoring raises wages in the recipient country by 7.5 percent leading to an increase in the unemployment rate of 2.75 percentage points. Consumption is higher in both countries. All told, households in the source country experience welfare gain of 1.6 percent of steady state consumption as a result of the threat of offshoring, while households in the recipient county experience a welfare loss of 0.15 percent.

Keywords: Unemployment, Wage bargaining, Multinational, Outside option

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1 Introduction

Does the threat of offshoring have an important effect on wages and employment? Judging by the amount of media attention devoted to the impact of offshoring on the US labor market, the popular perception suggests the answer is "yes". [1] Moreover, anecdotal evidence supports this perception. In September 2010, Sergio Marchionne, the CEO of the Italian automaker Fiat explicitly threatened to pull all production out of Italy and offshore it to lower cost plants located in Serbia and Poland if unions did not accept major concessions in labor negotiations. [2] The threat was apparently credible as unions eventually gave in to many of the concessions. In some sense this outsome is not surprising. Intuitively, in an environment of increased globalization the increased ease with which multinational firms can move production plants offshore should strengthen the outside options of these firms in wage negotiations.

As appealing as this argument may seem, standard models of international macroeconomics are ill-suited to provide a rigorous answer regarding the importance of offshoring for labor market outcomes. In standard models labor markets are assumed to be perfectly competitive and wages are determined in spot markets. Fear that a firm may relocate a job abroad simply doesn't enter into the wage determination process in those models. Yet, as the Fiat gamble clearly demonstrates, one channel through which offshoring may have an important impact on wages, stressed in Rodrik (1997), for example, is via the associated loss in workers' bargaining power and the decline in economic rent that accrues to them. In a recent attempt to quantify this channel, Blinder (2009) estimates that offshorability in the services sector, that is, the characteristics of a job that makes it more likely to be offshored, may lower wages by up to 14 percent for the service jobs most at risk of being moved abroad, a sizeable number. However, this estimate is not derived from a fully articulated general equilibrium modeling framework.

This is precisely the purpose of this paper. In order to analyze the effect of the threat of offshoring on wages and labor market allocations, we develop a relatively standard open economy model in which the labor market is subject to search frictions a la Mortensen/Pissarides in which firms and workers bargaining over wages. Wage bargaining is essential to modeling the threat of offshoring. In our framework, firms need to post vacancies to fill job openings, but can do so either in the domestic or foreign markets. Since firms operate both domestic and foreign plants, offshoring in our model captures an intra-firm production-sharing activity whereby the parent company is able

[1] A recent AP poll shows that nearly 70 percent of Americans think offshoring hurts the US economy. Not surprisingly, this sentiment has worked its way into the political arena. Mankiw and Swagel (2005) called offshoring the single most important, and least understood, economic issue for the 2004 US presidential campaign. Most recently, in late 2010, the Obama administration proposed legislation, the Creating American Jobs and End Offshoring Act, that would impose a direct tax on firms that are engaged in offshoring domestic jobs.

[2] "Fiat: Marchionne's gamble", Financial Times, Sept. 29, 2010.

to shift production from the domestic country to its foreign affiliates.

Within this environment, we model the threat of offshoring by introducing a sequential matching problem where firms first post vacancies in the domestic market (the day market), but have the outside option of waiting to subsequently fill the vacancies with foreign workers (the night market). We show that as a result of these sequential labor markets, the ability of the firm to exercise the outside option of offshoring production is taken into account in the wage bargaining process and, *ceteris paribus*, lowers negotiated domestic wages. In contrast, the downward effect of offshoring on wages disappears if we assume that the domestic and foreign labor markets clear simultaneously. To isolate the effect of the threat of offshoring on labor market conditions, we can therefore look at the difference in equilibrium prices and allocations between the sequential and simultaneous labor market structures.

Our main result is that the threat of offshoring production can put significant downward pressure on wages in the source country. In out benchmark calibration, the possibility that jobs may be offshored lowers domestic wages by roughly 5 percent compared to a world in which firms and workers do not internalize this outside option in the bargaining process. But, as a result of the fall in wages, employement also rises substantially, increasing 3.5 percent. For the foreign country, the recipient of offshored jobs, we find a quantitatively larger effect on wages, with the threat of offshoring raising wages nearly 8 percent. All told, the welfare costs of the threat of offshoring for in both the source and recipient countries is estimated to be about 1-1/2 percent of steady state consumption. This estimate is an order of magnatude larger than typical estimates of the welfare costs of business cycle fluctuations.

Our paper adds to a young literature that builds on Davidson, Martin, and Matusz (1988) by embedding labor market search frictions into open economy models (see, e.g., Helpman and Itskhoki (*forthcoming*), Helpman, Itskhoki, and Redding (*forthcoming*), Boz, Durdu, and Li (2009), Dutt, Mitra, and Ranjan (2009), and Mitra and Ranjan (2010)). Much of this work has concentrated on the impact of labor market frictions on trade flows, although Mitra and Ranjan (2010) explicitly considers offshoring. Our work, like Felbermayr, Prat, and Schmerer (2010), differs in that it focuses instead on wage formation. In particular, what is unique about our work is that by concentrating specifically on the impact of the threat of offshoring on wage negotiation outcomes we are able to provide a model-based answer to a policy-relevant question that has thus far proved largely elusive. To this end, our model is also related to the earlier work of Borjas and Ramey (1995) who studied the impact of trade on firms' rent, wages, and employment in a model in which firms and unions bargain over pay and the number of workers employed. Finally, our results complement the perviously mentioned empirical findings of Blinder (2009) who classifies the offshorability of jobs and its impact on wages and employment.

The idea that the value of outside options is important in wage negotiations has recently been challenged by Hall and Milgrom (2008). They argue that threatening to walk away from the negotiating table once a match has been formed is not credible. Instead, the more credible threat is to extend bargaining: job-seekers' best option is to try to hold on for a better deal, while firms should delay negotiations as long as possible. This approach to wage bargaining lowers the influence of outside options on negotiated outcomes and is useful for solving the well known Shimer (2006) puzzle in dynamic labor search models. However, in the case of the firms' ability to move production offshore, the value of offshoring may be so high that the threat of terminating employment becomes credible as demonstrated by Fiat's threat to Italian workers. Moreover, Lachowska (2010) presents empirical evidence using Swedish data that, in fact, outside options are important in the wage formation process.

The remainder of this paper is organized as follows. The next section presents some facts about the global activities of U.S. multinational firms. We then present the model. Section 4 describes the baseline calibration and presents the main results. In Section 5 we examine how the threat of offshoring influences the response of global wages and labor market allocations to a trade liberalization. Finally, Section 6 concludes.

2 U.S. Multinationals' Operations

We start our analysis by reviewing the extent of U.S. multinational firms' global activities using the Bureau of Economic Analysis' annual survey of U.S. multinational companies and their foreign affiliates. The BEA's statistics are derived from the universe of U.S. parents companies and their foreign affiliates operating in all industries and provide a very comprehensive look at the operations of multinational companies around the world. In this section, we will concentrate on the operations of non-bank multinational companies and their majority-owned foreign affiliates.

Figure 1 shows the evolution of U.S. multinationals' foreign employees as a share of their employment in the United States over the past two decades. Since 1990, that share rose roughly 60 percent, with the increase in U.S. multinationals' employment in developing Asia and Latin America accounting for about half the increase in total foreign employment. Clearly, U.S. multinational firms have shifted a sizeable part of their operations abroad.

Many reasons certainly underlie this trend, from a drop in trade and communications costs to difference in taxation and regulation across countries. But, as shown in Figure 2, the differential in real labor compensation between U.S. parent companies and their foreign affiliates may have also provided a strong incentive for multinational to increase their foreign employment. For instance, in 2007, the average compensation of employees at foreign affiliates was about 33 percent less than employees at parent companies in the United States, with the differential being even larger for

managers and professionals. Employees at foreign affiliates located in developing Asia or Latin America were paid sharply less, earning about only one third of U.S. employees' compensation.

Differences in productivity could account for the differential in real labor compensation across location of activities. Moreover, the tasks performed by U.S. and foreign employees may be substantially different and warrant different levels of pay, even within similar categories of employees (e.g., managers and professionals). However, abstracting from those differences, disparity in labor market institutions across countries could account for the gap in labor compensation. For instance, the OECD index of employment protection places the United States as the most flexible labor market and Brazil, India, or Mexico as one of those most protected. Our model will emphasize this aspect of the data as a source of offshoring.

Finally, operations of foreign affiliates have also risen in importance as a source of income for U.S. multinationals. Figure 4 shows that while net income from foreign affiliates accounted for less than 35 percent of U.S. parent companies' net income in 1985, it rose briskly in importance and, by 2007, even surpassed the income derived from activities in the U.S market.

3 The Model

We extend the textbook Pissarides (2000) labor search model to a two country setting. The key innovation is to introduce international production sharing into the model in such a way that it allows the opportunity to move production internationally to act as an outside option in wage negotiations. It is through this outside option that we introduce the threat effect of offshoring on global wages and labor market allocations.

3.1 Households

There is a continuum of identical households in both the Home and Foreign economy. The representative household in each country consists of a continuum of measure one of family members. During a given time period, each member of the household either works, is actively searching for a job, or is out of the labor force enjoying leisure. Individuals in the Home country search for jobs with domestic firms while individuals in the Foreign country optimally allocate search activity across two separate labor markets: one for domestic and one for offshored jobs, respectively. We rule out on-the-job search and assume that total household income in each country is divided evenly amongst all individuals, so each individual within a country has the same consumption. This later assumption follows Andolfatto (1996) and Merz (1995) and is common in general equilibrium search-theoretic models of labor markets.

Aggregate consumption in the Home country is measured by a composite consumption index

that is a CES aggregate of both a domestic and foreign final good

$$c_t \equiv \left(\lambda^{\frac{1}{\zeta}} c_{H,t}^{\frac{(\zeta-1)}{\zeta}} + (1-\lambda)^{\frac{1}{\zeta}} c_{F,t}^{\frac{(\zeta-1)}{\zeta}} \right)^{\frac{\zeta}{\zeta-1}} \tag{1}$$

where the parameter $\lambda \in (0,1)$ governs the share of the Home final good in the composite consumption index and $\zeta > 0$ is the constant elasticity of substitution between the Home and Foreign final good, $c_{H,t}$ and $c_{F,t}$, respectively. There exists an identical consumption index denoting Foreign aggregate consumption, c_t^*, which aggregates Foreign consumption of the Home and Foreign produced final goods, $c_{H,t}^*$ and $c_{F,t}^*$, respectively.

We normalize $p_{H,t} = 1$, so that all goods are valued in terms of the Home produced final good. With this normalization, the aggregate consumption-based price index in the Home country is given by

$$p_t \equiv \left(\lambda + (1-\lambda) p_{F,t}^{(1-\zeta)} \right)^{1/(1-\zeta)} \tag{2}$$

where $p_{F,t}$ is the price of imports from the Foreign country relative to the price of domestically produced goods. Equivalently, $p_{F,t}$ is the terms of trade for the Home country.

Demand functions for the Home and Foreign final consumption goods are given by

$$c_{H,t} = \lambda \left(\frac{1}{p_t} \right)^{-\zeta} c_t, c_{F,t} = (1-\lambda) \left(\frac{p_{F,t}}{p_t} \right)^{-\zeta} c_t, \tag{3}$$

An atomistic individual in the representative household is engaged in one of three activities: work, actively searching for employment, or enjoying leisure. In terms of notation, let s_t denote the time spent searching by agents in the Home country to achieve the desired level of employment with the domestic firm, n_t. An individual searching in the market for domestic jobs successfully finds employment with a domestic firm with probability $k_h(\theta_t)$, where θ_t is a measure of labor market tightness for the Home labor market defined below.

The utility of the representative household is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - h\left((1 - k_h(\theta_t)) s_t + n_t \right) \right] \tag{4}$$

We assume that households can purchase state-contingent bonds b_{t+1} that are traded internationally, so that asset markets are complete. The household chooses sequences of consumption, real bond holdings, and search activity to maximize lifetime utility subject to an infinite sequence of flow budget constraints

$$p_t c_t + \int p_{bt,t+1} b_{t+1} = w_t n_t + (1 - k_h(\theta_t)) s_t \chi + b_t + d_t \tag{5}$$

where: p_t is the aggregate price index in the Home country; w_t is the real wage paid to a worker in the Home country; $\chi$is the unemployment benefit that accures to individuals actively searching for

employment; $p_{bt,t+1}$ is the price of an asset that pays one unit of the domestic consumption good in a particular state of nature at time $t+1$; finally, d_t denotes the dividend paid to households by intermediate goods producing firms.

The household also faces perceived laws of motion for the number of jobs at domestic firms.

$$n_t = (1-\rho_h)n_{t-1} + s_t k_h(\theta_t) \tag{6}$$

The probability that a searching individual will be matched in a job operated by the domestic intermediate goods producing firm is $k_h(\theta_t)$, which in turn depends on labor market tightness. Labor market tightness is defined as $\theta_t = v_{h,t}/s_t$, where $v_{h,t}$ is the number of vacancies posted by domestic intermediate goods producing firm in the Home labor market. Finally, with fixed probability $\rho_h = \rho_h^o + (1-\rho_h^o)\rho_h^n$, which is known to both households and firms, an existing domestic job in the Home country is terminated at the beginning of period t. Termination may occur as a result of an existing job becoming obsolete, which occurs with probability ρ_h^o. Alternatively, even if a job remains operable separation may occur with probability ρ_h^n.

As shown in Appendix 7, the first order conditions on c_t and b_{t+1} can be manipulated into a standard consumption Euler equation

$$u'(c_t) = \beta \frac{1}{p_{bt,t+1}} E_t u'(c_{t+1}) \tag{7}$$

which defines the one period ahead stochastic discount factor, $\Xi_{t+1|t} = \beta u'(c_{t+1})/u'(c_t)$, with which firms, in equilibrium, discount flow profits.

Combining the first order conditions on s_t and n_t yields an optimal search condition in the labor market for domestic intermediate goods production

$$\frac{h_t'(lfp_t)}{u_t'(c_t)} = k_h(\theta_t)\left(w_t + (1-\rho_h)E_t\left(\Xi_{t+1|t}\frac{\delta_{t+1}}{u_{t+1}'(c_{t+1})}\right)\right) + (1-k_h(\theta_t))\,\chi \tag{8}$$

In equation 8 the variable δ_{t+1} denotes the shadow value on the household's beginning-of-period $t+1$ employment stock in domestic, n_t. Additionally, out of convenience we have used the notation $lfp_t = (1-k_h(\theta_t))s_t + n_t$ to denote labor force participation.

The Foreign household problem is similar but involves allocating search activity across two distinct labor markets: the one for domestic jobs and the one for offshored jobs. In terms of notation, let $s_{f,t}^*$ denote search activity in the market for domestic jobs in the Foreign country, $n_{f,t}^*$, and let $s_{h,t}^*$ denote search activity in the market for offshored jobs, $n_{h,t}^*$. Optimization on the part of the Foreign household will yields an analogue to equation 7 as well as two optimal search conditions–one for each labor market–analogous to equation **??**. Details for the solution of the Foreign household's optimization problem are given in Appendix 7.

3.2 Production

Firms in the Home country are multinationals in the sense that they engage in international production sharing. In contrast, firms in the Foreign country only produce domestically. Regardless of where physical production takes place, firms in either country must pay a sunk cost to create a job opening.[3] Once an opening is created, it must then be filled with a worker, which requires posting a vacancy in a frictional labor market. Firms in the Foreign country only post vacancies domestically, while the Home multinational posts vacancies both at Home as well as abroad. We assume that the multinational in the Home country respects local labor market institutions and pay workers a domestic currency wage when engaging in offshore production activity.

3.2.1 The Home Multinational Firm

The multinational firm in the Home country produces output, denoted y_t, using both domestic and foreign labor and sells that output in perfectly competitive goods markets both at home and abroad. The multinational chooses sequences of vacancy postings in each of the two distinctive labor markets to hit a target level of employment both domestically and abroad. The goal is to maximize discounted lifetime profits subject to the production technology and the respective laws of motion for employment.

$$\Pi_{it} = \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left[\frac{p_{i,t}}{p_t} z_t f(n^f_{h,t}, n^{*f}_{h,t}) - w_{h,t} n^f_{h,t} - q_t(1+\tau) w^*_{h,t} n^{*f}_{h,t} - \gamma_h v_{h,t} - \gamma^*_h v^*_{h,t} \right] \tag{9}$$

subject to:

$$n^f_{h,t} = (1-\rho) n^f_{h,t-1} + v_{h,t} k_f(\theta_{h,t}) \tag{10}$$

$$n^{*f}_{h,t} = (1-\rho^*) n^{*f}_{h,t-1} + v^*_{h,t} k_f(\theta^*_{h,t}) \tag{11}$$

Where the probability that a job posting will be matched with a Home worker in the domestic labor market and a Foreign worker employed in a job offshored from the Home country is given by $k_f(\theta_{h,t})$ and $k_f(\theta^*_{h,t})$, respectively. The parameters γ_h and γ^*_h denote the vacancy posting cost in the Home and Foreign market, respectively. As mentioned above, the wage paid to Foreign workers is paid in units of the foreign currency, so the intermediate goods producing firm must internalize movements in the real exchange rate in making its optimal offshoring decision. The multinational must pay an iceburg cost, τ, in order to produce abroad. Finally, note that vacancy postings in the Foreign labor market, $v^*_{h,t}$, are a drain on real resources in the Home country. In other words, the real exchange rate is assumed to not factor into the cost of posting vacancies, although conceivably it could.

[3] This aspect of the model builds on Fujita and Ramey (2006).

As shown in Appendix 8, the first order conditions on $v_{h,t}$ and $n_{h,t}$ can be manipulated into a vacancy posting condition necessary to fill an operable, vacant domestic job. The vacancy posting condition is given by

$$\frac{\gamma_h}{k_f(\theta_{h,t})} = z_t f_{1,t} - w_{ht} + (1-\rho)E_t\left[\Xi_{t+1|t}\frac{\gamma_h}{k_f(\theta_{h,t+1})}\right] \tag{12}$$

Similarly, the vacancy posting condition for filling vacant, operable offshored jobs can be obtained by manipulating the first order conditions on $v^*_{h,t}$ and $n^{*f}_{h,t}$ can be manipulated into

$$\frac{\gamma^*_f}{k_f(\theta^*_{h,t})} = mr_t z_t f_{2,t} - q_t(1-\tau)w^*_{h,t} + \beta(1-\rho^*)E_t\left[\Xi_{t+1|t}\frac{\gamma^*_f}{k_f(\theta^*_{h,t+1})}\right] \tag{13}$$

The vacancy posting conditions simply say that, at the optimal choice, once a position is created the cost incurred by the firm to post vacancies in order to fill the vacant position is equated to the discounted expected value of profits from the match. This condition is a free-entry condition in the posting of vacancies.

3.2.2 The Foreign Firm

The firm in the Foreign country produces output, denoted y^*_t, using only domestic labor. In order to do so it chooses sequences of vacancy postings to hit a target level of domestic employment. The goal is to maximize discounted lifetime profits subject to the production technology and the law of motion for domestic employment.

$$\Pi^*_{it} = \sum_{t=0}^{\infty}\beta^{*t}\frac{\lambda^*_t}{\lambda^*_0}\left[\frac{p^*_{i,t}}{p^*_t}z^*_t f^*(n^{f*}_{h,t}) - w^*_{f,t}n^{*f}_{f,t} - \gamma^*_f v^*_{f,t}\right] \tag{14}$$

subject to:

$$n^{*f}_{f,t} = (1-\rho^*)n^{*f}_{f,t-1} + v^*_{f,t}k_f(\theta^*_{f,t}) \tag{15}$$

where the probability that a job posting will be matched with a Foreign worker in the domestic labor market is given by $k_f(\theta^*_{h,t})$ and γ^*_f denotes the vacancy posting cost in the Foreign labor market.

The vacancy posting condition for the Foreign firm is given by

$$\frac{\gamma^*_f}{k_f(\theta^*_{f,t})} = z^*_t f^*_{1,t} - w^*_{f,t} + \beta^*(1-\rho^*)E_t\left[\Xi^*_{t+1|t}\frac{\gamma^*_f}{k_f(\theta^*_{f,t+1})}\right] \tag{16}$$

3.3 Wage Determination

The wage paid in any given job is determined in via Nash bargain between a matched worker and firm pair. The equilibrium of the economy has a total of three wages: two paid by the multinational

paid to domestic and offshore workers, respectively, and one paid by the Foreign firm to domestic workers.

In terms of notation, for the Home household let W_t denote the value of a domestic job and let U_t denote the value of the outside option, unemployment. For the Home multinational, let $J_{h,t}$ denote the value of a domestic operable job and let $V_{h,t}$ denote the value of the outside option, unemployment. Hence, the value of a domestic job to the Home household is given by $\mathbf{S_t^H} = W_t - U_t$ and the value to the Home multinational is given by $\mathbf{S_{h,t}^F} = J_{h,t} - V_{h,t}$. The analogous variables in for the Foreign domestic labor market are given by $W^*_{f,t}$, $U^*_{f,t}$, $J^*_{f,t}$, $V^*_{f,t}$, defining the surpluses $\mathbf{S^{*H}_{f,t}}$, and $\mathbf{S^{*F}_{f,t}}$ for the Foreign household and the firm, respectively. Finally, the value of an offshored job to the Foreign household is given by $W^*_{h,t}$ while the outside option is denoted $U^*_{h,t}$, giving rise to the value of an offshored job $\mathbf{S^{*H}_{h,t}}$. For the Home multinational, the value of an offshored job is denoted $J_{f,t}$ while the outside option is given by $V_{f,t}$, defining the surplus $\mathbf{S^F_{f,t}}$. A key thing to note is that the outside option of walking away from a domestic labor market match potentially differs from the outside option of walking away from an international labor market match.

Two alternative economies are considered. In both firms engage in offshoring activity; instead, what differentiates the two economies is whether or not the possibility of engaging in an international employment relationship can be used as an outside option (threat) in domestic wage negotiations (or vice versa). We discuss this more in the following two subsections describing the economy with sequential versus simultaneous wage bargaining, respectively.

3.3.1 Simultaneous Wage Bargaining (No Threat of Offshoring)

We begin with an economy in which bargaining in the market for domestic jobs occurs simultaneously with bargaining in the market for offshored jobs. In this setup, the simultaneous nature of wage negotiations implies that the participation in the market for offshored (domestic) jobs does not factor into the outside option of firms and workers engaged in domestic (international) wage negotiations.

Under simulataneous bargaining, the wage for domestic workers employed by the multinational in the Home country is given by

$$\begin{aligned} w_{h,t} &= (1-\eta)\chi + \eta(z_t f_{1,t} + \gamma) \\ &\quad +(1-\rho)E_t\left[\Xi_{t+1|t}\left(\eta(1-k^f_{h,t})\mathbf{S^F_{h,t+1}} - (1-\eta)(1-k^h_t)\mathbf{S^H_{t+1}}\right)\right] \end{aligned} \tag{17}$$

The wage for domestic workers employed by the Foreign firm is given by

$$\begin{aligned} w^*_{f,t} &= (1-\eta^*)\chi^* + \eta^*(z^*_t f^*_{1,t} + \gamma^*) \\ &\quad +(1-\rho^*)E_t\left[\Xi^*_{t+1|t}\left(\eta^*(1-k^{*f}_{f,t})\mathbf{S^{*F}_{f,t+1}} - (1-\eta^*)(1-k^{*h}_{f,t})\mathbf{S^{*H}_{f,t+1}}\right)\right] \end{aligned} \tag{18}$$

Finally, the wage for Foreign workers employed in an offshored job by the Home multinational is given by

$$\begin{aligned} w^*_{h,t} &= (1-\Delta_t)\chi^* + \Delta_t(z_t f_{2,t} + \gamma^*) \\ &\quad +(1-\rho^*)E_t\left[\Xi_{t+1|t}\left(\Delta_t(1-k^{*f}_{h,t})\mathbf{S^F_{f,t+1}}\right) - \Xi^*_{t+1|t}(1-\Delta_t)\left((1-k^{*h}_{h,t})\mathbf{S^{*H}_{h,t+1}}\right)\right] \end{aligned} \tag{19}$$

where $\Delta_t = \frac{\eta}{1-\eta(1-(1/(1-\tau)q_t))}$ is a bargaining weight that is a function of the real exchange rate.

The general structure of all the Nash wage solutions under simultaneous bargaining is that the wage is a weighted average of the marginal productivity of an additional worker and the outside option of the worker. With regard to outside options under simultaneous bargaining, if the worker walks away from a match he/she receives the unemployment benefit, whereas if the firm walks away from a match it receives the value of an unfilled vacancy, which as shown in section 3.4 is driven to the sunk cost of creating the position in the first place through free entry.

3.3.2 Sequential Wage Bargaining (Threat of Offshoring)

The threat of offshoring is modeled through the introduction of a sequential bargaining problem whereby, in any given period, bargaining in purely domestic employment relationships (ie, domestic workers matched with domestic firms) occurs prior to bargaining in international employment relationships (ie, domestic firms matched with foreign workers). Thus, if a searching firm (worker) fails to match in the market for domestic employment there is always the possibility of subsequently making a match in the market for offshored jobs within the same period. In this setup, both sides of the search market take into account the possibility of entering into an employment relationship with a foreign worker (firm) in the respective outside option that enters into wage negotiations.

Under sequential bargaining, the wage for domestic employment relationships in the Home country is given by

$$\begin{aligned} w_{h,t} &= (1-\eta)\chi + \eta(mr_t z_t f_{1,t} + \gamma + (1-k^f_{h,t})\gamma*) \\ &\quad +(1-\rho)E_t\left[\Xi_{t+1|t}\left(\eta(1-k^f_{h,t})\mathbf{S^F_{h,t+1}} - (1-\eta)(1-k^h_{h,t})\mathbf{S^H_{t+1}}\right)\right] \\ &\quad -\eta\beta(1-\rho^*)E_t\left[\Xi_{t+1|t}(1-k^f_{h,t})k^{*f}_{h,t}\mathbf{S^F_{f,t+1}}\right] \end{aligned} \tag{20}$$

The wage for domestic workers employed by the Foreign firm is given by

$$\begin{aligned} w^*_{f,t} &= (1-\eta^*)\chi^* + \eta^*(z^*_t f^*_{1,t} + \gamma^*) \\ &\quad +(1-\rho^*)E_t\left[\Xi^*_{t+1|t}\left(\eta^*(1-k^{*f}_{f,t})\mathbf{S^{*F}_{f,t+1}} - (1-\eta^*)(1-k^{*h}_{f,t})\mathbf{S^{*H}_{f,t+1}}\right)\right] \\ &\quad +(1-\rho^*)(1-\eta^*)E_t\left[\Xi^*_{t+1|t}(1-k^{*h}_{f,t})k^{*h}_{h,t}\mathbf{S^{*H}_{h,t+1}}\right] \end{aligned} \tag{21}$$

Finally, the wage for Foreign workers employed in an offshored job by the Home multinational is given by

$$\begin{aligned} w^*_{h,t} &= (1-\Delta_t)\chi^* + \Delta_t(z_t f_{2,t} + \gamma^*) \\ &\quad +(1-\rho^*)E_t\left[\Xi_{t+1|t}\left(\Delta_t(1-k^{*f}_{h,t})\mathbf{S^F_{f,t+1}}\right) - \Xi^*_{t+1|t}(1-\Delta_t)\left((1-k^{*h}_{h,t})\mathbf{S^{*H}_{h,t+1}}\right)\right] \end{aligned} \tag{22}$$

3.4 Free Entry Conditions

The number of job openings created in both the Home and Foreign labor markets is pinned down by a free entry condition which drives the value of an unfilled vacancy to the creation cost. The free entry condition in the Home domestic labor market is given by

$$V_{h,t} = \Gamma ne_t \tag{23}$$

where: $V_{h,t}$ is the value of an unfilled domestic vacancy to the Home multinational; Γ is the fixed cost of creating a domestic job opening; and ne_t is the number of doemstic openings.

Similarly, the free entry condition into the Foreign labor market for offshored jobs is given by

$$V_{f,t} = \Gamma ne^*_{h,t} \tag{24}$$

Finally, the free entry condition into the Foreign labor market for domestic jobs is given by

$$V^*_{f,t} = \Gamma^* ne^*_{f,t} \tag{25}$$

3.5 Matching Technology

Matches between unemployed individuals searching for jobs and firms searching to fill vacancies are formed according to a matching technology. There are three distinct labor markets in this model and each one requires its own matching function. All take a similar form.

Letting $m(s_t, v_{h,t})$ denote matches between the Home intermediate goods producing firm and Home workers, the evolution of total domestic employment in the Home country is given by

$$n_t = (1-\rho_h)n_{t-1} + m(s_t, v_{h,t}) \tag{26}$$

Using similar notation, the evolution of matches between Foreign workers employed by Foreign firms is given by

$$n^*_{f,t} = (1-\rho^*_f)n^*_{f,t-1} + m(s^*_{f,t}, v^*_{f,t}) \tag{27}$$

Finally, the evolution of offshored jobs from the Home country is given by

$$n^*_{h,t} = (1-\rho^*_f)n^*_{h,t-1} + m(s^*_{h,t}, v_{f,t}) \tag{28}$$

3.6 Equilibrium

Taking as given the trade costs, τ, a private sector equilibrium is made up of the endogenous processes c_t, c_t^*, $\frac{1}{p_t}$, $\frac{p_{F,t}^*}{p_t^*}$, w_t, $w_{h,t}^*$, $w_{f,t}^*$, s_t, $s_{h,t}^*$, $s_{f,t}^*$, θ_t, $\theta_{h,t}^*$, $\theta_{f,t}^*$, n_t, $n_{h,t}^*$, $n_{f,t}^*$, ne_t, $ne_{h,t}^*$, $ne_{f,t}^*$, z_t, z_t^*, q_t that satisfy: the risk sharing arrangement

$$q_t = \frac{u'(c_t)}{u^{*\prime}(c_t^*)} \tag{29}$$

the definitions of the price indexes in the Home and Foreign country (2 equations); optimal search behavior on the part of both the Home and Foreign household, represented by equation (**??**) for the Home household as well as its Foreign counterparts (3 equations); the optimality conditions for both final and intermediate goods producing firms in both the Home and Foreign countries, represented by (12) and (**??**) for the Home firms as well as its Foreign counterpart (3 equations); the free entry conditions, given by equations XX through YY; the wage equations, given by equations XX through YY; the laws of motion for employment, given by (26) through (28); and the exogenous process for technology in each country;

$$z_t = \rho_z z_{t-1} + \varrho_t \tag{30}$$

$$z_t^* = \rho_z^* z_{t-1}^* + \varrho_t^* \tag{31}$$

Finally, we have the resource constraints for each of the two countries, which are given below for the Home and Foreign country, respectively.

$$z_t f(n_t, n_{h,t}^*) = \lambda \left(\frac{1}{p_t}\right)^{-\zeta} \left(c_t + \left(\frac{1+\tau}{q_t}\right)^{-\zeta} c_t^*\right) + \gamma v_{h,t} + \gamma^* v_{h,t}^* + \Gamma n e_t n_t + \Gamma^* n e_{h,t}^* n_{h,t}^* \tag{32}$$

$$z_t^* f(n_{f,t}^*) = (1-\lambda) \left(\frac{p_{F,t}^*}{p_t^*}\right)^{-\zeta} \left(((1+\tau^*)q_t)^{-\zeta} c_t + c_t^*\right) + \gamma^* v_{f,t}^* + \gamma v_{f,t} + \Gamma^* n e_{f,t}^* n_{f,t}^* \tag{33}$$

All told, the system is 22 equations in 22 unknowns.

4 Quantitative Analysis

In this section, we derive a model-based estimate of the quantitative magnitude of the effect that the threat of offshoring has on global wages and labor market allocations. We begin with a description of the baseline parameterization and then present the main results.

4.1 Calibration

The parameter values used in the baseline model are summarized in Table 1. The Home country is calibrated to US data, where the existing labor search literature acts as a guide on parameter values. The calibration of the Foreign economy is, however, more contentious.

Our general strategy is to parameterize the Foreign economy by introducing three primary sources of asymmetry into the model. First, as discussed in section 3.2 we assume the production structure is asymmetric in that the multinational only exists in the Home country. This implies that all offshoring activity originates in the Home country and flows to the Foreign recipient and is intended to capture the simple idea that the US is a much larger source of offshoring activity then it is a recipient. Second, we assume that labor force participation is higher in the Home country than is the case in the Foreign country and that this difference reflects an asymmetry in preferences over leisure. Finally, we introduce asymmetry in labor markets institutions by imposing relatively larger labor market frictions in the Foreign economy. This third assumption is intended to capture the commonly held perception that US labor markets are more dynamic and flexible relative to much of the rest of the world.

Production. The functional form of the production function of the Home-based multinational is a CES aggregate of domestic and offshored labor

$$y_t = z_t \left(\alpha n_{h,t}^{\vartheta} + (1-\alpha) n_{h,t}^{*\vartheta} \right)^{\frac{1}{\vartheta}}$$

We assume $\vartheta = 0$, so that production is a Cobb-Douglas aggregate of (imperfectly substitutable) domestic and offshored labor. The share of domestic labor input in final production of the multinational is set to $\alpha = 0.90$, about the same value as was used in Burstein, Kurz, and Tesar (2007).

In contrast, Foreign production is assumed to be linear in domestic labor only, $y_t^* = z_t^* n_{f,t}^*$. Thus, the first key source of asymmetry in the model comes from the fact that offshoring is assumed to run North-South only.

With regard to technology, we assume that the level of aggregate technology is symmetric across the two countries, so that $z = z^* = 1$. This contrasts with much of the literature on offshoring in which technological differences are the primary source of offshoring activity. Nonetheless, we impose this assumption in order to highlight the role of labor market institutions in driving the (intensive) offshoring decision and, hence, the main results in the paper.

Preferences. The model is calibrated to quarterly data, so we set the subjective discount factor to $\beta = \beta^* = 0.99$, yielding an annual real interest rate of about 4 percent.

The functional form for instantaneous utility is standard

$$u(c_t, lfp_t) = \frac{1}{1-\sigma} c_t^{1-\sigma} - \frac{\kappa}{1+1/\iota} lfp_t^{1+1/\iota} \tag{34}$$

where the risk aversion parameter is set to $\sigma = \sigma^* = 2$ for both the Home and Foreign household, consistent with much of the existing literature.

For the subutility function over participation, we introduce asymmetry to reflect differences in long run labor force participation rates observed across countries. We calibrate the Home country

Table 1: Baseline Calibration

Home Country			**Foreign Country**	
Parameter	Value	Description	Value	Parameter
		Production		
z	1	Steady state technology	1	z^*
ϑ	0	Elasticity of substitution between domestic and offshored labor		
α	0.90	Share of domestic labor in multinational production		
		Preferences		
β	0.99	Discount factor	0.99	β^*
σ	2	Risk aversion	2	σ^*
ι	0.18	Elasticity of participation	0.18	ι^*
κ	42.5	Scale parameter for subutility of leisure	58.0	κ^*
ζ	0.5	Elasticity of substitution between Home and Foreign goods	0.5	ζ^*
λ	0.88	Share of Home goods in consumption basket	0.69	λ^*
		Labor Market		
ξ	0.50	Elasticity of matching function	0.50	ξ^*
η	0.50	Worker's bargaining power	0.25	η^*
ρ	0.025	Job destruction rate	0.025	ρ^*
ψ	0.52	Matching efficiency	0.38	$\psi_h^* = \psi_f^*$
Γ	0.348	Fixed entry cost	0.348	Γ^*
γ_h	2.18	Vacancy posting cost in domestic labor market	4.47	γ_f^*
		Vacancy posting cost in offshored labor market	3.57	γ_h^*
χ	0.265	Unemployment benefit	0.137	χ^*
		Trade Costs		
τ	0	Iceburg cost		

to US data; specifically, we set $\iota = 0.18$ following Arseneau and Chugh (2008) who showed that this value for the elasticity of labor force participation with respect to the real wage delivers participation dynamics over the business cycle that match the U.S. data. Similarly, the scale parameter is set to $\kappa = 42.5$ to deliver a steady-state participation rate of 66 percent in the US. For the Foreign country, we maintain a symmetric elasticity of participation, $\iota^* = 0.18$, under the assumption that the business cycle dynamics of participation do not differ much across countries. However, we introduce asymmetry into the scale parameter in order to deliver a lower participation rate in the Foreign country than in the US. We set $\kappa^* = 58$ to deliver a steady-state participation rate of 59.2 percent, which is the average in annual Mexican data (1980 to 2008) taken from the World Bank World Development Indictors (WDI).

The elasticity of substitution between Home and Foreign goods in the final consumption basket

is symmetric across countries and set to $\zeta = \zeta^* = 0.5$. With regard to the weights of domestic and foreign goods in the final consumption good, λ and λ^* are chosen so that the import to GDP ratio is 12 and 26 percent in the Home and Foreign country, respectively. These numbers correspond to the average share of imports in GDP for the US and Mexico (1980 to 2010), respectively, taken from Haver Analytics.

Labor Markets. As mentioned above, our strategy for calibrating the labor markets hinges on the idea that the US labor market is relatively flexible relative compared to foreign labor markets. Hence, we calibrate the Home labor market to US data and then introduce asymmetries into the calibration of the Foreign labor market designed to capture the fact that there are greater frictions in the Foreign country. Cross-country asymmetries not withstanding, we will assume throughout that labor markets *within a country* are parameterized symmetrically.

For each of the segmented labor markets (one in the Home country and two in the Foreign country) we assume a Cobb-Douglas matching function of the following general form:

$$m(s_t, v_t) = \psi s_t^{\xi} v_t^{1-\xi}$$

For the Home country, the elasticity of matches with respect to unemployed job seekers is set to $\xi = 0.50$, which is in the midpoint of estimates typically used in the literature and is in line with results reported in Petrongolo and Pissarides (2001). Following much of the existing literature, we impose symmetry between the elasticity of the matching function and the Home worker's bargaining power, so that $\eta = 0.5$. The job separation rate in the Home country is set to $\rho_h = 0.025$, in line with Shimer (2005) who calculates the average duration of a job to be two-and-a-half years. Matching efficiency in the Home country, $\psi = 0.52$, is chosen so that the quarterly job-filling rate of a vacancy is 90 percent, in line with Andolfatto (1990). We set the cost of posting a vacancy to target a steady state level of market tightness in the home country of $\theta_t = 0.3$ which is a touch below the the measure obtained from JOLTS data. The resulting value is $\gamma_h = 2.18$. The entry cost is given by $\Gamma = 0.348$. Finally, we calibrate the worker's outside option in the Home country to 40 percent of the wages of employed individuals in the Home household, implying a value of $\chi = 0.27$. The resulting implied aggregate unemployment rate for the Home country in our baseline calibration is roughly 6 percent.

For Foreign country, there is little in the way of data to guide us in calibrating the labor market of the countries to which the U.S. primarily offshores. In light of this our strategy is as follows. We impose cross-country symmetry in the matching elasticity parameter, so $\xi^* = \xi = 0.5$, the average duration of a job, so that $\rho^* = \rho^* = 0.025$, and the job filling probabilities, so that $\gamma_f^* = 4.47$ and $\gamma_h^* = 3.57$ implying $k_f^{f*}, t = k_h^{f*}, t = 0.9$. As in the Home country, the entry cost is given by $\Gamma^* = 0.348$. We then introduce asymmetry aimed at capturing the general perception that that the countries to which the US offshores have labor markets that are more frictional.

First, workers in the Foreign country are assumed to have *less bargaining power* in wage negotiations relative to US workers, so that $\eta^* = 0.25$. Next, we calibrate matching efficiency in the market for domestic and offshore jobs to hit an unemployment rate of 12 percent, the average level of Mexican unemployment using data from the WDI. The resulting values are $\psi_h^* = \psi_f^* = 0.38$. Finally, we assume that the US is more generous in its provision of unemployment benefits relative to a country such as Mexico. Accordingly we calibrate χ^* to a replacement rate of 20 percent of the wages of employed individuals. The resulting value is $\chi^* = 0.14$.

Trade Costs. We assume that there are no trade costs in the baseline calibration, so that $\tau = \tau^* = 0$. Section 5 examines how a change in trade costs interacts with the threat of offshoring.

4.2 Main Result

The main results are presented in Table 3. For each variable of interest, the first two columns of numbers present steady state prices and allocations for the economy in which offshoring *is used as a threat* in wage negotiations for the Home and Foreign country, respectively. The third and fourth columns present similar numbers for the economy in which outsourcing *is not used as a threat*. Finally, the last two columns in the table show the percentage difference in each variable when moving from the "no threat" to the "threat" economy.

There are two things that stand out about the baseline economy in which offshoring is used as a threat in wage negotiations. First, there are differences in wages across countries despite the fact that the two counties have similar levels of steady state technology. In particular, when converted into common currency units, workers in the country with the country with relatively smaller labor market frictions—the Home country in the Baseline calibration—earn a wage that is roughly 25 percent higher ($w_h/(q_t w_{h,t}^*) = 1.25$). While a higher wage paid by multinationals for domestic relative to offshored workers is qualitatively consistent with data from the BLS, quantitatively our estimate is smaller than that observed in the actual data. (The data show that domestic workers earn four times the wage of foreign workers in offshored jobs.) Thus, there is room for improvement in the model along this dimension.

Intuitively, the reason for this is relatively-straight forward when the fact that job creation itself is a fundamental part of the production technology is taken into account.[4] Thus, despite similarities across the two countries in the technology for transforming labor input into the final good, owing to the smaller labor market frictions the Home country is more efficient at generating labor matches in the first place. In this sense, the Home country enjoys a technological advantage in transforming leisure into final output, hence it's workers enjoy a higher wage.

[4] This point is made clearly in Arseneau and Chugh (2009), in which the authors define a search-based notion of the marginal rate of transformation in a general equilibrium search model.

Table 2: Main Results

	Threat of Offshoring		**No Threat of Offshoring**		**Pct. Change**	
	Home	Foreign	Home	Foreign	Home	Foreign
			Aggregate Variables			
w	0.6624	0.6832	0.7034	0.6317	−6.19	7.54
c	0.3868	0.4401	0.3836	0.4384	0.82	0.37
LFP	0.6600	0.5900	0.6645	0.5861	−0.45	0.39
UE	0.0551	0.1160	0.0974	0.0884	−4.23	2.76
			Sector-specific Variables			
w_h	0.6624	0.6832	0.7034	0.6248	−6.48	8.55
w_f		0.6832		0.6328		7.38
s_h	0.0520	0.0125	0.0797	0.0085	−53.43	32.57
s_f		0.0690		0.0567		17.75
v_h	0.0173	0.0022	0.0104	0.0030	39.71	−34.40
v_f		0.0123		0.0160		−30.89
n_h	0.6236	0.0802	0.5998	0.0764	3.82	4.80
n_f		0.4413		0.4579		−3.76
			International Relative Prices			
ToT	1.2286	0.8139	1.2382	0.8076	−0.78	0.77
q	0.7727	0.7727	0.7657	0.7657	0.91	0.91

The second thing to notice is that the Home country enjoys a terms of trade advantage over the Foreign country. This owes in part to home bias in the utility function for domestically produced goods, but it also reflects differences in real labor market frictions across the two countries.

We turn now to the main results of the paper concerning the effect of the threat of offshoring on global wages and labor market allocations. As shown in the two right-hand columns in the top panel of the table, there is an asymmetric effect on aggregate wages across the two countries.[5] The treat of offshoring depresses the aggregate wage in the source country by roughly 6-1/4 percent, while it boosts aggregate wages in the recipient country by about 7-1/2 percent.

In terms of thinking about implications for global labor market allocations, households in the Home country respond to the lower wage by reducing labor force participation. In contrast, the multinational firm redirects search activity toward the domestic labor market in order to take advantage of the lower wage. Hence, domestic job creation increases. The end result is that the drop in labor force participation is primarily accommodated by movements from search activity into leisure so that the unemployment rate declines. Our baseline estimate reveals that the threat of

[5] The aggregate wage is an average of the wages in the market for domestic and offshored jobs, weighted by the relative size of each labor market in aggregate employment.

offshoring reduces aggregate unemployment in the source country by about 4-1/4 percentage points relative to an economy in which the threat of offshoring does not factor into wage negotiations. Despite the lower wage, the increase in employment boosts household income allowing consumption in the Home country to rise by about 3/4 percent.

For the recipient country, the higher wage induces more labor force participation on the part of the Foreign household and reduces search activity of both the multinational and the Foreign firm. Accordingly, job creation in the Foreign economy declines pushing the unemployment rate up 2-3/4 percentage points. Increases from the higher wage more than offsets the loss in household income from higher unemployment, resulting in a modest increase in consumption.

In summary, the response of global wages to the threat of offshoring in our model confirms general intuition: the wages of workers in the source country fall while the wages of workers in the recipient country rise. However, the results with respect to global labor market allocations are less intuitive. We find that, contrary to popular opinion, the threat of offshoring actually boosts employment it the source country and reduces employment in the recipient country.

4.3 Welfare Costs

We measure the welfare costs of exploiting the threat of offshoring in wage negotiations as the percent increase in steady state consumption that the household would require in order to be as well off in utility terms as under the allocation that obtains when offshoring cannot be used as a threat in wage negotiations. In order to do this, however, we need to account for distortions introduced into the labor markets across the two countries given our calibration. We do this by first calculating the welfare costs associated with the allocations that prevail under the threat of offshoring relative to the socially efficient allocation. We then calculate the welfare costs associated with the allocations that prevail in absence of the threat of offshoring again relative to the socially efficient allocation and then subtract the two. The resulting measure reveals the percent of steady state consumption that the representative agent requires in order to be indifferent to whether or not the threat of offshoring is used in wage negotiations, controlling for any fundamental distortions introduced through the choice of calibrated parameters.

In terms of notation, for the Home country let $\widetilde{U}$ be utility for the Home household under the reference allocation – that is, the allocation that obtains in the solution to the social planners problem. Let c^{Threat} and lfp^{Threat} denote allocations that obtain in the "threat" economy. Our measure of the welfare cost of the allocation under the threat of offshoring relative to the allocations under the social planners problem is given by ω^{Threat}, which is implicitly defined as that which solves the following

$$u\left((1+\omega^{Threat}/100)c^{Threat}, lfp^{Threat}\right) = \widetilde{U}$$

Thus, ω^{Threat} can interpreted as the percent increase in steady state consumption that would be required to make the Home household exactly indifferent to the allocation that prevails when the threat of offshoring is used in wage negotiations and the socially efficient allocation. A similar equation defines the welfare cost, $\omega^{*Threat}$, for the Foreign household.

Similarly, let $c^{NoThreat}$ and $lfp^{NoThreat}$ denote allocations that obtain in the "no threat" economy. Our measure of the welfare cost of the allocation in absence of the threat of offshoring is given by $\omega^{NoThreat}$, which is implicitly defined as that which solves the following

$$u\left((1+\omega^{NoThreat}/100)c^{NoThreat}, lfp^{NoThreat}\right) = \widetilde{U}$$

A similar equation defines the welfare cost, $\omega^{*NoThreat}$, for the Foreign household.

Our measure of the welfare cost of the threat of offshoring is then defined for the Home household as: $\omega = \omega^{Threat} - \omega^{NoThreat}$. Similarly,we define the welfare cost for the Foreign household in a similar manner as $\omega^* = \omega^{*Threat} - \omega^{*NoThreat}$.

Under the baseline calibration, we find $\omega = -1.6$ and $\omega^* = 0.15$. In other words, the Home household is actually better off in a welfare sense as a result of the threat of offshoring being used by the multinational in domestic wage negotiations. In contrast, the Foreign household is worse off—the Foreign household is willing to give up nearly 1/4 percent of steady state consumption.

5 Trade Liberalization and The Threat of Offshoring

In this section we examine how the threat of offshoring influences the response of wages and labor market allocations to a trade liberalization. Our trade liberalization comes in the form of a 10 percent decrease in the trade costs. In order to isolate the effect of the threat of offshoring we first analyze the effects of a trade liberalization assuming that offshoring cannot be used as an outside option in wage negotiations and then analyze the effects of a trade liberalization assuming that it can be used as an outside option. A comparison of the two sets of results isolates the effect of the threat of offshoring alone.

Results are presented in the table below. The first two columns present the percent change in steady state allocations as a result of a trade liberalization under the assumption that offshoring is not used as an outside option in wage negotiations. The last two columns present the same information under the assumption that offshoring can be used as an outside option.

In general, a trade liberalization raises wages in both countries regardless of whether or not offshoring is used as a threat. However, the increase in wages tends to be larger in the presence of the threat of offshoring. Thus, the threat of offshoring appears to amplify the increase in wages that occurs as a result of a trade liberalization. In contrast, it appears to dampen—at least in the Home country—the response of employment.

Table 3: Trade liberalization

	% Δ in SS Allocations			
	No Threat of Offshoring		**Threat of Offshoring**	
	Home	Foreign	Home	Foreign
	Aggregate Variables			
w	1.37	4.49	1.68	4.57
c	−0.07	0.85	0.03	0.87
LFP	0.18	0.31	0.18	0.31
UE	−0.13	−0.32	0.01	−0.33
	International Relative Prices			
ToT	−3.20	3.31	−3.29	3.38
q	−1.81	−1.81	−1.66	−1.66

6 Conclusion

We developed a two-country labor search model to assess the role of the threat of offshoring for global wages and labor market allocations. Our model features a multinational firm in the Home country that operates both domestic and foreign production plants, so that the parent company can shift production from the domestic country to foreign affiliates. Foreign firms produce only domestically. Regardless of where it produces, each firm must hire labor in a frictional labor market; labor market frictions, in turn, give rise to an explicit role for bargaining in the wage formation process. We exploit this feature of the model to assess how the threat of offshoring influences wage formation and the resulting implications for global labor market allocations. To model the threat of offshoring we allow for a sequential bargaining problem in which bargaining over the wage in the market for domestic labor relationships takes place prior to bargaining over the wage in offshored jobs. In this sequential setup, multinational firms exploit the outside option of walking away from a match and instead shifting production across boarders to influence the bargained wage.

Our main finding is that the threat of offshoring has a quantitatively large effect both on global wages as well as global labor market allocations that generate significant welfare effects in both countries. Specifically, we find that the use of the threat of offshoring in wage negotiations depresses bargained wages in the source country and boosts bargained wages in the recipient country relative to an outcome in which the threat of offshoring is not used as an outside option in wage negotiations. While consumption is higher in both countries, the lower bargained wage reduces unemployment in the source country. In contrast, the higher bargained wage raises unemployment in the recipient country. All told, households in the source country experience welfare gain of 1.6 percent of steady state consumption as a result of the threat of offshoring, while households in the recipient county

experience a welfare loss of 0.15 percent.

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7 Details of the Household Problem

We describe the details of the Home household and the Foreign household in the following two subsections.

7.1 Home Households

The household in the Home country searches in a domestic labor market for jobs operated domestically by the multinational. The Home household's problem is to choose sequences of c_t, b_{t+1}, s_t, and n_{t+1} to maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - h\left((1 - k^h(\theta_t)) s_t + n_{h,t} \right) \right] \tag{35}$$

subject to:

$$c_t + \int p_{bt,t+1} b_{t+1} = w_{h,t} n_t + (1 - k^h(\theta_t)) s_t \chi + b_t + d_t \tag{36}$$

$$n_{h,t} = (1 - \rho) n_{h,t-1} + s_t k^h(\theta_t) \tag{37}$$

Let λ_t denote the multiplier on the budget constraint and δ_t denote the multiplier on the law of motion for domestic jobs. The first order conditions with respect to c_t, b_{t+1}, s_t, and $n_{t+1}$are:

$$u'(c_t) - \lambda_t = 0 \tag{38}$$

$$-\lambda_t p_{bt,t+1} + \beta E_t \lambda_{t+1} = 0 \tag{39}$$

$$-h'_t(1 - k^h(\theta_t)) + \lambda_t (1 - k^h(\theta_t)) \chi + \delta_t k^h(\theta_t) = 0 \tag{40}$$

$$-h'_t + \lambda_t w_t - \delta_t + \beta(1 - \rho) E_t \delta_{t+1} = 0 \tag{41}$$

Combining equations 38 and 39 yields a standard consumption Euler equation

$$u'(c_t) = \beta \frac{1}{p_{bt,t+1}} E_t u'(c_{t+1}) \tag{42}$$

In order to derive the optimal search conditions, solve equation 40 for δ_t to get

$$\delta_t = \frac{1 - k^h(\theta_t)}{k^h(\theta_t)} \left[h'_t - \chi \lambda_t \right] \tag{43}$$

We can now put this and use the fact that $\lambda_t = u'_t$ to rewrite the FOC on n_t as

$$\left(\frac{1 - k^h(\theta_t)}{k^h(\theta_t)} \right) \left[h'_t - \chi \lambda_t \right] = \lambda_t w_t - h'_t + \beta(1 - \rho) E_t \delta_{t+1} \tag{44}$$

Solving this expression for the marginal rate of substitution $h'(lfp_t)/u'(c_t)$ gives

$$\frac{h'(lfp_t)}{u'(c_t)} = k^h(\theta_t) \left[w_t + \beta(1 - \rho) E_t \left(\frac{u'(c_{t+1})}{u'(c_t)} \frac{\delta_{t+1}}{u'(c_{t+1})} \right) \right] + (1 - k^h(\theta_t)) \chi \tag{45}$$

which is equation **??** in the main text.

7.2 Foreign Households

The household in the Foreign country searches in two differentiated labor markets: one for jobs operated by domestic firms and one for offshored jobs operated by the Home multinational. The Foreign household's problem is to choose sequences of c_t^*, b_{t+1}^*, $s_{h,t}^*$, , $s_{f,t}^*$, $n_{h,t+1}^*$, and $n_{f,t+1}^*$ to maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[u^*(c_t^*) - h^* \left((1 - k^{*h}(\theta_{h,t}^*)) s_{h,t}^* + (1 - k^{*f}(\theta_{f,t}^*)) s_{f,t}^* + n_{h,t}^* + n_{f,t}^* \right) \right] \tag{46}$$

subject to:

$$c_t^* + \int p_{bt,t+1} b_{t+1}^* = (w_{h,t}^* n_{h,t}^* + w_{f,t}^* n_{f,t}^*) + \left[(1 - k^{*h}(\theta_{h,t}^*)) s_{h,t}^* + (1 - k^{*f}(\theta_{f,t}^*)) s_{f,t}^* \right] \chi^* + b_t^* + d_t^* \tag{47}$$

$$n_{h,t}^* = (1 - \rho^*) n_{h,t-1}^* + s_{h,t}^* k^{*h}(\theta_{h,t}^*) \tag{48}$$

$$n_{f,t}^* = (1 - \rho^*) n_{f,t-1}^* + s_{f,t}^* k^{*h}(\theta_{f,t}^*) \tag{49}$$

The household efficiency conditions are given by

$$u^{*\prime}(c_t^*) = \beta \frac{1}{p_{bt,t+1}} E_t u^{*\prime}(c_{t+1}^*) \tag{50}$$

$$\frac{h^{*\prime}(lfp_t^*)}{u^{*\prime}(c_t^*)} = k^{*h}(\theta_{h,t}^*) \left[w_{h,t}^* + \beta(1 - \rho^*) E_t \left(\frac{u^{*\prime}(c_{t+1}^*)}{u^{*\prime}(c_t^*)} \frac{\delta_{h,t+1}^*}{u^{*\prime}(c_{t+1}^*)} \right) \right] + (1 - k^{*h}(\theta_{h,t}^*)) \chi^* \tag{51}$$

and

$$\frac{h^{*\prime}(lfp_t^*)}{u^{*\prime}(c_t^*)} = k^{*h}(\theta_{f,t}^*) \left[w_{f,t}^* + \beta(1 - \rho^*) E_t \left(\frac{u^{*\prime}(c_{t+1}^*)}{u^{*\prime}(c_t^*)} \frac{\delta_{f,t+1}^*}{u^{*\prime}(c_{t+1}^*)} \right) \right] + (1 - k^{*h}(\theta_{f,t}^*)) \chi^* \tag{52}$$

8 Details of the Firm Problem

We describe the details of the Home multinational firm and the Foreign firm in the following two subsections.

8.1 The Home Multinational

The multinational firm in the Home country uses both domestic and foreign labor to produce through the production function $f(n_{h,t}, n^*_{h,t})$. When the multinational offshores production to the foreign country it must incur an iceburg cost, $(1-\tau)$, where $0 \leq \tau \leq 1$ is the fraction of production abroad that is lost in transforming it into the final good.

In this setup, the multinational chooses sequences of vacancy postings in each of the two distinctive labor markets to hit a target level of production domestically and abroad in order to maximize discounted lifetime profits subject to the production technology and the respective laws of motion for employment. We assume that Home multinational deflates profits by the domestic CPI, p_t, in the Home country and p^*_t, in the Foreign country.

$$\Pi_{it} = \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left[\frac{p_{i,t}}{p_t} z_t f(n_{h,t}, n^*_{h,t}) - w_{h,t} n_{h,t} - q_t(1+\tau) w^*_{h,t} n^*_{h,t} - \gamma v_{h,t} - \gamma^* v^*_{h,t} \right] \tag{53}$$

subject to:

$$n_{h,t} = (1-\rho^x) n_{h,t-1} + v_{h,t} k^f(\theta_{h,t}) \tag{54}$$

$$n^*_{h,t} = (1-\rho^{*x}) n^*_{h,t-1} + v^*_{h,t} k^f(\theta^*_{h,t}) \tag{55}$$

Associate the multipliers $\mu_{h,t}$, and $\mu^*_{h,t}$ to the production function and the domestic and foreign employment constraints, respectively. The first-order conditions with respect to $v_{h,t}$, $n_{h,t}$, $v^*_{h,t}$, $n^*_{h,t}$, and $p_{i,t}$, respectively, are

$$\mu_{ht} = \frac{\gamma}{k^f(\theta_{h,t})} \tag{56}$$

$$\mu_{h,t} = z_t f_{1,t}(n_{h,t}, n^*_{h,t}) - w_{h,t} + \beta E_t \left[\Xi_{t+1|t} (1-\rho^x) \mu_{h,t+1} \right] \tag{57}$$

$$\mu^*_{h,t} = \frac{\gamma^*}{k^f(\theta^*_{h,t})} \tag{58}$$

$$\mu^*_{h,t} = z_t f_{2,t}(n_{h,t}, n^*_{h,t}) - q_t(1+\tau) w^*_{h,t} + \beta E_t \left[\Xi_{t+1|t} (1-\rho^{*x}) \mu^*_{h,t+1} \right] \tag{59}$$

Combining the optimality conditions **??** and 56 yields the job creation condition for the creation of domestic jobs,

$$\frac{\gamma}{k^f(\theta_{h,t})} = z_t f_{1,t}(n_{h,t}, n^*_{h,t}) - w_{h,t} + \beta(1-\rho^x) E_t \left[\Xi_{t+1|t} \left(\frac{\gamma}{k^f(\theta_{h,t+1})} \right) \right] \tag{60}$$

Similarly, combining the optimality conditions **??** and 58 yields the optimal off-shoring condition,

$$\frac{\gamma^*}{k^f(\theta^*_{h,t})} = z_t f_{2,t}(n_{h,t}, n^*_{h,t}) - q_t(1+\tau)w^*_{h,t} + \beta(1-\rho^{*x})E_t\left[\Xi_{t+1|t}\left(\frac{\gamma^*}{k^f(\theta^*_{h,t+1})}\right)\right] \tag{61}$$

8.2 The Foreign Firm

The firm in the Foreign country uses only domestic labor to produce through the production function $f(n^*_{f,t})$. The foreign firm chooses sequences of vacancy postings in the domestic labor market to hit a target level of production in order to maximize discounted lifetime profits subject to the production technology and the law of motion for domestic employment. We assume that foreign firm deflates profits by the domestic CPI, p^*_t.

$$\Pi^*_{it} = \sum_{t=0}^{\infty} \beta^t \frac{\lambda^*_t}{\lambda^*_0}\left[\frac{p^*_{i,t}}{p^*_t} z_t f(n^*_{f,t}) - w^*_{f,t} n^*_{f,t} - \gamma^* v^*_{f,t}\right] \tag{62}$$

subject to:

$$n^*_{f,t} = (1-\rho^{*x})n^*_{f,t-1} + v^*_{f,t}k^f(\theta^*_{f,t}) \tag{63}$$

The foreign firms job creation curve is given by

$$\frac{\gamma^*}{k^f(\theta^*_{f,t})} = z^*_t f_{1,t}(n^*_{f,t}) - w^*_{f,t} + \beta(1-\rho^{*x})E_t\left[\Xi^*_{t+1|t}\left(\frac{\gamma^*}{k^f(\theta^*_{f,t+1})}\right)\right] \tag{64}$$

9 Sequential Wage Bargaining

9.1 Value Functions

9.1.1 Households

Let $\mathbf{W_t}$ be the value to a worker of a domestic job and let $\mathbf{U_t}$ be the value of unemployment. Define the value of a domestic job to a domestic worker, $\mathbf{W_t}$, as

$$\mathbf{W_t} = w_{h,t} - \frac{h'(lfp_t)}{u'(c_t)} + \beta E_t \left[\frac{u'(c_{t+1})}{u'(c_t)} \left((1-\rho)\mathbf{W_{t+1}} + \rho \mathbf{U_{t+1}} \right) \right]$$

which says that the value of work in the domestic job market is the wage the worker earns from supplying domestic labor to the domestic firm net of the disutility of labor effort plus the continuation value of being in an employment relationship with a domestic firm. The continuation value takes into account the fact that the job may or may not survive exogenous job destruction in order to continue producing tomorrow. If the job does survive it brings in continuation value $\mathbf{W_{t+1}}$, but if it does not the worker will receive continuation value $\mathbf{U_{t+1}}$, which is the value of unemployment at the beginning of period $t+1$.

Define the value of unemployment in the beginning of the period, $\mathbf{U_t}$, as

$$\mathbf{U_t} = \chi - \frac{h'(lfp_t)}{u'(c_t)} + \beta E_t \left[\frac{u'_{t+1}}{u'_t} \left((1-\rho) k^h(\theta_t) \mathbf{W_{t+1}} + \left(1 - k^h(\theta_t)(1-\rho) \right) \mathbf{U_{t+1}} \right) \right]$$

which says that with probability $k^h(\theta_t)$ the worker gets a job today. If he does get a job today he receives the unemployment benefit and suffers disutility of search, before getting the continuation value of the job tomorrow, provided it survives to produce. On the other hand, if the worker doesn't get a job today, he gets the continuation value of unemployment tomorrow.

The definitions of the value functions for the Foreign worker are a bit different due to the sequential nature of search. Let $\mathbf{W^*_{f,t}}$ be the value to a worker of a domestic job and let $\mathbf{U^*_{f,t}}$ be the value of not making a match in the marker for domestic jobs. Define the value of a domestic job to a domestic worker, $\mathbf{W^*_{f,t}}$, as

$$\mathbf{W^*_{f,t}} = w^*_{f,t} - \frac{h'(lfp^*_t)}{u'(c^*_t)} + \beta E_t \left[\frac{u'(c^*_{t+1})}{u'(c^*_t)} \left((1-\rho^*) \mathbf{W^*_{f,t+1}} + \rho^* \mathbf{U^*_{f,t+1}} \right) \right]$$

which has a similar interpretation as above.

Define the value of unsuccessful search in the market for domestic jobs, $\mathbf{U^*_{f,t}}$, as

$$\begin{aligned} \mathbf{U^*_{f,t}} &= k^h(\theta^*_{f,t}) \left(\chi^* - \frac{h'(lfp^*_t)}{u'(c^*_t)} + \beta E_t \left[\frac{u'(c^*_{t+1})}{u'(c^*_t)} \left((1-\rho^*) \mathbf{W^*_{f,t+1}} + \rho^* \mathbf{U^*_{f,t+1}} \right) \right] \right) \\ &+ \left(1 - k^h(\theta^*_{f,t}) \right) \left(\mathbf{1}[\mathbf{SB}] \mathbf{U^*_{h,t}} + (1 - \mathbf{1}[\mathbf{SB}]) \left(\chi^* - \frac{h'(lfp^*_t)}{u'(c^*_t)} + \beta E_t \left[\frac{u'(c^*_{t+1})}{u'(c^*_t)} \mathbf{U^*_{f,t+1}} \right] \right) \right) \end{aligned}$$

where $\mathbf{1}[\mathbf{SB}]$ is an indicator variable that takes on the value of one if there is sequential bargaining and is zero under simultaneous bargaining. Notice that under sequential bargaining if the foreign worker looses a job at the beginning of the period he/she can immediately begin searching in the market for domestic jobs at the beginning of the next period and therefore get the value of search in the offshore labor market.

Let $\mathbf{W^*_{h,t}}$ be the value to a Foreign worker of a job with the multinational firm and let $\mathbf{U^*_{h,t}}$ be the value of unsuccessful search in the market for offshored jobs. Define the value of an offshored job to a Foreign worker, $\mathbf{W^*_{h,t}}$, as

$$\mathbf{W^*_{h,t}} = w^*_{h,t} - \frac{h'(lfp^*_t)}{u'(c^*_t)} + \beta E_t \left[\frac{u'(c^*_{t+1})}{u'(c^*_t)} \left((1-\rho^*)\mathbf{W^*_{h,t+1}} + \rho^* \left(\mathbf{1}[\mathbf{SB}]\mathbf{U^*_{f,t+1}} + (1-\mathbf{1}[\mathbf{SB}])\mathbf{U^*_{h,t+1}} \right) \right) \right]$$

Finally, define the value of unsuccessful search in the market for offshored jobs, $\mathbf{U^*_{h,t}}$, as

$$\begin{aligned} \mathbf{U^*_{h,t}} &= \chi^* - \frac{h'(lfp^*_t)}{u'(c^*_t)} + k^h(\theta^*_{h,t})\beta E_t \left[\frac{u'(c^*_{t+1})}{u'(c^*_t)} \left((1-\rho^*)\mathbf{W^*_{h,t+1}} \right) \right] \\ &+ \left(1 - (1-\rho^*)k^h(\theta^*_{h,t}) \right) \beta E_t \left[\frac{u'(c^*_{t+1})}{u'(c^*_t)} \left(\mathbf{1}[\mathbf{SB}]\mathbf{U^*_{f,t+1}} + (1-\mathbf{1}[\mathbf{SB}])\mathbf{U^*_{h,t+1}} \right) \right] \end{aligned}$$

Under sequential bargaining the Foreign household can use the possibility of finding work with the multinational firm as a threat in negotiating wages with the domestic firm. With simultaneous bargaining this outside option is shut down.

9.1.2 Firms

Let $\mathbf{J_{h,t}}$ be the value to the multinational firm of a domestic worker and let $\mathbf{V_{h,t}}$ be the value of an unfilled vacancy opened by the multinational in the domestic job market. Define $\mathbf{J_{h,t}}$ as

$$\mathbf{J_{h,t}} = z_t f_1(n_{h,t}, n^*_{h,t}) - w_{h,t} + \beta E_t \left[\frac{u'(c_{t+1})}{u'(c_t)} \left((1-\rho)\mathbf{J_{h,t+1}} + \rho \mathbf{V_{h,t+1}} \right) \right] \tag{65}$$

which says that the value of a domestic job is equal to the additional revenue the firms gets from additional production net of the wage that the firm must pay the additional worker. The firm also gets a continuation value from the formation of a job, which yields production tomorrow if the job survives. If it doesn't, then the firm gets the continuation value of the vacancy posting tomorrow.

Define the value of an unfilled match, $\mathbf{V_{h,t}}$, as

$$\begin{aligned} \mathbf{V_{h,t}} &= -\gamma + k^f(\theta_{h,t})\beta E_t \left[\frac{u'(c_{t+1})}{u'(c_t)} \left((1-\rho)\mathbf{J_{h,t+1}} + \rho \mathbf{V_{h,t+1}} \right) \right] \\ &+ \left(1 - k^f(\theta_{h,t}) \right) \left(\mathbf{1}[\mathbf{SB}]\mathbf{V_{f,t}} + (1-\mathbf{1}[\mathbf{SB}])\, \beta E_t \left[\frac{u'_{t+1}}{u'_t} \mathbf{V_{h,t+1}} \right] \right) \end{aligned}$$

The value of a vacancy is the posting cost plus the continuation value of a matched vacancy provided it survives to produce in the next period weighted by the probability that the match is made. If the

match does not survive, the unfilled vacancy continues to have value. Moreover, under sequential bargaining, a vacancy that is unfilled in the market for domestic workers can be posted in the Foreign labor market.

Let $\mathbf{J_{f,t}}$ be the value of an offshore worker to the multinational firm. Define the value to a firm of an offshored job as

$$\begin{aligned}\mathbf{J_{f,t}} &= z_t f_2(n_{h,t}, n^*_{h,t}) - q_t(1+\tau)w^*_{h,t} \\ &+ \beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}\left((1-\rho^*)\mathbf{J_{f,t+1}} + \rho^*\left(\mathbf{1}[\mathbf{SB}]\mathbf{V_{h,t+1}} + (1-\mathbf{1}[\mathbf{SB}])\,\mathbf{V_{f,t+1}}\right)\right)\right]\end{aligned}$$

Define the value of an unfilled vacancy posted in the Foreign labor market, $\mathbf{V_{f,t}}$, as

$$\begin{aligned}\mathbf{V_{f,t}} &= -\gamma^* + k^f(\theta^*_{h,t})\beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}\left((1-\rho^*)\mathbf{J_{f,t+1}}\right)\right] \\ &+ \left(1-(1-\rho^*)k^f(\theta^*_{h,t})\right)\beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}\left(\mathbf{1}[\mathbf{SB}]\mathbf{V_{h,t+1}} + (1-\mathbf{1}[\mathbf{SB}])\,\mathbf{V_{f,t+1}}\right)\right]\end{aligned}$$

Let $\mathbf{J^*_{f,t}}$ be the value of domestic worker to the foreign firm defined as

$$\mathbf{J^*_{f,t}} = z^*_t f_1(n^*_{f,t}) - w^*_{f,t} + \beta E_t\left[\frac{u'^*_{t+1})}{u'^*_t)}\left((1-\rho^*)\mathbf{J^*_{f,t+1}} + \rho^*\mathbf{V^*_{f,t+1}}\right)\right]$$

Finally, define the value to a Foreign firm of an unfilled vacancy in the foreign labor market as

$$\mathbf{V^*_{f,t}} = -\gamma^* + \beta E_t\left[\frac{u'^*_{t+1})}{u'^*_t)}\left((1-\rho^*)k^f(\theta^*_{f,t})\mathbf{J^*_{f,t+1}}\right) + (1-(1-\rho^*))k^f(\theta^*_{f,t})\mathbf{V^*_{f,t+1}}\right]$$

9.2 Surplus With Simultaneous Bargaining, $(\mathbf{1}[\mathbf{SB}] = 0)$

9.2.1 Households

Define the surplus of a match to a Home worker as $\mathbf{S^h_t} = \mathbf{W_t} - \mathbf{U_t}$, which in is given by the following expression regardless of sequential or simultaneous bargaining

$$\mathbf{S^h_t} = w_{h,t} - \chi + \beta(1-\rho)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^h(\theta_{h,t})\mathbf{S^h_{t+1}}\right]$$

In contrast, the definitions of the surpluses for Foreign workers is dependant on whether labor markets clear sequentially or simultaneously. When $\mathbf{1}[\mathbf{SB}] = 0$ the expressions for the surplus of a domestic, $\mathbf{S^{*h}_{f,t}} = \mathbf{W^*_{f,t}} - \mathbf{U^*_{f,t}}$, and an international labor market relationship, $\mathbf{S^{*h}_{h,t}} = \mathbf{W^*_{h,t}} - \mathbf{U^*_{h,t}}$, are defined respectively as

$$\mathbf{S^{*h}_{f,t}} = w^*_{f,t} - \chi^* + \beta(1-\rho^*)E_t\left[\frac{u'(c^*_{t+1})}{u'(c^*_t)}(1-k^h(\theta^*_{f,t}))\mathbf{S^{*h}_{f,t+1}}\right]$$

and

$$\mathbf{S^{*h}_{h,t}} = w^*_{h,t} - \chi^* + \beta(1-\rho^*)E_t\left[\frac{u'(c^*_{t+1})}{u'(c^*_t)}(1-k^h(\theta^*_{h,t}))\mathbf{S^{*h}_{h,t+1}}\right]$$

9.2.2 Firms

When $\mathbf{1[SB]} = 0$ the expressions for the surplus of a domestic, $\mathbf{S^f_{h,t}} = \mathbf{J_{h,t}} - \mathbf{V_{h,t}}$, and an international labor market relationship, $\mathbf{S^f_{f,t}} = \mathbf{J_{f,t}} - \mathbf{V_{f,t}}$, are defined respectively as

$$\mathbf{S^f_{h,t}} = z_t f_1(n_{h,t}, n^*_{h,t}) - w_{h,t} + \gamma + \beta E_t \left(\frac{u'(c_{t+1})}{u'(c_t)} (1 - k^f(\theta_{h,t}))(1-\rho) \mathbf{S^f_{h,t+1}} \right)$$

and

$$\mathbf{S^f_{f,t}} = z_t f_2(n_{h,t}, n^*_{h,t}) - q_t(1+\tau) w_{h,t} + \gamma^* + \beta E_t \left[\frac{u'(c_{t+1})}{u'(c_t)} (1 - k^f(\theta^*_{h,t}))(1-\rho^*) \mathbf{S^f_{f,t+1}} \right]$$

In contrast, the definition of the surplus of a domestic labor market relationship to the Foreign firm is given by the following expression regardless of sequential or simultaneous bargaining

$$\mathbf{S^{*f}_{f,t}} = z^*_t f_1(n^*_{f,t}) - w^*_{f,t} + \gamma^* + \beta E_t \left[\frac{u'^*_{t+1})}{u'^*_t)} (1 - k^f(\theta^*_{f,t}))(1-\rho^*) \mathbf{S^{*f}_{f,t+1}} \right]$$

9.3 Surplus Under Sequential Bargaining, $(\mathbf{1[SB]} = 1)$

9.3.1 Households

Under sequential bargaining, the surpluses of the Foreign household change to reflect the sequential nature of search. However, as mentioned above, the surplus of a domestic job for the Home household, $\mathbf{S^h_{h,t}}$ does not change from what was reported above.

In order to derive an expression for the surplus of a domestic employment relationship to the Foreign household, $\mathbf{S^{*h}_{f,t}}$, substitute $\mathbf{U^*_{h,t}}$ directly into the expression for $\mathbf{U^*_{f,t}}$ to get

$$\begin{aligned} \mathbf{U^*_{f,t}} &= \chi^* - \frac{h'^*_t)}{u'^*)_t} + \beta E_t \left[\frac{u'^*_{t+1})}{u'^*_t)} \left((1-\rho^*) k^h(\theta^*_{f,t}) \mathbf{W^*_{f,t+1}} + \left(1 - k^h(\theta^*_{f,t})(1-\rho^*) \right) \mathbf{U^*_{f,t+1}} \right) \right] \\ &+ \beta E_t \left[\frac{u'^*_{t+1})}{u'^*_t)} (1-\rho^*) \left(1 - k^h(\theta^*_{f,t}) \right) k^h(\theta^*_{h,t}) \mathbf{S^{*h}_{fh,t+1}} \right] \end{aligned}$$

where $\mathbf{S^{*h}_{fh,t}} = \mathbf{W^*_{f,t}} - \mathbf{U^*_{h,t}}$ is the value to the Foreign worker of working in a domestic job net of the value of searching in the market for offshored jobs. We can subtract the above expression from the definition for $\mathbf{W^*_{f,t}}$ to derive a recursive expressions for the surplus of a domestic employment relationship.

$$\mathbf{S^{*h}_{f,t}} = w^*_{f,t} - \chi^* + \beta(1-\rho^*) E_t \left[\frac{u'^*_{t+1})}{u'^*_t)} (1 - k^h(\theta^*_{f,t})) \left(\mathbf{S^{*h}_{f,t+1}} - k^{*h}(\theta^*_{h,t}) \mathbf{S^{*h}_{fh,t+1}} \right) \right]$$

We follow a similar methodology to derive the following expression for the surplus of an international employment relationship to the Foreign household, $\mathbf{S^{*h}_{h,t}}$ to get

$$\mathbf{S^{*h}_{h,t}} = w^*_{h,t} - \chi^* + \beta(1-\rho^*) E_t \left[\frac{u'(c^*_{t+1})}{u'(c^*_t)} (1 - k^h(\theta^*_{h,t})) \mathbf{S^{*h}_{fh,t+1}} \right]$$

Finally, we need a recursive expression for to define the surplus of an international employment relationship relative to searching in the domestic labor market.

$$\mathbf{S^{*h}_{fh,t}} = w^*_{h,t} - \chi^* + \beta(1-\rho^*)E_t\left[\frac{u'^*_{t+1})}{u'^*_t)}\left(1-(1-k^h(\theta^*_{f,t}))k^h(\theta^*_{h,t})\right)\mathbf{S^{*h}_{fh,t+1}} - k^h(\theta^*_{f,t})\mathbf{S^{*h}_{h,t+1}}\right]$$

9.3.2 Firms

Under sequential bargaining, the surpluses of the multinational change to reflect the sequential nature of search. However, as mentioned above, the surplus of a domestic job for the Foreign firm, $\mathbf{S^{*f}_{f,t}}$ does not change from what was reported above.

In order to derive an expression for the surplus of a domestic employment relationship to the multinational, $\mathbf{S^F_{h,t}}$, substitute $\mathbf{V_{f,t}}$ directly into the expression for $\mathbf{V_{h,t}}$ to get

$$\begin{aligned}\mathbf{V_{h,t}} &= -\gamma - \left(1-k^f(\theta_{h,t})\right)\gamma^* \\ &+ \beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}\left(k^f(\theta_{h,t})(1-\rho)\mathbf{J_{h,t+1}} + \left(1-k^f(\theta_{h,t})(1-\rho)\right)\mathbf{V_{h,t+1}}\right)\right] \\ &+ \beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-\rho^*)\left(1-k^f(\theta_{h,t})\right)k^f(\theta^*_{h,t})\mathbf{S^f_{fh,t}}\right]\end{aligned}$$

where $\mathbf{S^f_{fh,t}} = \mathbf{J_{f,t}} - \mathbf{V_{h,t}}$ is the value to the multinational of employing a domestic worker net of the value of searching in the market for offshored jobs. We can subtract the above definition from $\mathbf{J_{h,t}}$ to derive a recursive expressions for the surplus of a domestic employment relationship.

$$\begin{aligned}\mathbf{S^f_{h,t}} &= z_t f_1(n_{h,t}, n^*_{h,t}) - w_{h,t} + \gamma + \left(1-k^f(\theta_{h,t})\right)\gamma^* \\ &+ \beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^f(\theta_{h,t}))\left((1-\rho)\mathbf{S^f_{h,t+1}} - k^f(\theta^*_{h,t})(1-\rho^*)\mathbf{S^f_{fh,t+1}}\right)\right]\end{aligned}$$

We follow a similar methodology to derive the following expression for the surplus of an international employment relationship to the multinational, $\mathbf{S^f_{f,t}}$ to get

$$\mathbf{S^f_{f,t}} = z_t f_2(n_{h,t}, n^*_{h,t}) - q_t(1+\tau)w^*_{h,t} + \gamma^* + \beta(1-\rho^*)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^f(\theta^*_{h,t}))\mathbf{S^f_{fh,t+1}}\right]$$

Finally, we need to define the surplus of an offshored job relative to hiring a domestic worker to do the job.

$$\begin{aligned}\mathbf{S^F_{fh,t}} &= z_t f_2(n_{h,t}, n^*_{h,t}) - q_t(1+\tau)w^*_{h,t} + \gamma^* \\ &+ \beta E_t\left[\frac{u'_{t+1}}{u'_t}\left((1-\rho^*)\left(1-(1-k^f(\theta_{h,t}))k^f(\theta^*_{h,t})\right)\mathbf{S^F_{fh,t+1}} - (1-\rho)k^f(\theta_{h,t})\mathbf{S^F_{hh,t+1}}\right)\right]\end{aligned}$$

These continuation values will help in expressing the Nash wage solution in the next section.

9.4 Nash Bargaining Under Simultaneous Bargaining, ($\mathbf{1}[\mathbf{SB}] = 0$)

The Nash bargaining rule is

$$\mathbf{S^h_{h,t}} = \frac{\eta}{1-\eta}\mathbf{S^f_{h,t}}$$

Begin by plugging in the solution for $\mathbf{S^h_{h,t}}$ on the left-hand side.

$$w_{h,t} - \chi + \beta(1-\rho)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^h(\theta_{h,t}))\mathbf{S^h_{h,t+1}}\right] = \frac{\eta}{1-\eta}\mathbf{S^f_{h,t}}$$

Next, we can substitute in for $\mathbf{S^f_{h,t}}$ on the right hand side and solve the resulting expression for $w_{h,t}$ to get

$$\begin{aligned} w_{h,t} &= (1-\eta)\chi + \eta\left(z_t f_1(n_{h,t}, n^*_{h,t}) + \gamma\right) \\ &+ \eta\beta(1-\rho)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^f(\theta_{h,t}))\mathbf{S^f_{h,t+1}}\right] \\ &- (1-\eta)\beta(1-\rho)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^h(\theta_{h,t}))\mathbf{S^h_{h,t+1}}\right] \end{aligned}$$

The analogous wage expression for the foreign worker in a foreign job would be

$$\begin{aligned} w^*_{f,t} &= (1-\eta^*)\chi^* + \eta^*\left(z^*_t f_1(n^*_{f,t}) + \gamma^*\right) \\ &+ \eta^*\beta(1-\rho^*)E_t\left[\frac{u^{'}(c^*_{t+1})}{u^{'}(c^*_t)}(1-k^f(\theta^*_{f,t}))\mathbf{S^{*f}_{f,t+1}}\right] \\ &- (1-\eta^*)\beta(1-\rho^*)E_t\left[\frac{u^{'}(c^*_{t+1})}{u^{'}(c^*_t)}(1-k^h(\theta^*_{f,t}))\mathbf{S^{*h}_{f,t+1}}\right] \end{aligned}$$

Finally, for the wage paid to Foreigners working for the multinational, the bargaining rule is

$$\mathbf{S^{*h}_{h,t}} = \frac{\eta^*}{1-\eta^*}\mathbf{S^f_{f,t+1}}$$

To solve for the wage, begin by plugging in the solution for $\mathbf{S^{*h}_{h,t}}$ on the left-hand side.

$$w^*_{h,t} - \chi^* + \beta(1-\rho^*)E_t\left(\frac{u'^*_{t+1})}{u'^*_t)}(1-k^h(\theta^*_{h,t}))\mathbf{S^h_{h,t+1}}\right) = \frac{\eta^*}{1-\eta^*}\mathbf{S^f_{f,t+1}} \tag{66}$$

We can substitute in the definition for $\mathbf{S^f_{f,t}}$ on the right hand side and derive the following expression for the wage.

$$\begin{aligned} w^*_{h,t} &= \frac{1-\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\chi^* + \frac{\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\left(z_t f_2(n_{h,t}, n^*_{h,t}) + \gamma^*\right) \\ &+ \frac{\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\beta(1-\rho^*)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}\left(1-k^f(\theta^*_{h,t})\right)\mathbf{S^f_{f,t+1}}\right] \\ &- \frac{1-\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\beta(1-\rho^*)E_t\left[\frac{u^{'}(c^*_{t+1})}{u^{'}(c^*_t)}(1-k^h(\theta^*_{h,t}))\mathbf{S^{*h}_{f,t}}\right] \end{aligned} \tag{67}$$

9.5 Nash Bargaining Under Sequential Bargaining, ($\mathbf{1}[\mathbf{SB}] = 1$)

Similar algebra to the subsection above yields an expression for the domestic wage paid by the multinational to Home workers $w_{h,t}$ to get

$$\begin{aligned} w_{h,t} &= (1-\eta)\chi + \eta\left(z_t f_1(n_{h,t}, n^*_{h,t}) + \gamma + (1-k^f(\theta_{h,t}))\gamma*\right) \\ &+ \eta\beta(1-\rho)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^f(\theta_{h,t}))\mathbf{S^f_{h,t+1}}\right] \\ &- (1-\eta)\beta(1-\rho)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^h(\theta_{h,t}))\mathbf{S^h_{h,t+1}}\right] \\ &- \eta\beta(1-\rho^*)E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}(1-k^f(\theta_{h,t}))k^f(\theta^*_{h,t})\mathbf{S^f_{fh,t+1}}\right] \end{aligned}$$

The analogous wage expression for the foreign worker in a foreign job is

$$\begin{aligned} w^*_{f,t} &= (1-\eta^*)\chi^* + \eta^*\left(z^*_t f_1(n^*_{f,t}) + \gamma^*\right) \\ &+ \eta^*\beta(1-\rho^*)E_t\left[\frac{u^{'}(c^*_{t+1})}{u^{'}(c^*_t)}(1-k^f(\theta^*_{f,t}))\mathbf{S^{*f}_{f,t+1}}\right] \\ &- (1-\eta^*)\beta(1-\rho^*)E_t\left(\frac{u^{'}(c^*_{t+1})}{u^{'}(c^*_t)}(1-k^h(\theta^*_{f,t}))\mathbf{S^{*h}_{f,t+1}}\right) \\ &+ (1-\eta^*)\beta(1-\rho^*)E_t\left(\frac{u^{'}(c^*_{t+1})}{u^{'}(c^*_t)}(1-k^h(\theta^*_{f,t}))k^h(\theta^*_{f,t})\mathbf{S^{*h}_{fh,t+1}}\right) \end{aligned} \tag{68}$$

Finally, the wage paid by the multinational to Foreign workers employed in offshored jobs is

$$\begin{aligned} w^*_{h,t} &= \frac{1-\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\chi^* + \frac{\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\left(mr_t z_t f_{2,t} + \gamma^*\right) \\ &+ \frac{\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\beta(1-\rho^*)E_t\left[\frac{u^{'}(c_{t+1})}{u^{'}(c_t)}\left(1-k^f(\theta^*_{h,t})\right)\mathbf{S^f_{fh,t+1}}\right] \\ &- \frac{1-\eta^*}{1-\eta^*\left(1-(1+\tau)q_t\right)}\beta(1-\rho^*)E_t\left[\frac{u^{'}(c^*_{t+1})}{u^{'}(c^*_t)}(1-k^h(\theta^*_{h,t}))\mathbf{S^{*h}_{fh,t+1}}\right] \end{aligned} \tag{69}$$

9.6 Solving the System

All told, the wage system $\{w_{h,t}, w^*_{h,t}, w^*_{f,t}\}$ is a function of: (1.) $\mathbf{S^h_{h,t}}$, the surplus to Home workers of having a domestic job net of the value of unemployment; (2.) $\mathbf{S^f_{h,t}}$, the surplus to the multinational of having a domestic employee working in a job net of the value of an unfilled vacancy in the domestic labor market; (3.) $\mathbf{S^{*f}_{f,t}}$, the surplus to the Foreign firm of having a domestic worker net of the value of an unfilled vacancy; (4.) $\mathbf{S^{*h}_{f,t}}$, the surplus to Foreign workers of having a domestic job net of the value of search in the market for domestic jobs; (5.) $\mathbf{S^{*h}_{fh,t}}$, the surplus to Foreign workers of having an offshored job net of the value of search in the market for domestic jobs; and (6.) $\mathbf{S^f_{fh,t}}$, the surplus to the multinational of offshoring a job net of the value of an unfilled vacancy in the market for domestic jobs.

10 Social Planner's Problem

The social planner chooses sequences of $\{c_{H,t}, c_{F,t}, c^*_{H,t}, c^*_{F,t}, n_{h,t}, n^*_{h,t}, n^*_{f,t}, s_{h,t}, s^*_{h,t}, s^*_{f,t}, v_{h,t}, v^*_{h,t}, v^*_{f,t}\}$ to maximize an equally weighted average of discounted lifetime Home and Foreign utility subject to the laws of motion for the respective employment stocks and the resource constraint. The social planners problem is

$$E_0 \sum_{t=0}^{\infty} \beta^t (u\left(c(c_{H,t}, c_{F,t})\right) - h\left((s_{h,t} - m(s_{h,t}, v_{h,t})) + n_{h,t}\right) \tag{70}$$

$$+u^*\left(c^*(c^*_{H,t}, c^*_{F,t})\right) - h^*((s^*_{h,t} - m^*(s^*_{h,t}, v^*_{h,t})) + (s^*_{f,t} - m^*(s^*_{f,t}, v_{f,t})) + n^*_{h,t} + n^*_{f,t})) \tag{71}$$

subject to:

$$n_{h,t} = (1-\rho_x) n_{h,t-1} + m(s_{h,t}, v_{h,t}) \tag{72}$$

$$n^*_{h,t} = (1-\rho^*_x) n^*_{h,t-1} + m^*(s^*_{h,t}, v_{h^*,t}) \tag{73}$$

$$n^*_{f,t} = (1-\rho^*_x) n^*_{f,t-1} + m^*(s^*_{f,t}, v^*_{f,t}) \tag{74}$$

$$z_t f\left(n_{h,t}, n^*_{f,t}\right) = c_{H,t} + c^*_{H,t} + \gamma v_{h,t} \tag{75}$$

$$z^*_t f\left(n^*_{h,t}\right) = c_{F,t} + c^*_{F,t} + \gamma^* v^*_{h,t} + \gamma^* v_{f,t} \tag{76}$$

Let and $\Upsilon_{h,t}$, $\Upsilon^*_{h,t}$, $\Upsilon^*_{f,t}$, Ψ_t, Ψ^*_t be the multipliers on the three laws of motion for the employment stocks and the aggregate global resource constraints for the Home and Foreign countries, respectively. The resulting first order conditions are:

$$\frac{\partial u\left(c(c_{H,t}, c_{F,t})\right)}{\partial c_{H,t}} = \Psi_t \tag{77}$$

$$\frac{\partial u\left(c(c_{H,t}, c_{F,t})\right)}{\partial c_{F,t}} = \Psi^*_t \tag{78}$$

$$\frac{\partial u^*\left(c^*(c^*_{H,t}, c^*_{F,t})\right)}{\partial c^*_{H,t}} = \Psi_t \tag{79}$$

$$\frac{\partial u^*\left(c^*(c^*_{H,t}, c^*_{F,t})\right)}{\partial c^*_{F,t}} = \Psi^*_t \tag{80}$$

$$-h^{'}_t + \Upsilon_{h,t} - \beta(1-\rho^x)\Upsilon_{h,t+1} + z_t f_1(n_{h,t}, n^*_{h,t})\Psi_t = 0 \tag{81}$$

$$-h^{'*}_t + \Upsilon^*_{h,t} - \beta * (1-\rho^{*x})\Upsilon^*_{h,t+1} + z^*_t f_2(n_{h,t}, n^*_{h,t})\Psi_t = 0 \tag{82}$$

$$-h^{'*}_t + \Upsilon^*_{f,t} - \beta(1-\rho^{*x})\Upsilon^*_{f,t+1} + z^*_t f^*_1(n^*_{f,t})\Psi^*_t = 0 \tag{83}$$

$$-h^{'}_t(1 - m_s(s_{h,t}, v_{h,t})) + \Upsilon_{h,t} m_s(s_{h,t}, v_{h,t}) = 0 \tag{84}$$

$$-h^{'*}_t(1 - m^*_s(s^*_{h,t}, v^*_{h,t})) + \Upsilon^*_{h,t} m^*_s(s^*_{h,t}, v^*_{h,t}) = 0 \tag{85}$$

$$-h_t^{'*}(1 - m_s^*(s_{f,t}^*, v_{f,t})) + \Upsilon_{f,t}^* m_s^*(s_{f,t}^*, v_{f,t}^*) = 0 \tag{86}$$

$$-h_t^{'} m_v(s_{h,t}, v_{h,t}) + \Upsilon_{h,t} m_v(s_{h,t}, v_{h,t}) - \gamma \Psi_t = 0 \tag{87}$$

$$-h_t^{'*} m_v^*(s_{h,t}^*, v_{h,t}^*) + \Upsilon_{h,t}^* m_v^*(s_{h,t}^*, v_{h,t}^*) - \gamma^* \Psi_t = 0 \tag{88}$$

$$-h_t^{'*} m_v^*(s_{f,t}^*, v_{f,t}) + \Upsilon_{f,t}^* m_v^*(s_{f,t}^*, v_{f,t}^*) - \gamma^* \Psi_t^* = 0 \tag{89}$$

Figure 1. Foreign Employment of US Multinationals

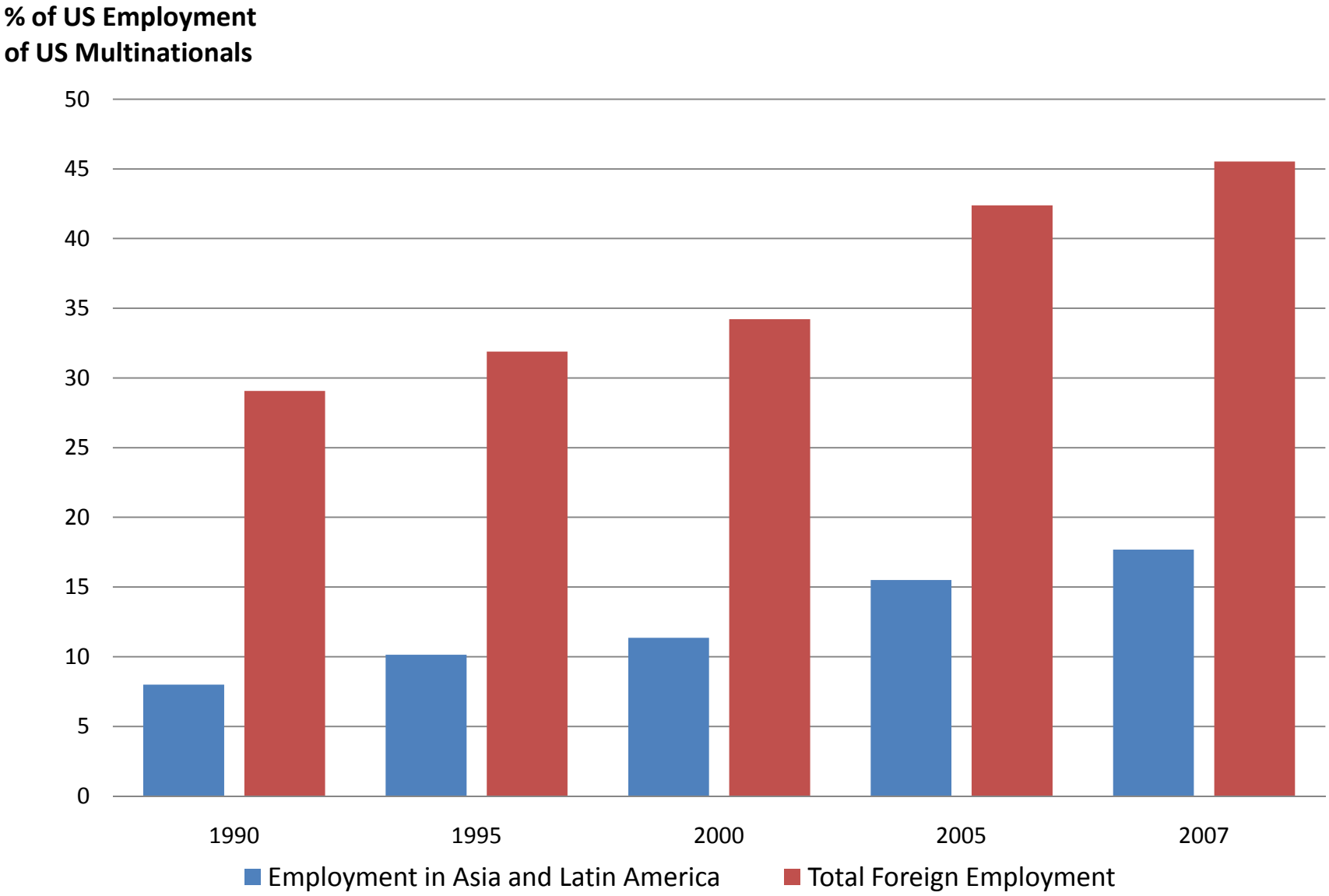
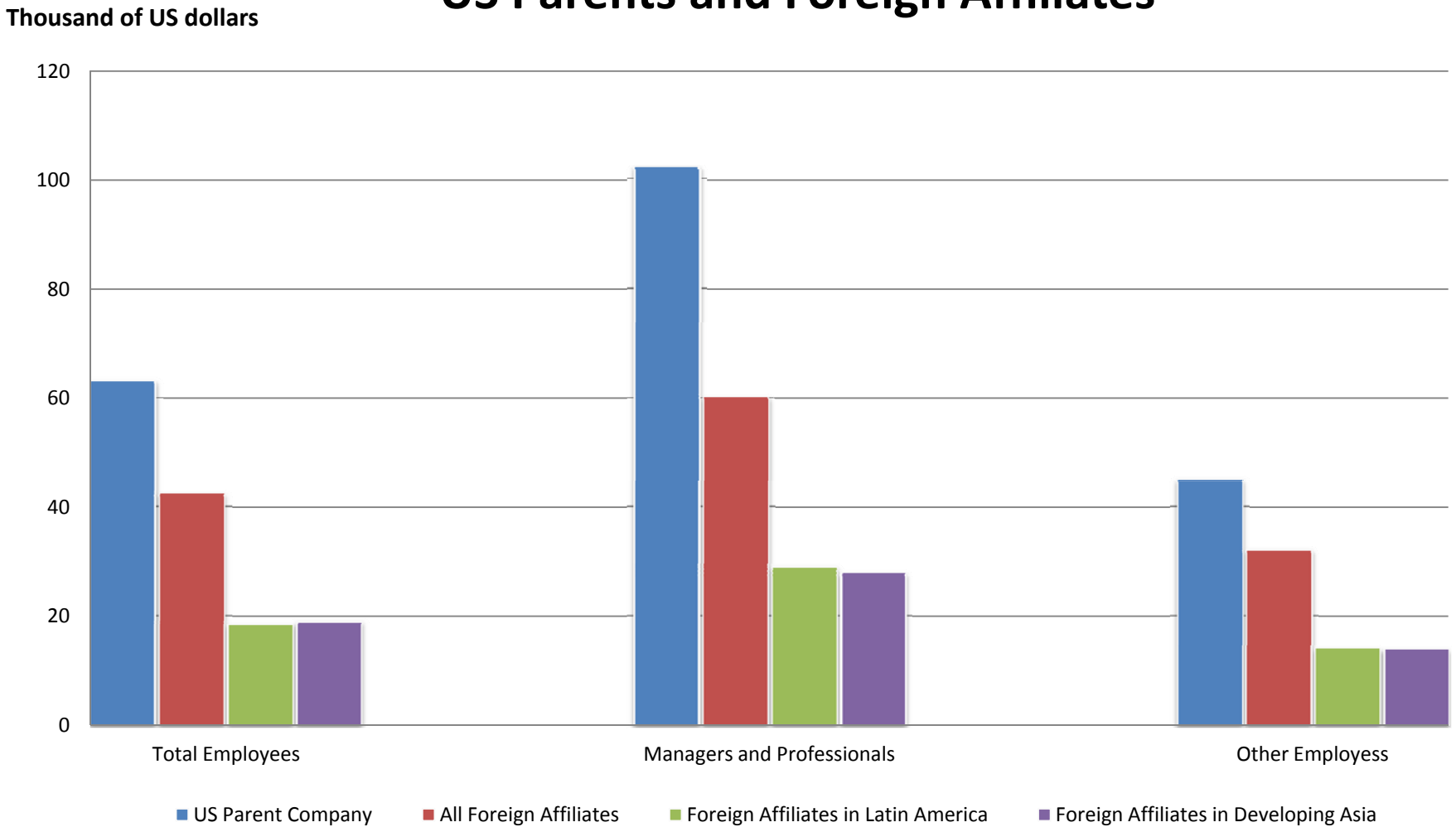


Figure 2. Average Compensation : US Parents and Foreign Affiliates



Source: Bureau of Economic Analysis, U.S. Direct Investment Abroad: Operations of U.S. Parent COmpanies and Their Foreign Affiliates, 2007.

Figure 3. OECD Index of Employment Protection (2008)

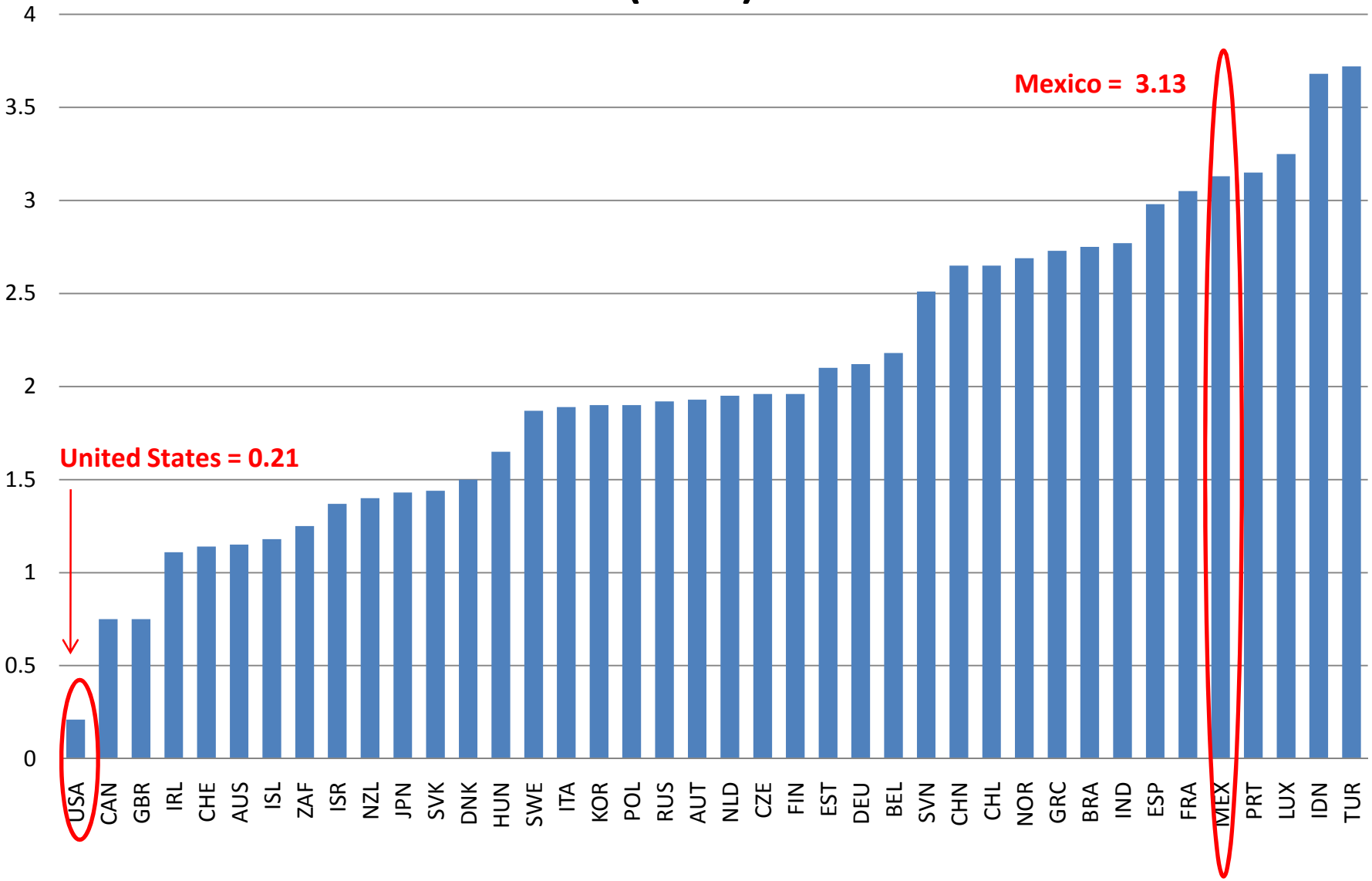


Figure 4. Net Income from U.S. Foreign Affiliates