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 to produce a final good. A key innovation to the model is the sequential nature of domestic and foreign labor markets in combination with fixed costs of entry. These features introduce an outside option for the multinational in its wage negotiations, by allowing shifts of production overseas. Using this framework, we derive a model-based estimate of the effect of the threat of offshoring on global wages and labor market allocations. In the short run, when firm entry is impeded from fully adjusting, we find that the threat of offshoring has sizable effects: domestic wages are lower, there are fewer jobs and the unemployment rate is higher. This occurs even though the actual amount of offshoring is very small in the economy. Moreover, in the short run, the threat of offshoring mitigates the responsiveness of the wage to underlying shocks, with the threat of offshoring operating like a real rigidity. In contrast, when entry is free to adjust over the long run we find that the threat of offshoring has a minimal effect on the economy.

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1 Introduction

Significant advances in transportation, communication, and information technologies have increased firms' ability to relocate jobs abroad over the past 30 years. Moreover, these continued innovations make jobs with particular characteristics likely to be offshored in the future. While actual offshoring can have an important effect on wages and employment, the mere fact that jobs are offshorable may also be an important driver of labor market outcomes.[1] An environment of increased globalization that eases the process by which multinational firms can move production plants offshore should strengthen their outside options in wage negotiations, with consequences for wages and employment. For instance, the increased contestability of U.S. jobs by foreign workers could lower U.S. wages, even while the jobs stay in the United States. Yet, there is very little empirical or theoretical work on the effect of offshorability on labor market outcomes.

In this paper, we take a theoretical approach and analyze the effect of the threat of offshoring on wages and unemployment in an open economy model in which the labor market is subject to search frictions à la Diamond-Mortenson-Pissarides. In our framework, multinational firms operate domestic and foreign plants and can shift production from the domestic country to its foreign affiliates depending on economic conditions. Because of the presence of search frictions, employment relationships generate a surplus and the share accruing to workers and firms depend on the threat of offsoring, that is, on the fact that the multinational firms *may* relocate domestic jobs abroad.

To model the threat of offshoring, we introduce two additional innovations. First, we assume that in order to create a new position, firms must have capital in place and therefore must pay a cost prior to entry. This cost of entry implies that once a firm has entered the market, an unfilled vacancy retains a strictly positive value under free entry. Second, we introduce 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). Taken together, these two features allow us to formalize the threat of offshoring in a tractable way In particular, using this approach we can clearly derive how the threat of offshoring affects the bargained wages in equilibrium.

Our main result is that the threat of offshoring production can put significant downward pressures on wages in the source country, even if the existing amount of offshoring is very small. In our benchmark calibration, offshored production accounts for only one percent of total output. Nevertheless, we show that the ability of the multinational to exercise the outside option of offshoring domestic production lowers the domestic wage in the bargaining process by nearly 7 percent, about

[1] Leamer (2007) emphasizes the importance of distingusing between actual offshoring and offshorability, or in his terminology between movement and mobility, when examining the effects of offshoring and trade on wages.

half the empirical estimate of Blinder (2009) who constructs an index of offshorability for U.S. occupations. Moreover, the responses of wages and the unemployment rate to transitory shocks is significantly dampened under the threat of offshoring, so that the threat of offshoring acts like a real rigidity in the model.

We also show that these effects occur mainly in the short run, whereas the quantitative impact of the threat of offshoring on labor market outcomes is muted considerably in the long run when firm entry and the capital stock are allowed to freely adjust. The higher short-run impact arises because of the higher value of an unfilled vacancy in the short run, which makes part of the firm's outside option, that is then eroded in the long run due to firm entry and adjustment in the capital stock.

Our paper adds to a growing literature that builds on early work by Davidson, Martin, and Matusz (1988) by embedding labor market search frictions into open economy models (see, e.g., Helpman and Itskhoki (2010), Helpman, Itskhoki, and Redding (2011, 2010a, 2010b), 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.[2] 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, using

[2] Davidson, Matusz, and Shevchenko (2008) look at the the influence of offshoring on wages through the firm's outside option, but this analysis is of the partial equilibrium labor market.

Swedish data, Lachowska (2010) presents empirical evidence indicating that outside options are important in the wage formation process.

The remainder of this paper is organized as follows. The next section presents a simple, intuitive discussion of how the main mechanisms that we introduce into the model combine to generate the threat effect. With that intuition as back ground, the model is presented in Section 3. Section 4 focuses on the channels through which the threat effect influences domestic wages as seen through the lens of the theoretical model. We then turn to measurement. Section 5 describes the baseline calibration and presents the main results. We examine the sensitivity of our baseline results to some key parameters of the model in Section 6. Finally, Section 7 concludes.

2 The Structure of the Labor Market and Model Timing

Before getting into the details of the model, it is first useful to briefly discuss the structure of the labor market and the assumptions regarding model timing in order to develop intuition for how we formalize the threat of offshoring.

A multinational residing in the Home country produces an intermediate good at "plants" that are located both domestically and abroad. Our concept of a "plant" is sufficiently broad. It might literally mean the physical infrastructure that allows a job to be performed (implying it cannot be easily relocated internationally); alternatively, it might also be a blueprint for how to do a specific task (which is more portable). Regardless, the multinational must pay a fixed cost of entry in order to establish a plant. Once established, the plant needs to be staffed with a worker hired in a frictional labor market. Hiring is done in one of two segmented labor markets: a market for domestic jobs located in the Home country or a market for offshore jobs located in the Foreign country. In each market, the multinational pays a per period vacancy posting cost until the dormant plant is matched with a worker. The fact that the multinational pays a fixed cost of entry to establish a plant implies that an unfilled vacancy retains some positive value even under free entry.

Importantly, we assume that a certain fraction of production is done with jobs that exhibit characteristics that make them particularly susceptible to being easily relocated abroad—these jobs are meant to be "offshorable"in the sense of Blinder (2007). For example, an offshorable job can be thought of as one that is sufficiently routine such that it can be easily codified, allowing a foreign worker to learn how to do the task just as easily as a domestic worker. The fixed cost of entry for these types of jobs might be best thought of as the cost of making the blueprint describing how to perform the task; once the cost for formulating the blueprint is incurred, the job itself is easily transferable across borders.

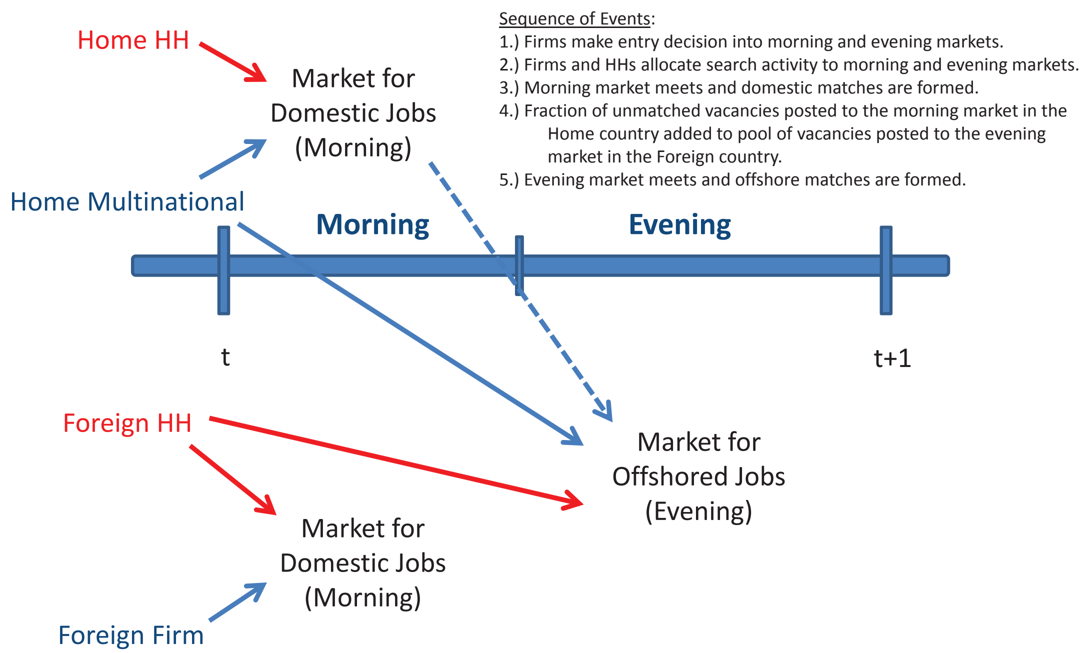

Figure 1: Model Timing

With that brief description of the general structure of the labor market, we turn now to the model timing, presented in Figure 1. Following the money search literature, we break each time period up into two subperiods which we refer to as the morning and evening periods, respectively.[3]

The sequence of events within a period, outlined in the inset box in the figure, is as follows. At the start of the period, both the multinational and the foreign firm make their respective entry decisions. The multinational enters into both the (morning) domestic market as well as into the (evening) offshore market, while the foreign firm enters into its (morning) domestic market only. Once the entry decision is made, firms and households then allocate search activity directly to each respective market. So, for example, at the beginning of the period the multinational posts vacancies to both the domestic and offshore labor market and the foreign household makes a similar choice regarding its allocation search activity.

At this point, the morning market meets. Searching individuals are matched with open vacancies and domestic employment relationships are formed in both the Home and Foreign countries.

[3]In Lagos and Wright (2005) a decentralized search market (in which money is essential for conducting goods transactions) meets in the morning, while a centralized market meets in the evening. This timing assumption is made for technical reasons. With quasi-linear utility, evening trade in the centralized market serves to kill the wealth distribution that arises due to trade in the decentralized morning market. Thus, the timing assumption is made in order to make the model more tractable. Our motivation for introducing a sequential market structure is similar: we want to formalize the threat of offshoring in the most tractable way possible.

However, due to the matching frictions, not all open vacancies will be matched with workers. Searching individuals that fail to match with an open vacancy in the domestic labor market are counted as unemployed. Similarly, for jobs that are not offshorable, those plants that fail to match with a worker remain inactive. On the other hand, for the fraction of jobs that are offshorable, the portability of the blueprint allows the multinational to carry the open vacancy over to the evening market in an attempt to fill the position with a foreign worker. That is, the vacancy is not attached to a specific plant at Home and can be transferred abroad to fill in the job with a foreign worker at an idle foreign plant.

Finally, the evening market meets. Individuals searching in the Foreign market for offshored jobs are matched with open vacancies. Those individuals that fail to match in the evening market are added to the Foreign unemployment pool. Unfilled vacancies that were posted directly to the offshore market remain abroad as inactive plants and unfilled vacancies that were offshored from the morning market are returned to the domestic labor market in the Home country.

With this understanding of the general labor market structure and model timing, the intuition behind how we formalize the threat of offshoring is clear. The sequential markets setup, in conjunction with the fact that the fixed cost of entry implies that the value of an unfilled vacancy is not driven to zero, alters the multinational's outside option when bargaining over the wage with domestic workers in the morning market. Both the worker and the multinational know that the multinational can walk away from a match with a domestic worker and fill the position later that evening with a foreign worker.

3 The Model

We extend the textbook Diamond-Mortenson-Pissarides labor search model to a two country setting and introduce a multinational firm residing in the Home country that engages in international production sharing. We then introduce two innovations to the model. First, we introduce a cost of entry into the labor market, which has the implication that free entry does not drive the value of an unfilled vacancy to zero. Second, we alter the intra-period timing of the model by introducing a sequential setup whereby the market for domestic jobs meets in the morning of each period and the market for offshore jobs meets in the evening. Taken together, these two ingredients allow us to capture, in a tractable manner, the idea that the ability of the multinational to shift production internationally alters its outside option in wage negotiations. It is through this outside option that we formalize the threat effect of offshoring on wages and other labor market allocations.

3.1 Notation

We will denote by a subscripted D variables in the *domestic market* located in either the Home or Foreign country; subscript O's denote variables in the *offshore market* located in the Foreign country. Asterisks (*) denote variables that are physically located in the Foreign country, while the lack of an asterisk denotes variables that are physically located in the Home country. Finally, where applicable, we differentiate short run variables with a hat, so that for example $\widehat{w}_{d,t}$ is the short run wage in the domestic labor market in the Home country. Lack of a hat indicates a long run variable. The distinction between short and long run variables will be discussed further in Section 3.7.

3.2 Production

There is a representative firm in the Home country (the North) which is a multinational in the sense that it engages in international production sharing. The multinational operates a large number of plants located both at home and abroad. Plant-level production is aggregated into an intermediate good both in the Home country and in the offshore market. The offshored intermediate good is shipped back to the Home country and, along with the domestic intermediate good, is processed into a final good. This final good is in turn sold internationally. In contrast, the Foreign final good is processed using an intermediate good that is the aggregate of strictly domestic plant-level production. Thus, for tractability, we assume that offshoring activity in the model is North-South only.

3.2.1 The Multinational Firm

The multinational produces a final good, denoted y_t, using intermediate goods produced at a large number of plants residing both domestically, $y_{\text{D},t}$, and abroad, The multinational produces a final good, denoted y_t, using intermediate goods produced at plants residing both domestically, $y_{\text{D},t}$, and abroad, $y^*_{\text{O},t}$. The offshored intermediate good is potentially subject to an iceberg shipping cost, denoted Υ, so that, in terms of general notation, the technology for the production of the final good is given by $y_t = f(y_{\text{D}\ ,t}, (1-\Upsilon)y^*_{\text{O},t})$. Once the intermediate goods are combined, the final output is sold in perfectly competitive goods markets both at home and abroad.

Intermediate goods, in turn, are the aggregate of plant-level production. Prior to an individual plant becoming operational, regardless of where it resides, the multinational must first incur a sunk entry cost in order to set up the plant up in the first place. Once entry takes place and then plant is established, it then needs to be staffed with a single worker—throughout the remainder of the paper a plant is synonymous with a worker or a job—hired in a frictional labor market. Hired workers are then combined with capital rented from domestic households in a frictionless capital market to produce output according to a constant returns to scale production technology. In the domestic labor market plant-level production is given by $y^i_{\mathrm{D},t} = g(l, k_{\mathrm{D},t})$, where l is hours per worker for Home workers, which we normalize to one. Similarly, plant-level production in the offshore market is given by $y^{i*}_{\mathrm{O},t} = g(l^*, k^*_{\mathrm{O},t})$, where l^* is hours per worker for Foreign workers, which we also normalize to one.

Total intermediate goods production then simply aggregates across plant-level production, so that domestic and offshore intermediate goods production are given by, respectively:

$$y_{\mathrm{D},t} = z_{\mathrm{D},t} n_{\mathrm{D},t} y^i_{\mathrm{D},t} = z_{\mathrm{D},t} g(n_{\mathrm{D},t}, K_{\mathrm{D},t}); \qquad y^*_{\mathrm{O},t} = z^*_{\mathrm{O},t} n^*_{\mathrm{O},t} y^{i*}_{\mathrm{O},t} = z^*_{\mathrm{O},t} g(n^*_{\mathrm{O},t}, K^*_{\mathrm{O},t}) \tag{1}$$

where: $z_{\mathrm{D},t}$ and $z^*_{\mathrm{O},t}$ are technology shocks that can potentially differ across the multinational's domestic and offshore plants; $n_{\mathrm{D},t}$ and $n^*_{\mathrm{O},t}$ denote the stock of labor (or, equivalently the number of plants) in domestic and offshored jobs; and $K_{\mathrm{D},t} = n_{\mathrm{D},t} k_{\mathrm{D},t}$ and $K^*_{\mathrm{O},t} = n^*_{\mathrm{O},t} K^*_{\mathrm{O},t}$ denote the aggregate capital stock used by domestic and offshore plants, respectively.

In order to fill open positions, plants must recruit workers which requires posting vacancies in a frictional local labor market. Let $v_{\mathrm{D},t}$ and $v^*_{\mathrm{O},t}$ denote vacancies posted directly to the domestic and offshore labor markets, respectively. Let $k^f(\theta_{\mathrm{D},t})$ denote the probability that a vacancy posted by the multinational is matched with a worker in the domestic labor market. This probability depends on labor market tightness, which for the domestic labor market is defined as $\theta_{\mathrm{D},t} = v_{\mathrm{D},t}/s_{\mathrm{D},t}$ where $s_{\mathrm{D},t}$ is the total number of individuals searching for domestic jobs, as discussed in Section 3.4 below. Similarly, let $k^f(\theta^*_{\mathrm{O},t})$ denote the probability that a vacancy posted by the multinational in the offshore labor market is matched with a Foreign worker.

The sequential nature of markets means that even if a vacancy that is posted directly to the domestic job market goes unfilled in the morning market, which happens with probability $1 - k^f(\theta_{\mathrm{D},t})$, the multinational still has an opportunity to fill that opening with a foreign worker in the evening, provided the job is offshorable. Recalling that Ω is the fraction of offshoreable jobs, the total number of open vacancies in the offshore market, $\widetilde{v}^*_{\mathrm{O},t}$, is the sum of vacancies posted directly in that market at the start of the period, $v^*_{\mathrm{O},t}$, and those that rolled over from the morning market, so that $\widetilde{v}^*_{\mathrm{O},t} = v^*_{\mathrm{O},t} + \Omega(1 - k^f(\theta_{\mathrm{D},t}))v_{\mathrm{D},t}$. Under the assumption that $\Omega = 0$ the intra period timing becomes irrelevant as the three labor markets are completely segmented from one another.

The resulting perceived laws of motion for the multinational's employment stock of domestic and offshore workers, respectively, are given by

$$n_{\mathrm{D},t} = (1 - \rho^x_{\mathrm{D}})(1 - \rho^n_{\mathrm{D}}) n_{\mathrm{D},t-1} + v_{\mathrm{D},t} k^f(\theta_{\mathrm{D},t}) \tag{2}$$

$$n^*_{\mathrm{O},t} = (1 - \rho^{*x}_{\mathrm{O}})(1 - \rho^{*n}_{\mathrm{O}}) n^*_{\mathrm{O},t-1} + \widetilde{v}^*_{\mathrm{O},t} k^f(\theta^*_{\mathrm{O},t}), \tag{3}$$

where $k^f(\theta^*_{\mathrm{O},t})$ denotes the probability that a vacancy is filled in the offshore market . This probability is a function of market tightness in the market for offshored jobs, defined as $\theta^*_{\mathrm{O},t} = \widetilde{v}^*_{\mathrm{O},t}/s^*_{\mathrm{O},t}$

where $s^*_{\mathrm{O},t}$ is the number of individuals searching for offshore jobs.

These laws of motion simply say that employment at time t depends on the number of remaining jobs today plus the number of matches the firm expects to make by posting vacancies to the respective markets. The number of remaining domestic jobs today is equal to yesterday's end-of-period employment stock, $n_{\mathrm{D},t-1}$, net of the total number of jobs that are exogenously terminated at the beginning of period t. Job termination may occur as a result of an existing job becoming obsolete, which occurs with probability ρ^x_{D}. Alternatively, even if a job remains operable, it may separate exogenously, which occurs with probability ρ^n_{D}. We require job separation along both margins: the first margin allows for a flow equilibrium in entry while the second allows for a flow equilibrium in employment conditional on entry. A similar set of notation applies to the probability of job termination due to obsolescence, ρ^{x*}_{O}, or separation, ρ^{n*}_{O}, for jobs in the offshore market.

As discussed in Fujita and Ramey (2007), a direct consequence of introducing the sunk cost of entry is that vacancies become a state variable.[4] The associated laws of motion for vacancies posted domestically and abroad are given by:

$$v_{\mathrm{D},t} = (1-\rho^x_{\mathrm{D}})\rho^n_{\mathrm{D}} n_{\mathrm{D},t-1} + (1-\rho^x_{\mathrm{D}})(1-k^f(\theta_{\mathrm{D},t-1}))(1-\Omega k^f(\theta^*_{\mathrm{O},t-1}))v_{\mathrm{D},t-1} + ne_{\mathrm{D},t} \tag{4}$$

$$v^*_{\mathrm{O},t} = (1-\rho^{*x}_{\mathrm{O}})\rho^{*n}_{\mathrm{O}} n^*_{\mathrm{O},t-1} + (1-\rho^{*x}_{\mathrm{O}})(1-k^f(\theta^*_{\mathrm{O},t-1}))v^*_{\mathrm{O},t-1} + ne^*_{\mathrm{O},t}. \tag{5}$$

The stock of vacancies in a given market tomorrow is equal to newly opened vacancies resulting from non-obsolescent jobs that have separated exogenously (which occurs with probability $(1-\rho^x_{\mathrm{D}})\rho^n_{\mathrm{D}}$ in the domestic market, for example) plus the sum of the stock of existing unfilled vacancies inherited from yesterday and newly created vacancies associated with entrants, denoted $ne_{\mathrm{D},t}$ and $ne^*_{\mathrm{O},t}$ for entrants into the domestic and offshore markets, respectively. Note that in equation (4) we also need to take into account the fact that, for domestic jobs that are offshorable, unfilled vacancies in the domestic market can potentially be filled in the evening.[5]

The multinational's optimization problem, therefore, is to choose sequences of $K_{\mathrm{D},t}$, $K^*_{\mathrm{O},t}$, $n_{\mathrm{D},t}$, $n^*_{\mathrm{O},t}$, $v_{\mathrm{D},t}$, and $v^*_{\mathrm{O},t}$ to maximize discounted lifetime profits, defined as:

$$\Pi_t = \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0}[f(y_{\mathrm{D},t},(1-\Upsilon)y^*_{\mathrm{O},t}) - w_{\mathrm{D},t}n_{\mathrm{D},t} - q_t w^*_{\mathrm{O},t}n^*_{\mathrm{O},t} - r^k_{\mathrm{D},t}K_{\mathrm{D},t} - q_t r^{k*}_{\mathrm{O},t}K^*_{\mathrm{O},t} - \gamma_{\mathrm{D}}v_{\mathrm{D},t} - \gamma^*_{\mathrm{O}}\tilde{v}^*_{\mathrm{O},t}]$$

subject to: the technologies for producing intermediate goods at home and abroad, given in equation (**??**); the laws of motion for domestic and offshore employment, given by equations (2) and (3),

[4] Fujita and Ramey (2007) introduced an exogenous fixed cost of vacancy creation to introduce persistence into vacancy postings over the business cycle in an effort to better fit the data.

[5] For jobs that are not offshorable, the probability that a vacancy goes unmatched in a given period is $(1-k^f(\theta_{\mathrm{D},t}))$, while the same probability for jobs that are offshorable is given by $(1-k^f(\theta_{\mathrm{D},t}))(1-k^f(\theta^*_{\mathrm{O},t}))$. Weighting the two probabilities by $1-\Omega$ and Ω, respectively, and adding the resulting expressions gives $(1-k^f(\theta_{\mathrm{D},t}))(1-\Omega k^f(\theta^*_{\mathrm{O},t}))$, which appears in equation 4 weighted by the probability of non-obsolescence.

respectively; the laws of motion for domestic and foreign vacancies, equations (4) and (5); and the identity $\widetilde{v}^*_{\text{O},t} = v^*_{\text{O},t} + \Omega(1 - k^f(\theta_{\text{D},t}))v_{\text{D},t}$.

In the multinational's profit function, once the cost of entry is paid and capital is put in place so that a new job opening is created, the firm must pay a per-period posting cost denoted by γ_{D} (γ^*_{O}) for vacancies posted domestically (abroad). Entry costs and vacancy posting costs in both markets are a drain on real resources in the Home country. The rental rates of domestic and offshore capital are given by $r^k_{\text{D},t}$ and $r^{k*}_{\text{O},t}$. Finally, all factor payments made in the offshore market are made in units of the foreign currency, so the multinational must internalize movements in the real exchange rate, q_t, when making its optimal offshoring decision.

Details of the solution are shown in Appendix A. Beginning with the multinational's optimal offshoring decision, the first order conditions for $v^*_{\text{O},t}$ and $n^*_{\text{O},t}$, respectively, are given by

$$\lambda^*_{\text{O},t} = -\gamma^*_{\text{O}} + k^f(\theta^*_{\text{O},t})\mu^*_{\text{O},t} + (1 - k^f(\theta^*_{\text{O},t}))(1 - \rho^{*x}_{\text{O}})E_t[\Xi_{t+1|t}\lambda^*_{\text{O},t+1}] \tag{6}$$

$$\mu^*_{\text{O},t} = f_{n^*_{\text{O}},t} - q_t w^*_{\text{O},t} + (1 - \rho^{*x}_{\text{O}})E_t\left[\Xi_{t+1|t}\left(\rho^{*n}_{\text{O}}\lambda^*_{\text{O},t+1} + (1 - \rho^{*n}_{\text{O}})\mu^*_{\text{O},t+1}\right)\right] \tag{7}$$

where: $\lambda^*_{\text{O},t}$ is the multiplier on equation (5) and $\mu^*_{\text{O},t}$ is the multiplier on equation (3). These multipliers define the value of an open vacancy in the offshore market, $\mathbf{V}^*_{\text{O},t} \equiv \lambda^*_{\text{O},t}$, and a filled job in the offshore market, $\mathbf{J}^*_{\text{O},t} \equiv \mu^*_{\text{O},t}$, to the multinational.

The first equation says that the value of an unfilled vacancy in the offshore market is equal to its expected return net of the per period cost of posting a vacancy. The expected return on an open vacancy is equal to the probability that vacancy is filled today times the value of the resulting job plus the expected continuation value of the vacancy tomorrow, conditional on it not being filled today and not being rendered obsolete. The second equation says that the value of an additional offshore worker to the multinational is equal to the worker's marginal product net of the wage (paid in local currency) plus the expected continuation value of the job. The continuation value is the stream of additional marginal revenue brought in over the expected life of the match plus, in the event that the match breaks up, stream of benefit that comes from having an unfilled vacancy.

Importantly, both jobs and unfilled vacancies deliver a flow of value over time. This contrasts with a more standard labor search model in which there is no fixed cost of entry. To make this point more explicit, note that in absence of the entry cost we would have $\lambda^*_{\text{O},t} = 0$ which would imply $\mu^*_{\text{O},t} = \gamma^*_{\text{O}}/k^f(\theta^*_{\text{O},t})$ by equation (6). Plugging this into equation (7) results in a job creation condition that arises in most standard general equilibrium labor search models.

Turning to the multinational's search activity in the domestic market, the first order conditions for $v_{\text{D},t}$ and $n_{\text{D},t}$, respectively, are given by

$$\begin{aligned} \lambda_{\text{D},t} \quad = \quad & -\gamma - \Omega(1 - k^f(\theta_{\text{D},t}))\gamma^*_{\text{O}} + k^f(\theta_{\text{D},t})\mu_{\text{D},t} + \Omega(1 - k^f(\theta_{\text{D},t}))k^f(\theta^*_{\text{O},t})\mu^*_{\text{O},t} \\ & +(1 - k^f(\theta_{\text{D},t}))(1 - \Omega k^f(\theta^*_{\text{O},t}))(1 - \rho^x_{\text{D}})E_t[\Xi_{t+1|t}\lambda_{\text{D},t+1}] \end{aligned} \tag{8}$$

$$\mu_{\mathrm{D},t} = f_{n_{\mathrm{D}},t} - w_{\mathrm{D},t} + (1-\rho^x_{\mathrm{D}})E_t\left[\Xi_{t+1|t}\left(\rho^n_{\mathrm{D}}\lambda_{\mathrm{D},t+1} + (1-\rho^n_{\mathrm{D}})\,\mu_{\mathrm{D},t+1}\right)\right] \tag{9}$$

where: $\lambda_{\mathrm{D},t}$ is the multiplier on equation (4) and $\mu_{\mathrm{D},t}$ is the multiplier on equation (2). These multipliers define the value of an open domestic vacancy, $\mathbf{V}_{\mathrm{D},t} \equiv \lambda_{\mathrm{D},t}$, and a filled domestic job, $\mathbf{J}_{\mathrm{D},t} \equiv \mu_{\mathrm{D},t}$, to the multinational.

The value of a vacancy in the domestic market differs from the value of a vacancy in the offshore market in one important way. The last term on the right side of the first line in equation (8) captures the idea that, to the degree that a job exhibits characteristics that make it offshoreable, the ability to fill a vacancy originally posted in domestic market with a foreign worker changes the outside option of the firm. This outside option, $\Omega(1-k^f(\theta_{\mathrm{D},t}))k^f(\theta^*_{\mathrm{O},t})\mu^*_{\mathrm{O},t}$, increases the value of an unfilled domestic vacancy and is the primary lever through which the threat of offshoring influences wages and labor market allocations in our model. Note that if $\Omega = 0$, so that no jobs are offshorable, then the outside option disappears and equation (8) will look very similar to equation (6) above. Thus, to the degree that the *domestic job creation condition* looks different from a standard search model, it is due to both the continuation value of a vacancy as well as the sequential nature of labor markets.

Finally, the multinational's optimal capital demand equations are given by:

$$f_{k_{\mathrm{D}},t} = r^k_{\mathrm{D},t} \tag{10}$$

$$f_{k^*_{\mathrm{O}},t} = q_t r^{k^*}_{\mathrm{O},t} \tag{11}$$

3.2.2 The Foreign Firm

The final goods producing firm in the Foreign country uses only domestically-produced intermediate goods, $y^*_{\mathrm{D},t}$, to produce the final good, y^*_t. The intermediate good, in turn, is an aggregate of plant-level production, where production at the plant level uses domestic labor and capital, so that $y^{*i}_{\mathrm{D},t} = g^*(n^*_{\mathrm{D},t}, k^*_{\mathrm{D},t})$. Aggregating across all plants gives $y^*_{\mathrm{D},t} = z^*_{\mathrm{D},t}n^*_{\mathrm{D},t}y^{i*}_{\mathrm{D},t} = z^*_{\mathrm{D},t}g^*(n^*_{\mathrm{D},t}, K^*_{\mathrm{D},t})$, where $K^*_{\mathrm{D},t} = n^*_{\mathrm{D},t}k^*_{\mathrm{D},t}$ is the aggregate stock of capital used by domestic firms in the Foreign country. Intermediate goods are assumed to be transformed unit-for-unit into the final good, so that $y^*_t = f(y^*_{\mathrm{D},t}) = y^*_{\mathrm{D},t}$.

The foreign firm's optimization problem is to choose sequences $K^*_{\mathrm{D},t}$, $n^*_{\mathrm{D},t}$, and $v^*_{\mathrm{D},t}$ to maximize discounted lifetime profits subject to the production technology and the laws of motion for both domestic employment and vacancies.

$$\Pi^*_t = \sum_{t=0}^{\infty}\beta^{*t}\frac{\lambda^*_t}{\lambda^*_0}\left[f(y^*_{\mathrm{D},t}) - w^*_{\mathrm{D},t}n^*_{\mathrm{D},t} - r^{k^*}_t K^*_{\mathrm{D},t} - \gamma^*_{\mathrm{D}}v^*_{\mathrm{D},t}\right] \tag{12}$$

subject to:

$$y^*_{\mathrm{D},t} = z^*_{\mathrm{D},t}g(n^*_{\mathrm{D},t}, K^*_{\mathrm{D},t}) \tag{13}$$

$$n^*_{\mathrm{D},t} = (1-\rho^{x*}_{\mathrm{D}})(1-\rho^{n*}_{\mathrm{D}})n^*_{\mathrm{D},t-1} + v^*_{\mathrm{D},t}k^f(\theta^*_{\mathrm{D},t}) \tag{14}$$

$$v^*_{\mathrm{D},t} = (1-\rho^{x*}_{\mathrm{D}})\rho^{n*}_{\mathrm{D}}n^*_{\mathrm{D},t-1} + (1-\rho^{x*}_{\mathrm{D}})(1-k^f(\theta^*_{\mathrm{D},t-1}))v^*_{\mathrm{D},t-1} + ne^*_{\mathrm{D},t} \tag{15}$$

where: $k^f(\theta^*_{\mathrm{D},t})$ is the probability that a job posting will be matched with a Foreign worker in the domestic labor market; γ^*_{D} denotes the vacancy posting cost in the Foreign labor market; and ne^*_t is entry into the Foreign domestic market.

As shown in Appendix A, the firm's first order conditions for $v^*_{\mathrm{D},t}$ and $n^*_{\mathrm{D},t}$, respectively, are given by:

$$\lambda^*_{\mathrm{D},t} = -\gamma^*_{\mathrm{D}} + k^f(\theta^*_{\mathrm{D},t})\mu^*_{\mathrm{D},t} + (1-k^f(\theta^*_{\mathrm{D},t}))E_t[\Xi^*_{t+1|t}(1-\rho^{x*}_{\mathrm{D}})\lambda^*_{\mathrm{D},t+1}] \tag{16}$$

and

$$\mu^*_{\mathrm{D},t} = f_{n^*_{\mathrm{D}},t} - w^*_{\mathrm{D},t} + (1-\rho^{*x}_{\mathrm{D}})E_t\left[\Xi^*_{t+1|t}\left(\rho^{n*}_{\mathrm{D}}\lambda^*_{\mathrm{D},t+1} + (1-\rho^{n*}_{\mathrm{D}})\mu^*_{\mathrm{D},t+1}\right)\right] \tag{17}$$

where $\mu^*_{\mathrm{D},t}$ is the multiplier on equation (14) and $\lambda^*_{\mathrm{D},t}$ is the multiplier on equation(4). These multipliers define the value of an open domestic vacancy, $\mathbf{V}^*_{\mathrm{D},t} \equiv \lambda^*_{\mathrm{D},t}$, and a filled domestic job, $\mathbf{J}^*_{\mathrm{D},t} \equiv \mu^*_{\mathrm{D},t}$, to the foreign firm.

Equations (16) and (17) have similar interpretations as the multinational's first order conditions given by 8 and 9. However, note that the foreign firm does not search sequentially within the period, it only searches in the morning market for domestic workers.

Finally, the optimal capital accumulation equation is given by

$$f_{k^*_{\mathrm{D}},t} = r^{k^*}_{\mathrm{D},t} \tag{18}$$

3.3 Free Entry

In all three labor markets, free entry in the creation of new positions drives the value of an unfilled vacancy to the creation cost, or the value of capital in place for a given worker (or plant). Thus, the free entry conditions for the multinational into the domestic and offshore labor markets, respectively, are given by:

$$\mathbf{V}_{\mathrm{D},t} = r^k_{\mathrm{D},t}\frac{K_{\mathrm{D},t}}{n_{\mathrm{D},t}} \tag{19}$$

and

$$\mathbf{V}^*_{\mathrm{O},t} = q_t r^{k*}_{\mathrm{O},t}\frac{K^*_{\mathrm{O},t}}{n^*_{\mathrm{O},t}} \tag{20}$$

Similarly, the free entry condition in the creation of new positions for the Foreign firm into the Foreign labor market is given by

$$\mathbf{V}^*_{\mathrm{D},t} = r^{k^*}_{\mathrm{D},t}\frac{K^*_{\mathrm{D},t}}{n^*_{\mathrm{D},t}} \tag{21}$$

3.4 Households

There is a continuum of identical households in both the Home and Foreign economies. 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 operated domestically by the Home multinational while individuals in the Foreign country optimally allocate search activity across two separate labor markets: one for jobs operated by Foreign firms producing domestically and one for jobs that have been offshored to the foreign plant by the Home multinational. 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.

3.4.1 Home Households

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

$$c_t \equiv \left(\lambda^{\frac{1}{\zeta}} c_{\mathrm{H},t}^{\frac{(\zeta-1)}{\zeta}} + (1-\lambda)^{\frac{1}{\zeta}} c_{\mathrm{F},t}^{\frac{(\zeta-1)}{\zeta}} \right)^{\frac{\zeta}{\zeta-1}} \tag{22}$$

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, $c_{\mathrm{H},t}$ and $c_{\mathrm{F},t}$, respectively.

We normalize $p_{\mathrm{H},t} = 1$, so that all goods in the economy 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

$$p_t \equiv \left(\lambda + (1-\lambda) p_{\mathrm{F},t}^{(1-\zeta)} \right)^{1/(1-\zeta)} \tag{23}$$

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

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

$$c_{\mathrm{H},t} = \lambda \left(\frac{1}{p_t} \right)^{-\zeta} c_t, \qquad c_{\mathrm{F},t} = (1-\lambda) \left(\frac{p_{\mathrm{F},t}}{p_t} \right)^{-\zeta} c_t \tag{24}$$

Workers in the Home country search only for jobs operated domestically by the multinational. In terms of notation, let $s_{\mathrm{D},t}$ denote the time spent searching to achieve the desired level of employment with the domestic firm, $n_{\mathrm{D},t}$, and let $k^w(\theta_{\mathrm{D},t})$ denote the probability that a searching individual will be matched in a domestic job. Finally, we define labor force participation as $lfp_t = (1 -$

$k^w(\theta_{\mathrm{D},t}))s_{\mathrm{D},t}+n_{\mathrm{D},t}$. That is, participation is unsuccessful searchers (unemployed) plus those actively working in jobs (employed).[6]

The utility of the representative household is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[u(c_t) - h\left(lfp_t\right)\right] \tag{25}$$

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 c_t, K_{t+1}, b_{t+1}, $s_{\mathrm{D},t}$, and $n_{\mathrm{D},t+1}$ to maximize lifetime utility subject to an infinite sequence of flow budget constraints and perceived laws of motion for domestic jobs:

$$p_t c_t + p_t\left(K_{\mathrm{D},t+1} - (1-\delta) K_{\mathrm{D},t}\right) + \int p_{bt,t+1} b_{t+1} = p_t w_{\mathrm{D},t} n_{\mathrm{D},t} + p_t r^k_{\mathrm{D},t} K_{\mathrm{D},t} + (1-k^w(\theta_{\mathrm{D},t}))s_{\mathrm{D},t}\chi + b_t + p_t d_t \tag{26}$$

$$n_{\mathrm{D},t} = (1-\rho_{\mathrm{D}})n_{\mathrm{D},t-1} + s_{\mathrm{D},t}k^w(\theta_{\mathrm{D},t}) \tag{27}$$

where: $k_{\mathrm{D},t}$ is the domestic capital stock; δ is the rate of depreciation of the capital stock; $p_{bt,t+1}$ is the price of the state-contingent bond that pays one unit of the domestic consumption good in a particular state of nature at time $t+1$; $w_{\mathrm{D},t}$ is the real wage paid to a worker in the Home country; $r^k_{d,t}$ is the real return on a unit of capital; χ is the unemployment benefit that accrues to individuals actively searching for employment; and, finally, d_t denotes the dividend paid to households by intermediate goods producing firms. For convenience, we have introduced the parameter $\rho_{\mathrm{D}} = \rho^x_{\mathrm{D}} + (1-\rho^x_{\mathrm{D}})\rho^n_{\mathrm{D}}$ to denote the total exogenous probability of job termination, inclusive of both job obsolescence and exogenous destruction.

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

$$\frac{u'(c_t)}{p_t} = \beta E_t\left[\frac{1}{p_{bt,t+1}}\frac{u'(c_{t+1})}{p_{t+1}}\right] \tag{28}$$

which defines the one period ahead stochastic discount factor, $\Xi_{t+1|t} = \beta E_t\left[\frac{u'(c_{t+1})}{u'(c_t)}\frac{p_t}{p_{t+1}}\right]$.

Combining the first order conditions on c_t, b_{t+1} , and $k_{d,t+1}$ yields the standard no arbitrage condition between capital and bond holdings

$$\frac{1}{p_{bt,t+1}} = E_t\left[1-\delta + r^k_{d,t+1}\right] \tag{29}$$

[6]The timing of labor market activity allows for instantaneous matching. To avoid double counting, we need to net out successful searchers (ie, those that find jobs with probability $k^w(\theta_{\mathrm{D},t})$) from labor force participation. As in Arseneau and Chugh (2010), we use this timing convention for analytical convenience—in the case of this paper, it helps us to express the threat effect in a tractable way.

Finally, combining the first order conditions on $s_{d,t}$ and $n^w_{d,t}$ yields an optimal search condition in the labor market for domestic intermediate goods production

$$\frac{1-k^h(\theta_{\mathrm{D},t})}{k^h(\theta_{\mathrm{D},t})}\frac{h'(lfp_t)-\chi\frac{u'(c_t)}{p_t}}{\frac{u'(c_t)}{p_t}}=w_{\mathrm{D},t}-\frac{h'(lfp_t)}{\frac{u'(c_t)}{p_t}}+(1-\rho_{\mathrm{D}})E_t\left[\Xi_{t+1|t}\frac{1-k^h(\theta_{\mathrm{D},t+1})}{k^h(\theta_{\mathrm{D},t+1})}\frac{h'(lfp_{t+1})-\chi\frac{u'(c_{t+1})}{p_{t+1}}}{\frac{u'(c_{t+1})}{p_{t+1}}}\right]$$

The interpretation is standard. Optimal search on the part of the Home household equates the marginal utility of an additional unit of time spent searching net of the unemployment benefit to the expected gain of search. The expected gain is the wage net of the disutility of labor effort expended in the job plus the continuation value of entering into a long-lasting working relationship with a firm.[7]

3.4.2 Foreign Households

The Foreign household solves a similar problem as the Home household, but—just as with the multinational—the Foreign household's problem involves optimally allocating search activity across two labor markets that we assume segmented. In addition, the Foreign household invests in two separate capital stocks for use in intermediate goods production by the domestic firm and the multinational, respectively.

In terms of notation, let $s^*_{\mathrm{D},t}$ denote search activity in the market for domestic jobs operated by the Foreign firm, and let $s^*_{\mathrm{O},t}$ denote search activity in the market for offshored jobs operated by the multinational. Similarly, let $k^w(\theta^*_{\mathrm{D},t})$ and $k^w(\theta^*_{\mathrm{O},t})$ denote the probability of successful search on the part of households in the market for domestic and offshored jobs, respectively. Define labor force participation in the Foreign country as $lfp^*_t=(1-k^w(\theta^*_{\mathrm{D},t}))s^*_{\mathrm{D},t}+(1-k^w(\theta^*_{\mathrm{O},t}))s^*_{\mathrm{O},t}+n^*_{\mathrm{D},t}+n^*_{\mathrm{O},t}$. Total unemployment is the sum of the measure of unsuccessful searchers in both markets; similarly, total employment is the sum of the measure of employed in both markets.

The Foreign household's problem is to choose sequences of c^*_t, b^*_{t+1}, $K^*_{\mathrm{D},t+1}$, $K^*_{\mathrm{O},t+1}$, $s^*_{\mathrm{O},t}$, $s^*_{\mathrm{D},t}$, $n^*_{\mathrm{O},t+1}$, and $n^*_{\mathrm{D},t+1}$ to maximize:

$$E_0\sum_{t=0}^{\infty}\beta^{*t}\left[u^*(c^*_t)-h^*(lfp^*_t)\right] \tag{30}$$

subject to:

$$\begin{aligned}p^*_tc^*_t+K^*_{\mathrm{D},t+1}+K^*_{\mathrm{O},t+1}-(1-\delta^*)(K^*_{\mathrm{D},t}+K^*_{\mathrm{O},t})+\textstyle\int p_{bt,t+1}b^*_{t+1}=w^*_{\mathrm{O},t}n^*_{\mathrm{O},t}+w^*_{\mathrm{D},t}n^*_{\mathrm{D},t}\\+r^{*k}_{\mathrm{D},t}K^*_{\mathrm{D},t}+r^{*k}_{\mathrm{O},t}K^*_{\mathrm{O},t}+((1-k^w(\theta^*_{\mathrm{D},t}))s^*_{\mathrm{D},t}+(1-k^w(\theta^*_{\mathrm{O},t}))s^*_{\mathrm{O},t})\chi^*+b^*_t+d^*_t\end{aligned} \tag{31}$$

$$n^*_{\mathrm{D},t}=(1-\rho^*_{\mathrm{D}})n^*_{\mathrm{D},t-1}+k^w(\theta^*_{\mathrm{D},t})s^*_{\mathrm{D},t} \tag{32}$$

[7] The $1-k^h(\theta_{\mathrm{D},t})$ term in the numerator of the right hand side of equation (??) and in the continuation value shows up due to the instantaneous timing assumption. See Appendix B for details

$$n^*_{\mathrm{O},t} = (1-\rho^*_{\mathrm{O}})n^*_{\mathrm{O},t-1} + k^w(\theta^*_{\mathrm{O},t})s^*_{\mathrm{O},t} \tag{33}$$

As above, we have introduced the notation $\rho^*_{\mathrm{D}} = \rho^{*x}_{\mathrm{D}} + (1-\rho^{*x}_{\mathrm{D}})\rho^{*n}_{\mathrm{D}}$ and $\rho^*_{\mathrm{O}} = \rho^{*x}_{\mathrm{O}} + (1-\rho^{*x}_{\mathrm{O}})\rho^{*n}_{\mathrm{O}}$ in order to save space. While the Foreign household and the multinational solve a similar problem in the sense that both allocate search activity across two segmented labor markets, the two problems differ in that we have shut down sequential search for the Foreign household. All search activity in the market for offshore jobs is directly allocated to that market. This assumption is made in order to simplify the model and is based on the idea that the threat of offshoring is more relevant to the demand side of the labor market.

Optimization on the part of the Foreign household yields an analogue to equation (28); two arbitrage conditions analogous to equation (29) that pin down the supply of the two capital stocks; and two optimal search conditions analogous to equation (**??**). Details are given in Appendix B.

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, each requiring its own matching function. All take a similar form.

Letting $m(s_{\mathrm{D},t}, v_{\mathrm{D},t})$ denote domestic matches formed in the Home country—that is, matches between the multinational and Home workers—the evolution of total domestic employment in the Home country is given by:

$$n_{\mathrm{D},t} = (1-\rho_{\mathrm{D}})n_{\mathrm{D},t-1} + m(s_{\mathrm{D},t}, v_{\mathrm{D},t}) \tag{34}$$

Using similar notation, the evolution of foreign domestic matches is given by:

$$n^*_{\mathrm{D},t} = (1-\rho^*_{\mathrm{D}})n^*_{\mathrm{D},t-1} + m(s^*_{\mathrm{D},t}, v^*_{\mathrm{D},t}) \tag{35}$$

Finally, the evolution of offshore matches is given by:

$$n^*_{\mathrm{O},t} = (1-\rho^*_{\mathrm{O}})n^*_{\mathrm{O},t-1} + m(s^*_{\mathrm{O},t}, \widetilde{v}^*_{\mathrm{O},t}), \tag{36}$$

Note that $\widetilde{v}^*_{\mathrm{O},t} = v^*_{\mathrm{O},t} + \Omega(1-k^f(\theta_{\mathrm{D},t}))v_{\mathrm{D},t}$ directly links the evolution of the domestic and offshore labor stock. When the multinational posts a vacancy in the domestic market, it influences market tightness at home, as one would expect. But, to the degree that jobs are offshorable, it also influences tightness in the offshore labor market abroad. Moreover, the foreign household will optimally reallocate search activity in response to this change in tightness in the market for offshore jobs. As a result, a vacancy posted by the multinational in the Home country can have an indirect influence on domestic labor markets in the Foreign country. In this sense, the offshorability of jobs links global labor markets together more tightly.

3.6 Wage Determination

The wage paid in any given job is determined in via Nash bargain between a matched worker and firm pair.[8] 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 what follows we present the solutions for the bargained wages in the short and long run, respectively, leaving the details of the solution to Appendix C.

3.6.1 The Short Run Wage

In the short run, the number of firms and the amount of physical capital is assumed to be fixed. Beginning with the Home country, the short run wage paid by the multinational to domestic workers is given by:

$$\begin{aligned}\widehat{w}_{\mathrm{D,t}} \;=\;& (1-\eta)\frac{h'(lfp_t)}{u'(c_t)} + \eta f_{n_{\mathrm{D}},t} \\ & +\eta\left(\gamma - k^f(\theta_{\mathrm{D},t})\left(\widehat{\mathbf{J}}_{\mathrm{D},t} - (1-\rho^x_{\mathrm{D}})E_t\left[\Xi_{t+1|t}\widehat{\mathbf{V}}_{\mathrm{D},t+1}\right]\right)\right) \\ & +\eta\Omega(1-k^f(\theta_{\mathrm{D},t}))\left(\gamma^*_{\mathrm{O}} - k^f(\theta^*_{\mathrm{O},t})\left(\widehat{\mathbf{J}}^*_{\mathrm{O},t} - (1-\rho^x_{\mathrm{D}})E_t\left[\Xi_{t+1|t}\widehat{\mathbf{V}}_{\mathrm{D},t+1}\right]\right)\right)\end{aligned} \tag{37}$$

Generally speaking, the bargained wage is simply a weighted average of the worker and firm threat points in wage negotiations where the weight is given by the worker's bargaining power, η. In the interest of easing exposition, we leave a detailed intuitive discussion until later in a stand-alone Section 4. For now, we will simply say that the threat points in wage negotiations are driven by the value of of the worker's and firm's respective outside options. From the multinational's point of view, the higher is the value of its outside option that comes from walking away from a match, the lower is the resulting bargained wage.

The short run wage paid to workers at domestic intermediate goods producing plants in the Foreign country is given by:

$$\begin{aligned}\widehat{w}^*_{\mathrm{D},t} \;=\;& (1-\eta^*)\frac{h'^*_t}{u'^*_t} + \eta^* f^*_{n^*_{\mathrm{D}},t} \\ & +\eta^*\left(\gamma^*_{\mathrm{D}} - k^f(\theta^*_{\mathrm{D},t})\left(\widehat{\mathbf{J}}^*_{\mathrm{D},t} - (1-\rho^{*x}_{\mathrm{D}})E_t\left[\Xi^*_{t+1|t}\widehat{\mathbf{V}}^*_{\mathrm{D},t+1}\right]\right)\right)\end{aligned} \tag{38}$$

where: η^* is the bargaining power of Foreign workers. Equation 38 takes an identical form as equation 37 in the case in which $\Omega = 0$, so the intuition behind what drives the domestic wage in the Foreign country is similar to what drives the domestic wage in the Home country in this special case. As such, and again in the interest of ease of exposition, we leave a detailed intuitive discussion until Section 4.

[8] We chose Nash bargaining as the wage determination mechanism because it is easy to work with and well understood. Clearly, there are other bargaining protocols we could investigate, but we leave that for future research.

Finally, the short run wage paid by the Home multinational to Foreign workers employed in offshored jobs is given by:

$$\begin{aligned}\widehat{w}^*_{\text{O},t} &= (1-\eta^*)\frac{h'^*_t}{u'^*_t} + \eta^*\frac{1}{q_t}f_{n^*_\text{O},t} \\ &\quad +\eta^*\frac{1}{q_t}\left(\gamma^*_\text{O} - k^f(\theta^*_{\text{O},t})\left(\widehat{\mathbf{J}}^*_{\text{O},t} - (1-\rho^{*x}_\text{O})E_t\left[\Xi_{t+1|t}\widehat{\mathbf{V}}^*_{\text{O},t+1}\right]\right)\right) \\ &\quad +\eta^*\frac{1}{q_t}(1-\rho^{*x}_\text{O})(1-\rho^{*n}_\text{O})E_t\left[\frac{\Xi^*_{t+1|t}q_t - \Xi_{t+1|t}q_{t+1}}{q_{t+1}}\left(\widehat{\mathbf{J}}^*_{\text{O},t+1} - \widehat{\mathbf{V}}^*_{\text{O},t+1}\right)\right]\end{aligned} \tag{39}$$

There are two things worth pointing out about the offshore wage, each of which stem from the fact that bargaining is done internationally. First, the real exchange rate enters into the effective bargaining share. When the real exchange rate appreciates (q_t gets larger) the effective bargaining weight of the multinational, η^*/q_t, increases putting downward pressure on the negotiated wage. Second, the term in the third line captures the fact that the surplus split moves around dynamically in response to movements in both the real exchange rate as well as to differences in the stochastic discount factors of Home and Foreign households.

3.6.2 The Long Run Wage

In the long run, capital is free to adjust and free entry into the labor market drives the value of an unfilled vacancy to the cost of capital. The long run wage paid to domestic workers in the Home country is given by:

$$w_\text{D} = (1-\eta)\frac{h'}{u'} + \eta\left(f_{n_\text{D}} - (1-\beta(1-\rho^x_\text{D}))\,r^k_\text{D}\frac{K_\text{D}}{n_\text{D}}\right) \tag{40}$$

where we have dropped the time subscripts because w_D is a long run steady state variable.

The long run wage paid by the multinational to offshore workers in the Foreign country is given by:

$$w^*_\text{D} = (1-\eta^*)\frac{h'^*}{u'^*} + \eta^*\left(f^*_{n^*_\text{D}} - (1-\beta(1-\rho^{*x}_\text{D}))\,r^{k*}_\text{D}\frac{K^*_\text{D}}{n^*_\text{D}}\right) \tag{41}$$

Finally, the long run wage paid by the multinational to offshore workers in the Foreign country is given by:

$$w^*_\text{O} = (1-\eta^*)\frac{h'^*}{u'^*} + \eta^*\frac{1}{q}\left(f_{n^*_\text{O}} - (1-\beta(1-\rho^{*x}_\text{O}))\,qr^{k*}_\text{O}\frac{K^*_\text{O}}{n^*_\text{O}}\right) \tag{42}$$

All three equations have a similar form in the steady state. As with the subsection above, we leave an intuitive discussion of the long run wage until Section 4 below.

3.7 Equilibrium

As in Davidson, Matusz, and Shevchenko (2008), and Rosen and Wasmer (2005), we differentiate between a long run equilibrium in which entry is free to adjust in absence of frictions and a short run equilibrium in which free entry is impeded. The short run equilibrium can be thought of as one in which there are infinite adjustment costs to entry as opposed to zero adjustment costs in the long run equilibrium. As will be made clear later on, the differentiation between the short and long run—and, in particular, the ability of firms to freely entry each labor market—turns out to be critical to thinking about the role of the threat effect on labor markets.

Taking as given the trade costs, Υ, a private sector *equilibrium in the long run* is made up of the endogenous processes $\{c_t, c_t^*, p_{bt,t+1}, p_{bt,t+1}^*, r_{\mathrm{D},t}^k, r_{\mathrm{D},t}^{k*}, r_{\mathrm{O},t}^{k*}, K_{\mathrm{D},t}, K_{\mathrm{D},t}^*, K_{\mathrm{O},t}^*, w_{\mathrm{D},t}, w_{\mathrm{D},t}^*, w_{\mathrm{O},t}^*, s_{\mathrm{D},t}, s_{\mathrm{D},t}^*, s_{\mathrm{O},t}^*, \theta_{\mathrm{D},t}, \theta_{\mathrm{D},t}^*, \theta_{\mathrm{O},t}^*, n_{\mathrm{D},t}, n_{\mathrm{D},t}^*, n_{\mathrm{O},t}^*, \mathbf{V}_{\mathrm{D},t}, \mathbf{V}_{\mathrm{D},t}^*, \mathbf{V}_{\mathrm{O},t}^*, \mathbf{J}_{\mathrm{D},t}, \mathbf{J}_{\mathrm{D},t}^*, \mathbf{J}_{\mathrm{O},t}^*, ne_{\mathrm{D},t}, ne_{\mathrm{D},t}^*, ne_{\mathrm{O},t}^*, \frac{1}{p_t}, \frac{p_{\mathrm{F},t}^*}{p_t^*}, q_t\}$ that satisfy:

The risk sharing arrangement

$$q_t = \frac{u'(c_t)}{u^{*\prime}(c_t^*)} \tag{43}$$

the definitions of the price indexes in the Home and Foreign country (2 equations); the Home Euler equation (28), and its Foreign counterpart (1 equation); the Home arbitrage condition given by equation (29) and its foreign counterparts (2 equations); optimal search behavior on the part of the Home household, represented by equation (**??**), and the Foreign counterparts (2 equations); optimal capital accumulation on the part of the Home firm, equations (10) and (11) and the Foreign counterpart equation 18; optimal search behavior for the Home firm, equations (6), (7), (9), (8) and their Foreign counterparts, equations (16) and (17); the long run wage equations, given by equations (41) through (42); the laws of motion for vacancies, given by equations (4), (5), and (15); the free entry conditions, given by equations (19), (21), and (20); and the laws of motion for employment, given by (34) through (36).

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

$$f(z_{\mathrm{D},t} g(n_{\mathrm{D},t}, K_{\mathrm{D},t}), (1-\Upsilon) z_{\mathrm{O},t}^* g(n_{\mathrm{O},t}^*, K_{\mathrm{O},t}^*)) = \left(\frac{1}{p_t}\right)^{-\zeta} \left(\lambda c_t + (1-\lambda^*) \left(\frac{1}{q_t}\right)^{-\zeta} c_t^*\right) \tag{44}$$
$$+K_{\mathrm{D},t+1} - (1-\delta) K_{\mathrm{D},t} + \gamma_{\mathrm{D},t} v_{\mathrm{D},t} + \gamma_{\mathrm{O},t}^* v_{\mathrm{O},t}^* + \mathbf{V}_{\mathrm{D},t} ne_{\mathrm{D},t} + \mathbf{V}_{\mathrm{O},t}^* ne_{\mathrm{O},t}^*$$

$$\begin{aligned} f(z_{d,t}^* g(n_{\mathrm{D},t}^*, K_{\mathrm{D},t}^*)) \quad = \quad & \left(\frac{p_{\mathrm{F},t}^*}{p_t^*}\right)^{-\zeta} \left((1-\lambda) q_t^{-\zeta} c_t + \lambda^* c_t^*\right) + K_{\mathrm{D},t+1}^* - (1-\delta^*) K_{\mathrm{D},t}^* \\ & +K_{\mathrm{D},t+1}^* - (1-\delta^*) K_{\mathrm{D},t}^* + \gamma_{\mathrm{D},t}^* v_{\mathrm{D},t}^* + \mathbf{V}_{\mathrm{D},t}^* ne_{\mathrm{D},t}^* \end{aligned} \tag{45}$$

Note that the total cost of entry into each market shows up in the resource constraint. All told, the *long run equilibrium* is a system of 34 equations in 34 unknowns.

In contrast, in the *short run equilibrium* entry in all markets is taken as given and assumed to be constant at some initial long run equilibrium. Thus, for a given $ne_{\text{D},t}$, $ne^*_{\text{D},t}$, and $ne^*_{\text{O},t}$ we drop the the free entry conditions, equations (19), (21), and (20), from the system and replace the long run wage expressions with their short run counterparts given by equations (38) through (37). All told, the in the short run equilibrium, the system is 31 equations in 31 unknowns.

4 The Threat Effect on Domestic Wages

In this section, we discuss how the two key modeling mechanisms that we have introduced—the sequential nature of markets and entry cost—change the outside option of the multinational in wage negotiations both in the short- and long-run.

In order to highlight how these two mechanisms operate, both separately and together, note that we can shut down the sequential nature of markets by assuming $\Omega = 0$ so that no jobs are offshorable. In principle, we can also shut down, either separately or together, the cost of entry into the Home domestic and/or Foreign offshore labor markets.

To clarify this last point, we allow for asymmetry in the cost of entry across different markets. We do this because it offers a convenient way to tease out analytically how the sequential nature of labor markets and fixed costs of entry influence the threat effect. Note that when we shut down the cost of entry into the Home domestic labor market, free entry drives the value of an unfilled domestic vacancy to zero, $\mathbf{V}_{\text{D},t} = 0$, implying $\gamma_{\text{D}} = k^f(\theta_{\text{D},t})\widehat{\mathbf{J}}_{\text{D},t}$. Similarly, when we shut down the cost of entry into the Foreign offshore labor market, free entry drives the value of an unfilled offshore vacancy to zero, $\mathbf{V}^*_{\text{O},t} = 0$, implying $\gamma^*_{\text{O}} = k^f(\theta^*_{\text{O},t})\widehat{\mathbf{J}}^*_{\text{O},t}$. We will use these two facts to help establish under which conditions the threat effect arises.

The threat effect in the short run. For convenience, we restate the wage paid by the multinational to domestic workers in the short-run equilibrium.

$$
\begin{aligned}
\widehat{w}_{\text{D},t} \quad = \quad & (1-\eta)\frac{h'(lfp_t)}{u'(c_t)} + \eta f_{n_{\text{D},t}} \\
& +\eta\left(\gamma_{\text{D}} - k^f(\theta_{\text{D},t})\left(\widehat{\mathbf{J}}_{\text{D},t} - (1-\rho^x_{\text{D}})E_t\left[\Xi_{t+1|t}\widehat{\mathbf{V}}_{\text{D},t+1}\right]\right)\right) \\
& +\eta\Omega(1-k^f(\theta_{\text{D},t}))\left(\gamma^*_{\text{O}} - k^f(\theta^*_{\text{O},t})\left(\widehat{\mathbf{J}}^*_{\text{O},t} - (1-\rho^x_{\text{D}})E_t\left[\Xi_{t+1|t}\widehat{\mathbf{V}}_{\text{D},t+1}\right]\right)\right)
\end{aligned}
$$

The worker's threat point is the marginal rate of substitution (MRS) between consumption and leisure—if the wage drops below the MRS, the worker is better off walking away from the match to enjoy leisure instead. The threat point of the multinational is the marginal product of domestic labor (MPL) plus the *outside option* to the firm of walking away from the match. The multinational's outside option is critical to our main results and consists of two components: (1.) one component stems from the fact that, due to the cost of entry, an open vacancy in the domestic and/or offshore labor market has positive value independent of the threat of offshoring; and (2.) another component that stems directly from the threat of offshoring.

In order to isolate the first component, consider the special case in which $\Omega = 0$, so that markets no longer meet sequentially and, as a consequence, the threat of offshoring is completely shut down. In this case, the multinational's outside option is entirely a function of the fixed cost of entering into the market for domestic jobs. To see this, consider that in absence of the fixed cost, we would have $\widehat{\mathbf{V}}_{\text{D},t} = 0$ and free entry would imply $\gamma_{\text{D}} = k^f(\theta_{\text{D},t})\widehat{\mathbf{J}}_{\text{D},t}$. Consequently, the multinational's outside option of walking away from a match would disappear.

Instead, with a positive fixed cost we can use equation 8 and the fact that $\lambda_{\text{D},t} = \widehat{\mathbf{V}}_{\text{D},t}$ to rewrite the entire term in the second line of the wage expression as the contemporaneous value of an open vacancy net of its continuation value, $-\eta(\widehat{\mathbf{V}}_{\text{D},t} - (1-\rho^x_{\text{D}})E_t[\Xi_{t+1|t}\widehat{\mathbf{V}}_{\text{D},t+1}])$. Written this way, it is easy to see that the multinational influences the domestic wage through the outside option of walking away from a match and, by doing so, retaining the contemporaneous value of the open vacancy net of its continuation value. In the short run equilibrium, where $\widehat{\mathbf{V}}_{\text{D},t} = \widehat{\mathbf{V}}_{\text{D},t+1} = \widehat{\mathbf{V}}_{\text{D}}\forall t$, this outside option unambiguously puts downward pressure on the domestic wage.[9]

The second component of the multinational's outside option stems from the possibility of filling domestic vacancies with Foreign workers—that is, the ability of the multinational to offshore when $\Omega > 0$. In order to isolate the effect of offshoring alone, we need to allow for an asymmetry in the cost of entry across markets. In particular, assume that the multinational must pay a fixed cost associated with entry into the offshore market, but not the domestic market. Under this assumption, the multinational's outside option simplifies to $\eta\Omega(1-k^f(\theta_{\text{D},t}))(\gamma^*_{\text{O}} - k^f(\theta^*_{\text{O},t})\widehat{\mathbf{J}}^*_{\text{O},t})$.[10] Concentrating on the term $k^f(\theta^*_{\text{O},t})\widehat{\mathbf{J}}^*_{\text{O},t}$ it is clear that, conditional on the open position being offshorable (which occurs with probability Ω) and provided the vacancy for that particular position is not filled with a domestic worker in the morning market (which occurs with probability $(1-k^f(\theta_{\text{D},t}))$, then the ability of the multinational to fill that opening with a Foreign worker unambiguously lowers the domestic wage.

Lastly, it is useful to point out that the symmetric assumption of no fixed cost of entry into both the domestic and offshore labor markets, so that $\widehat{\mathbf{V}}_{\text{D},t} = 0$ and $\widehat{\mathbf{V}}^*_{\text{O},t} = 0$, is sufficient to kill

[9] That said, in the fully dynamic economy the outside option could be either positive or negative depending on the contemporaneous value of an open vacancy relative to the discounted continuation value of an open vacancy.

[10] Note that using Equation (6) and the fact that $\lambda^*_{\text{O},t} = \widehat{\mathbf{V}}^*_{\text{D},t}$ we could equivalently rewrite this expression as $-(\widehat{\mathbf{V}}^*_{\text{O},t} - (1-\rho^{*x}_{\text{O}})E_t[\Xi_{t+1|t}\widehat{\mathbf{V}}^*_{\text{O},t+1}])$. In other words, under the assumption of no fixed cost of entry into the domestic labor market, the threat of offshoring is equivalently captured by the contemporaneous value of an unfilled vacancy in the offshore market.

the threat effect, even though actual offshoring still occurs in equilibrium. This highlights the fact that each of our core assumptions—the sequential nature of markets and the cost of entry (into the offshore market at a minimum)—are necessary in order to generate a threat effect.

The threat effect in the long run. In the long run equilibrium, free entry adjusts frictionlessly to drive the value of an open vacancy to the creation cost, so that $\mathbf{V}_{\mathrm{D}} = r^k_{\mathrm{D}} k_{\mathrm{D}}/n_{\mathrm{D}}$. For convenience, we restate the wage paid by the multinational to domestic workers in the long-run equilibrium.

$$w_{\mathrm{D}} \quad = \quad (1-\eta)\frac{h'}{u'} + \eta\left(f_{n_{\mathrm{D}}} - (1-\beta(1-\rho^x_{\mathrm{D}}))\, r^k_{\mathrm{D}}\frac{k_{\mathrm{D}}}{n_{\mathrm{D}}}\right)$$

Clearly, because $(1-\beta(1-\rho^x_{\mathrm{D}})) > 0$ the positive value of an unfilled vacancy puts unambiguous downward pressure on the domestic wage in the long run equilibrium as well. But, what is interesting about this result is that it obtains in the long run equilibrium regardless of whether or not jobs are offshorable (i.e., regardless of the value of Ω). In other words, the threat of offshoring does not explicitly enter into the wage equation in the long run equilibrium. Instead, the threat effect is implicitly embedded in the equilibrium allocations through free entry and the adjustment of the domestic capital stock. Finally, it is useful to note that in absence of the cost of entry, so that $\mathbf{V}_{\mathrm{D}} = 0$, the third term on the right hand side of the equals sign goes to zero and the wage collapses to $w_{\mathrm{D}} = (1-\eta)\frac{h'}{u'} + \eta f_{n_{\mathrm{D}}}$, which is familiar from standard general equilibrium search models.

5 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 wages and labor market allocations. We begin with a description of the baseline parameterization and then present the main results.

5.1 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. For the Foreign country, we mostly use Mexican data to guide our calibration. Our general strategy is to parameterize the foreign country so that its labor market is more rigid than the domestic one. This description is consistent with the OECD index of employment protection, which shows that in 2008 the US labor market ranked as the most flexible of the 40 countries studied, while Mexico's labor market ranked, 36th out of 40, is one of the most rigid.

Production. The functional form of the production function for the final good produced by the multinational is a CES aggregate of the domestic and offshored intermediate goods.

$$y_t = \left(\Gamma\left(y_{\mathrm{D},t}\right)^{\vartheta} + (1-\Gamma)\left((1-\Upsilon)y^*_{\mathrm{O},t}\right)^{\vartheta}\right)^{\frac{1}{\vartheta}}$$

We assume $\vartheta = 0$, so that production is a Cobb-Douglas aggregate of (imperfectly substitutable) domestic and offshored intermediate inputs. The share of domestically-produced inputs into final production of the multinational is set to $\Gamma = 0.98$, in line with the BEA's data on the sales of US multinationals' affiliates in Mexico back to their US parent companies as a ratio of the total sales of US parent companies. We set the iceberg cost to zero in the baseline calibration, so that $\Upsilon = 0$. In the Foreign economy, final goods production is assumed to be a linear transformation of the intermediate good, so that $y^*_t = z^*_{\mathrm{D},t} y^*_{\mathrm{D},t}$.

Intermediate goods production at the plant-level is a Cobb-Douglas aggregate of capital and labor input for plants operated by both the multinational (located domestically and abroad) and the foreign firm, respectively.

$$y_{\mathrm{D},t} = z_{\mathrm{D},t} n^{\alpha}_{\mathrm{D},t} k^{1-\alpha}_{\mathrm{D},t} \qquad y^*_{\mathrm{O},t} = z^*_{\mathrm{O},t} n^{*\alpha^*}_{\mathrm{O},t} k^{*1-\alpha^*}_{\mathrm{O},t} \qquad y^*_{\mathrm{D},t} = z^*_{\mathrm{D},t} n^{*\alpha^*}_{\mathrm{D},t} k^{*1-\alpha^*}_{\mathrm{D},t}$$

Labor's share for the multinational's domestic plant is set to $\alpha = 0.7$, while intermediate goods production in the Foreign country is assumed to be more labor intensive, so that $\alpha^* = 0.85$.

With regard to technology, we assume that the level of aggregate technology is symmetric across the two countries, so that $z_{\mathrm{D}} = z^*_{\mathrm{O}} = z^*_{\mathrm{D}} = 1$. 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 both the (intensive) offshoring decision itself as well as the strength of the threat effect on wages and labor market allocations.

Capital Accumulation. The rate of depreciation for capital in both the Home and Foreign country is $\delta = \delta^* = 0.02$.

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 given by

$$u(c_t, lfp_t) = \frac{1}{1-\sigma} c_t^{1-\sigma} - \frac{\kappa}{1+1/\iota} lfp_t^{1+1/\iota} \tag{46}$$

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 labor force participation (lfp), we introduce asymmetry to reflect differences in long run participation rates observed across countries. We calibrate the Home country to US data; specifically, we set $\iota = 0.18$ following Arseneau and Chugh (2008) who showed

Table 1: Baseline Calibration

Home Country			Foreign Country	
Parameter	Value	Description	Value	Parameter
		Production		
$z_{\mathrm{D}} = z^*_{\mathrm{O}}$	1	Steady state technology	1	z^*_{D}
ϑ	0	Elasticity of substitution between domestic and offshored labor		
Γ	0.98	Share of domestic intermediate good in final production		
α	0.70	Share of labor in intermediate goods production	0.85	α^*
		Capital Accumulation		
δ	0.02	Depreciation rate for capital stock	0.02	δ^*
		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	24.85	Scale parameter for subutility of leisure	67.49	κ^*
ζ	1.5	Elasticity of substitution between Home and Foreign goods	1.5	ζ^*
λ	0.20	Weight on domestically-produced goods in consumption basket	0.975	λ^*
		Labor Market		
ξ	0.50	Elasticity of matching function	0.50	ξ^*
η	0.50	Worker's bargaining power	0.25	η^*
ρ^x_{D}	0.0075	Probability of domestic job obsolescence	0.0075	ρ^{*x}_{D}
		Probability of offshore job obsolescence	0.0375	ρ^{*x}_{O}
ρ^n_{D}	0.017635	Probability of job separation	0.017635	$\rho^{*n}_{\mathrm{D}} = \rho^{*n}_{\mathrm{O}}$
ψ_{D}	0.50	Matching efficiency	0.38	$\psi^*_{\mathrm{D}} = \psi^*_{\mathrm{O}}$
γ_{D}	1.78	Vacancy posting cost in domestic labor market	7.60	γ^*_{D}
		Vacancy posting cost in offshored labor market	20.80	γ^*_{O}
χ	0.56	Unemployment benefit	0.169	χ^*
Ω	0	Offshorabilty of domestic jobs		
		Trade Cost		
Υ	0	Iceberg cost		

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 $\kappa = 24.85$ 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 $\kappa^* = 67.49$ to deliver a steady-state participation rate of 59 percent, which is the average observed 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 $\zeta = \zeta^* = 1.5$. 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, respectively, taken from Haver Analytics over the period 1980 to 2010.

Labor Markets. 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 $\xi = 0.5$, 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 $\eta = 0.5$. Following Fujita and Ramey (2007), the job obsolescence rate is set to $\rho^x_{\mathrm{D}} = 0.0075$ and the separation rate is set to $\rho^n_{\mathrm{D}} = 0.017635$. Together these probabilities imply that the total job separation rate $\rho_{\mathrm{D}} = \rho^x_{\mathrm{D}} + (1 - \rho^x_{\mathrm{D}})\rho^n_{\mathrm{D}} = 0.025$, which is 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, $\psi = 0.50$, 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 $\theta_{\mathrm{D},t} = 0.31$ which is a touch below the the measure obtained from JOLTS data. The resulting value is $\gamma_{\mathrm{D}} = 1.78$. 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 $\chi = 0.56$. The resulting implied aggregate unemployment rate for the Home country in our baseline calibration is roughly 6 percent.

For the Foreign country, there is less available data to guide the calibration of the foreign labor markets. 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 domestic job, so that $\rho_{\mathrm{D}}^{*x} = \rho_{\mathrm{D}}^{x}$, $\rho_{\mathrm{D}}^{*n} = \rho_{\mathrm{D}}^{n}$, and the job filling probabilities, so that $\gamma_{\mathrm{D}}^* = 7.60$ and $\gamma_{\mathrm{O}}^* = 20.80$ imply $k^f(\theta_{\mathrm{D}}^*) = k^f(\theta_{\mathrm{O}}^*) = 0.9$. With symmetry imposed across these parameters, we then introduce asymmetry into the cross-country calibration aimed at capturing the general view, supported by OECD data, that the countries to which US multinationals offshore have labor markets that are more frictional.

We operationalize the notion of a relatively more frictional foreign labor market through three main parameters: (1.) worker bargaining power; (2.) matching efficiency; and (3.) unemployment benefits. 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 $\psi_{\mathrm{D}}^* = \psi_{\mathrm{O}}^* = 0.38$. For foreign unemployment benefits, we assume that the US is more generous in its provision of 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 about half the baseline calibration for the Home country. The resulting value is $\chi^* = 0.169$. In addition to these three parameters, for technical reasons we also introduce asymmetry into the calibration of the rate of offshore job obsolescence, setting $\rho_{\mathrm{O}}^{*x} = 0.035$, which implies $\rho_{\mathrm{O}}^* = \rho_{\mathrm{O}}^{*x} + (1 - \rho_{\mathrm{O}}^{*x})\rho_{\mathrm{O}}^{*n} = 0.055$.

Finally, we impose $\Omega = 0$ so that the threat of offshoring is shut down in the baseline model. The results presented in the next subsection focus on how wages and labor market allocations change with this parameter.

Trade Costs. We assume that there are no trade costs in the baseline calibration, so that $\Upsilon = 0$. Sections **??** and 5.2.2 examine how a change in trade costs interacts with the threat of offshoring by examining the impact of a trade liberalization.

5.2 Main Results

We present our main results in two different ways. In the next subsection, we first conduct an exercise designed to measure the size of the threat effect in our calibrated model. We then study the impact of the threat effect on the response of the economy to shocks.

5.2.1 Measuring the Threat Effect

We first examine the threat of offshoring on labor market outcomes by comparing long run steady states in response to a change in globalization stemming from a permanent increase in the offshorability of domestic jobs. Specifically, we introduce a shock to the model that takes the economy from the steady state in the baseline calibration in which existing domestic jobs are initially not offshorable ($\Omega = 0$, hence there is no threat effect operating in the model) to a steady state in which 20 percent of domestic jobs are offshorable ($\Omega = 0.2$, and hence the threat effect operates). We then compare wages and allocations across the initial and terminal long run equilibria under two extreme assumptions regarding entry: (1.) entry is free to adjust in absence of frictions; and (2.) entry is prohibited from adjusting and instead is fixed at its initial level (due to an infinite adjustment cost, for example). These two assumptions provide us with an lower and upper bound, respectively, of the magnitude of the threat effect in a general equilibrium setting.

Table 2: The threat effect in response to a shock of offshorability,

	Free Entry		Fixed Entry	
	Home Country	Foreign Country	Home Country	Foreign Country
		Labor Market Aggregates		
w	-0.01	~ 0	-6.54	1.50
n	-0.02	~ 0	-1.65	0.42
UE	0.01	~ 0	0.60	-0.06
lfp	~ 0	~ 0	-0.67	0.20
ne	6.46	-7.48	$--$	$--$
		Macroeconomic Aggregates		
c	-0.01	~ 0	-0.67	-0.18
k	-0.02	~ 0	-1.09	-0.03
y	-0.02	~ 0	-1.15	-0.03
q	-0.01		-0.99	

† Results reported as % change in allocation from steady state in which no domestic jobs are offshorable ($\Omega = 0$) to one in which 20% of domestic jobs are offshorable ($\Omega = 0.2$).

Results for the main labor market and macroeconomic aggregates are presented in Table 2. The first two columns in the table show results for Home and Foreign country, respectively, under the assumption of free entry the third and fourth columns show the same information when entry is fixed. Beginning with the first row of the table, as discussed in Section 4, when entry is free to adjust there is minimal impact on the real wage in either the Home or Foreign country. In contrast, when entry is restricted from adjusting freely the threat effect allows the multinational to more forcefully exploit its outside option in wage negotiations. As a result, there is a relatively large impact from the threat of offshoring on the domestic wage in the Home country and hence also on labor market and broader macroeconomic allocations (discussed below). We find that in a general equilibrium setting the threat of offshoring depresses domestic wages by roughly 6-1/2 percent. This estimate is a bit lower than what we found in the *ceterus paribus* exercise as well as what is reported in Blinder (2009); nevertheless, it is still represents a substantial reduction in wages. In contrast, Foreign wages (an employment weighted average of the wage paid by the domestic firm and the multinational) are boosted by roughly 1-1/2 percent. The idea that the threat of offshoring has the potential to generate international spillovers is a point that has been largely overlooked in the existing literature, but is well articulated in our general equilibrium modeling framework.

Moving beyond the wages effects, the remainder of the rows in the first two columns of the table show that under free entry the threat of offshoring has a minimal effect on the rest of the economy. This is perhaps not surprising given the small impact on the bargained wage. One key exception, however, is entry. In response to a globalization shock that increases the offshorability of domestic jobs, the multinational responds by reducing entry into the Foreign labor market and instead increasing entry back home.

To understand this, it is useful to note that the offshorability shock can be viewed as a technological change whereby the process of transforming an unfilled domestic vacancy into a productive match, regardless of where that match ultimately resides, is made more efficient. From the multinational's perspective, this matters for three reasons. First, $\Omega > 0$ implies that, all else equal, an unfilled domestic vacancy becomes more valuable simply because the multinational has an additional opportunity to fill it with a foreign worker in the offshore labor market. This happens with probability $(1 - k^f(\theta_{\mathrm{D}}))k^f(\theta^*_{\mathrm{O}})$ and delivers the value of an additional offshore match, $\widehat{\mathbf{J}}^*_{\mathrm{O},t}$, net of the posting cost, γ^*_{O}. Second, precisely because that additional opportunity exists, it also implies that an unfilled domestic vacancy is more likely to be filled within the period (either with a domestic worker or with a foreign worker in an offshored job) thereby increasing the flow of unfilled domestic vacancies into productive matches. All else equal, this will tend to reduce the number of unfilled domestic vacancies in the Home country.[11] Finally, the same is true of unfilled vacancies in the offshore labor market. The expression for offshore vacancies, $\widetilde{v}^*_{\mathrm{O},t} = v^*_{\mathrm{O},t} + \Omega(1 - k^f(\theta_{\mathrm{D},t}))v_{\mathrm{D},t}$, shows that, holding $\widetilde{v}^*_{\mathrm{O},t}$ constant, when $\Omega > 0$ vacancies posted to the domestic market that fail to match in the morning market will crowd out vacancies posted directly to the offshore market.

From this perspective, increased entry into the domestic labor market simply reflects the fact that $\Omega > 0$ increases the value of an unfilled domestic vacancy by changing the multinational's outside option. Provided it is unimpeded, the multinational will increase entry into the domestic labor market to the point at which the value of an unfilled domestic vacancy is driven to the cost

[11] This can be seen directly by imposing steady state on equation 4 and then solving the resulting expression for $v_d = \frac{(1-\rho^x_{\mathrm{D}})\rho^n_{\mathrm{D}} n_{\mathrm{D}} + ne_{\mathrm{D}}}{1-(1-\rho^x_{\mathrm{D}})(1-k^f(\theta_{\mathrm{D}}))(1-\Omega k^f(\theta^*_{\mathrm{O}}))}$. All else equal, we have that $\frac{\partial v_d}{\partial \Omega} < 0$.

of creating a new position, $r^k_{\mathrm{D},t}k_{\mathrm{D},t}$. The capital stock is relatively insensitive to whether or not the threat effect operates in the model so the resulting impact on the wage and other allocations is minimal. At the same time, unfilled domestic vacancies spill over to the offshore market crowding out vacancies posted directly to that market causing the multinational to reduce entry into the offshore market. In summary, *provided there are no barriers to entry* in either labor market, the multinational responds to an increase in offshorability by altering entry in such a way that wages, and labor market and other macroeconomic allocations are by and large left unchanged.

In contrast, the next two columns of the table show that when there are barriers to entry, the threat effect has a much larger impact. The sharply lower wage causes Home households to substitute out of consumption and into leisure so that both consumption and labor force participation decline. Adjustment along the participation margin occurs through employment which drops by 1-1/2 percent. The decline in the total number of domestic jobs reflects the fact that, in absence of free entry, the increase in offshorability lowers the number of unfilled domestic vacancies by increasing the flow into productive matches abroad. As the number of domestic vacancy postings declines, households increase search activity so that the unemployment rate increases by nearly 3/4 of a percentage point in our baseline calibration. All told, the threat of offshoring lowers domestic wages, reduces the number of domestic jobs, and increases the unemployment rate.

There are spillovers to the Foriegn economy as well. Equation 39 shows that the lower real exchange rate effectively shifts bargaining power away from the multinational and, in doing so, pushes up the wage that Foreign workers receive in the offshore labor market. Greater rewards in the offshore labor market increases participation in the labor force by Foreign households and causes a reallocation of search activity away from the domestic labor market and into the offshore labor market. Along with the increased flow of open vacancies from the Home domestic market that comes as a byproduct of $\Omega > 0$, the increased household search activity in the offshore market increases employment sharply in that sector. At the same time, the Foreign firm increases vacancy postings in the domestic labor market and agrees to a higher wage for workers in the domestic labor market so that the number of domestic employees remains essentially unchanged. All told, the threat of offshoring increases Foreign wages by roughly 1-1/2 percent and increases teh aggregate number of jobs in the Foreign economy by 1/2 percent. Wage increases occur across the board in both sectors, but the increase in the number of jobs comes exclusively from the offshore market. The Foreign the unemployment rate declines by roughly 10 basis points.

5.2.2 The Threat Effect and the Response to Shocks

We now use our framework to assess the influence of the threat effect on the dynamic response of the economy to shocks. We show that the interaction of the threat effect with underlying fundamental shocks is important for the effects of those shocks on the economy.

We focus the analysis in this section on two specific disturbances: (1.) a technology shock that increases the productivity of the multinational's domestic plant, $z_{\mathrm{D},t}$; and (2.) a trade liberalization shock that lowers the iceberg cost, Υ_t, incurred by the multinational for transporting the offshored intermediate good back to the Home country. In terms of implementation, we increase (decrease) home technology (the iceberg cost) by 1 percent relative to the baseline calibration and assume the shock fades out gradually with an assumed persistence of $\rho = 0.95$.

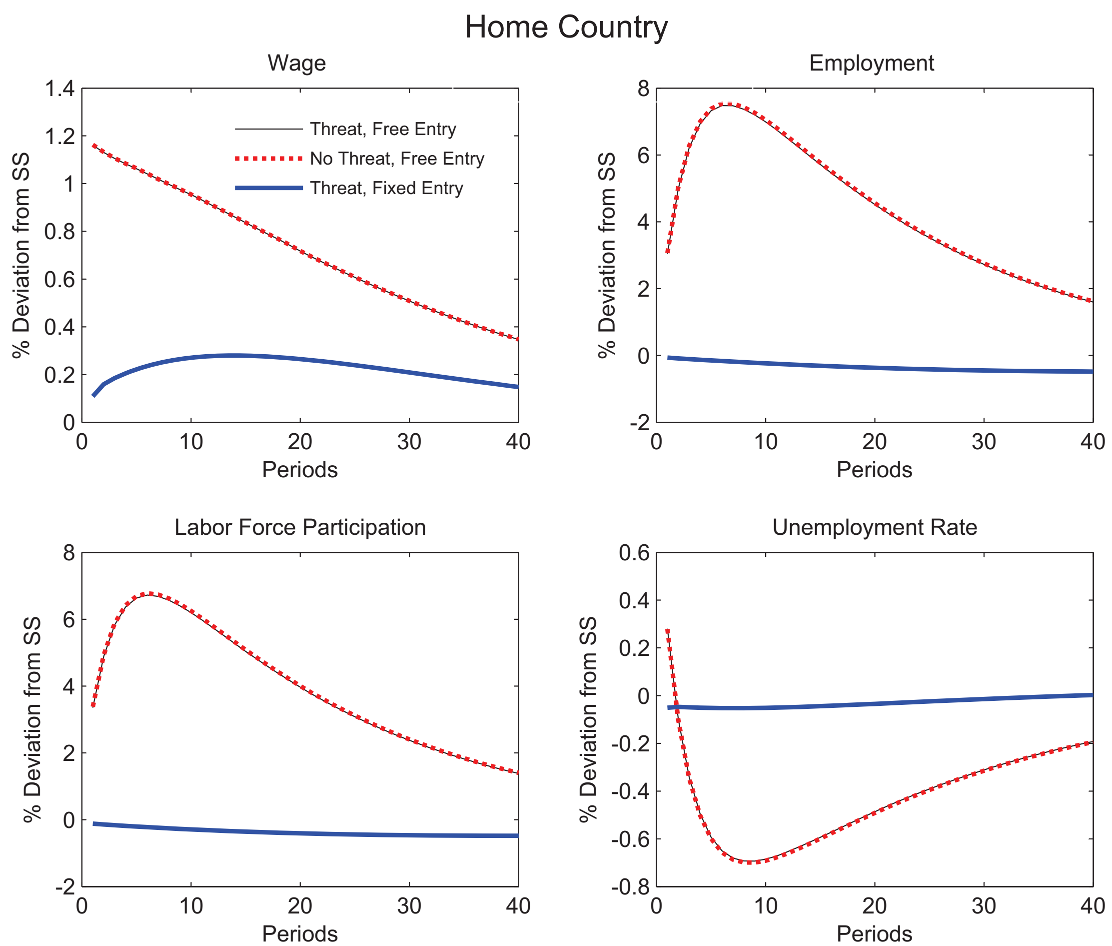

Figure 2: Impact of threat effect on the Home labor market in response to a temporary technology shock to Home intermediate goods production.

Figure 2 summarizes the response of the domestic labor market to a technology shock to domestic intermediate goods production for the Home country. Each panel shows an impulse response for a given labor market variable under the assumption of: free entry with no threat effect (the dotted line); free entry with the threat effect (the thin solid line); and fixed entry with the threat effect (the thick solid line). The top left panel shows that, as expected, the favorable technology shock drives up the real wage. Importantly, as long as entry is free to adjust, the real wage rises by a similar amount regardless of whether the threat of offshoring is operating in the model or not. (The thin solid line lies directly on top of the thick dotted line.) In contrast, when entry is restricted, the threat effect notably dampens the responsiveness of the real wage. It cushions the impact effect of the shock, for example, by roughly 90 percent relative to the case of free entry.

The intuition behind this result is clear. As can be seen in equation (9), the favorable technology shock directly increases the value to the multinational of a domestic job by increasing the marginal product of labor. This, in turn, drives up the value of an unfilled domestic vacancy—equation (8) shows that the vacancy itself is more valuable simply because there is a chance, with probability $k^f(\theta_{\mathrm{D}})$, that it could turn into a more valuable match. In the *long run*, when entry is free to adjust, the multinational will increase entry into the domestic labor market to the point at which the value of the unfilled vacancy is driven back down to the cost of entry. Hence, free entry implies that the primary impact on the wage occurs directly via the increased value of a job. But, in the *short run,* when entry is prevented from adjusting freely, the higher value of the unfilled vacancy partially offsets this upward wage pressure. Thus, one way to interpret our result is that when entry is restricted the threat of offshoring acts as an endogenous source of real wage rigidity that mutes the effect of the technology shock on wages.

The remaining panels in the figure tell a similar story. As long as entry is free to adjust, the threat effect has essentially no impact on the response of any of the labor market allocations. In contrast, when entry is restricted the threat effect dampens substantially the labor market response. When entry adjusts freely, the resulting increase in vacancies generates additional job creation, so employment rises (top right panel). The higher wage draws additional individuals into the labor force (bottom left panel) in order to search for jobs. While some of these individuals successfully match with an open vacancy, not all are able to find matches immediately. As a result, the influx of new searchers from outside the labor force actually drives up the unemployment rate in the short run. This increase reverses itself, however, after a couple of quarters and the unemployment rate eventually declines reflecting the increase in employment shown in the top right panel. It is clear that when entry is prevented from adjusting freely the dampened response of the wage carries over to the other labor market allocations, which react minimally to the shock.

Figure 3 shows spillovers to the Foreign labor market, which occur through the multinational's involvement in the offshore labor market as well as through the real exchange rate. With regard

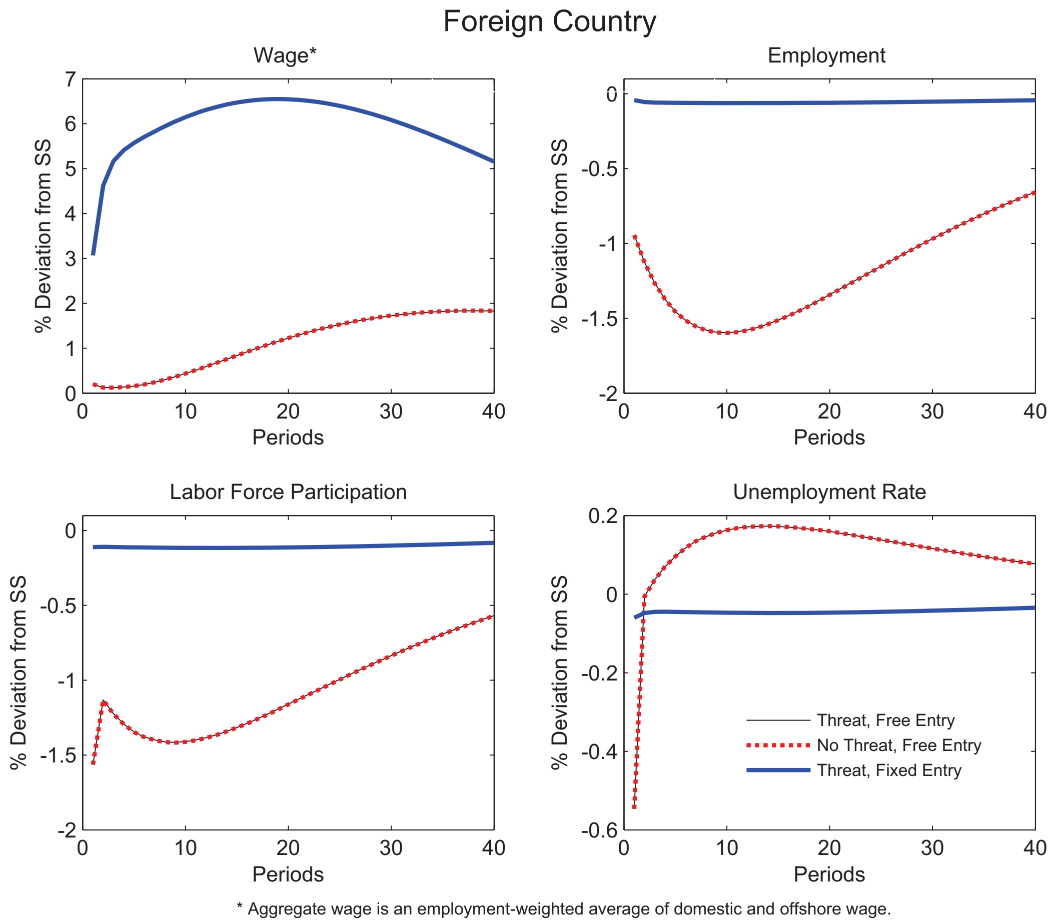

Figure 3: Impact of threat effect on the Foreign labor market in response to a temporary technology shock to Home intermediate goods production.

to the labor market, any technology shock that hits domestic plants will also raise the marginal product of labor for offshore workers because domestically-produced and offshored intermediate goods are imperfect substitutes in the multinational's final goods production technology. Hence, the technology shock drives up the multinational's demand for both domestic and offshore labor. Under free entry, the multinational simply increases entry into the offshore market, posting additional vacancies to the point at which the value of an open vacancy in the offshore market is driven back down to its creation cost. These additional vacancies provide an incentive for the Foreign household to shift search activity out of the market for domestic jobs and into the market for offshored jobs. This reallocation makes it more difficult for Foreign firms to hire workers, hence the value of a vacancy posted by the Foreign firm declines. Again, under free entry the Foreign firm will exit the market in order to drive the value of an open vacancy back up the the creation cost. Aggregate employment (top right panel), which is largely driven by what happens in the domestic market given its size relative to the offshore market, falls and those that loose their jobs drop out of the labor force (lower left panel). Despite an initial decline on impact of the shock, the unemployment rate rises gradually, peaking after about 12 quarters and then falls as the foreign firm begins building back the employment stock through a higher wage (top left panel).

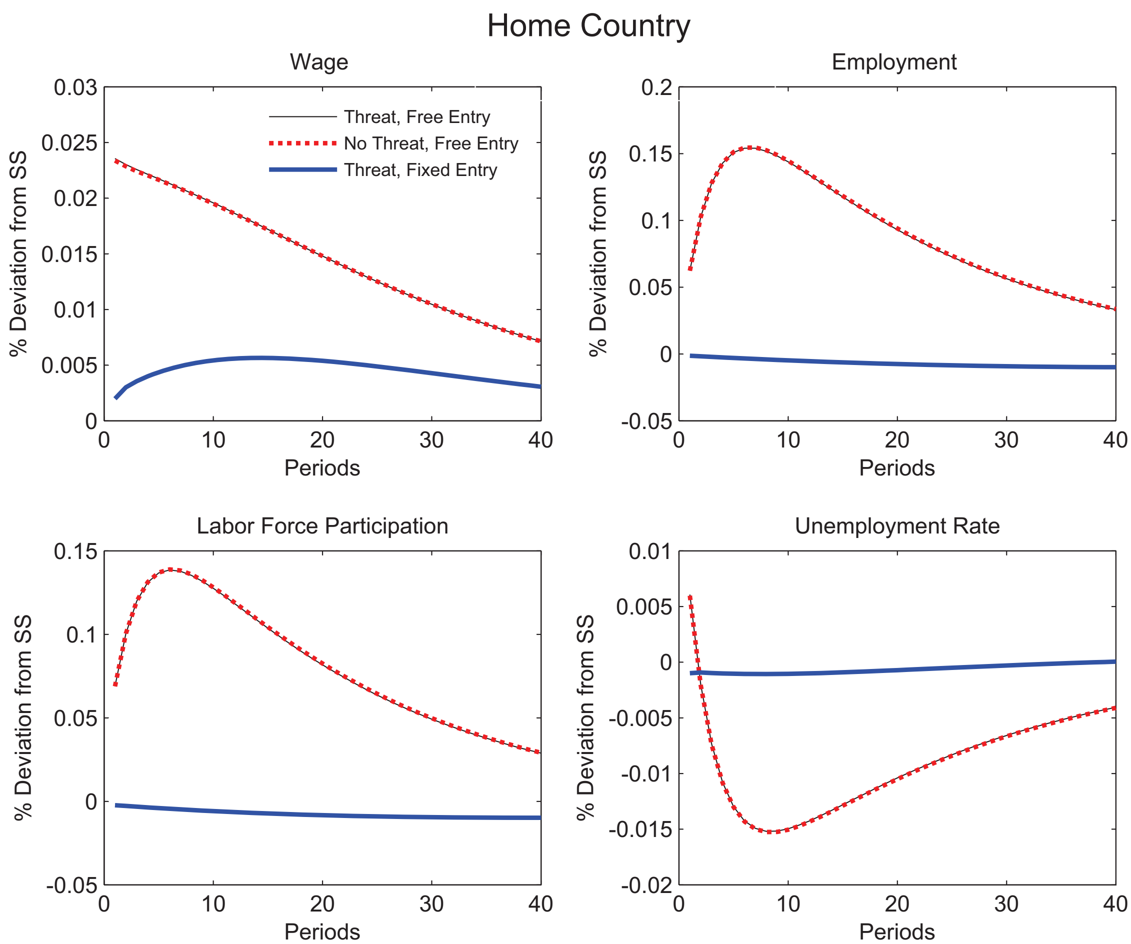

Figure 4: Impact of threat effect on the Home labor market in response to a temporary shock to the iceberg cost of shipping the offshored intermediate good back to the Home country.

When entry is fixed, the Foreign firm cannot respond to the declining value of a domestic vacancy and, as can be seen in equation (38) the Foreign wage rises. (The aggregate wage plotted in Figure 3 is an employment-weighted average of the wage in the domestic and offshore markets. Given that offshore employment is only a small fraction of total Foreign employment the Foreign aggregate wage is primarily driven by the domestic measure.) This result contrasts with results presented above for the Home country in the sense that, rather than dampening the wage response, the threat effect actually amplifies the response of the wage in the Foreign country. Nevertheless, the remainder of the labor market responses are much more muted in the Foreign economy under the threat effect, inheriting the similar dampening effect of the threat of offshoring on Home variables.

Figure 4 shows the reaction of the Home labor market to a trade liberalization shock. The response of the wage as well as other labor market allocations are all qualitatively very similar to what we found with the technology shock in Figure 2. This is intuitive given that a shock to the iceberg cost of shipping the offshored intermediate good is observationally equivalent to a technology shock to the offshore production technology. Quantitatively, however, the responses are much smaller likely reflecting the fact that offshored intermediate goods comprise only a small fraction of total final output. Nonetheless, the central result—that the threat of offshoring acts as an endogenous source of real wage rigidity—holds up across both shocks. As with the technology shock, the threat of offshoring cushions the impact effect of the trade cost shock by about 90 percent relative to the case of free entry.

6 Sensitivity Analysis

We investigate the sensitivity of our results to a number of underlying parameters in order to give a better sense of what drives the strength of the threat effect. The general result that the threat of offshoring matters very little under free entry is robust regardless of the specific parameterization of the model. As such, this section focuses exclusively on the case of fixed entry. Moreover, for the sake of brevity we concentrate our sensitivity analysis on the response of the wage and the unemployment rate in the Home country only to a positive, temporary, technology shock to the production of Home intermediate goods.

We consider alternative parameterizations of parameters that can intuitively have a large impact on the threat effect. In particular, in Figure 5, we look at variations in parameters dictating the relative importance of offshoring (Γ), as well as the substitutability between Home and Foreign intermediate goods (ϑ) in the production function and the substitutability of Home and Foreign goods in aggregate consumption (ζ). Alternatively, Figure 6, shows the sensitivity of our results to our parameterization of the frictions in the Foreign labor market. We consider the effect from varying the bargaining power of Foreign workers, η^*; the unemployment benefit, χ^*; and the cost to the multinational of posting a vacancy in the offshore labor market, γ_O^*. The baseline response in each panel (thick black line) of Figures 5 and 6 is identical to the response shown in Figure 2, under fixed entry.

The story is consistent across all cases: varying the parameter in a direction that strengthens the threat effect tends to mitigate the increase in the real wage further. For instance, Figure 5 shows that a larger share of offshored production, or more substitutability between Home and Foreigns goods all lower the responsiveness of the wage rate to a Home technology shock. Similarly, 5 shows that there is less upward pressures on the wage rate when Foreign workers have less bargaining power, lower unemployment benefits, and when the cost of posting a vacancy offshore is lower. In general, the fall in the unemployment rate is also more pronounced the less the wage rate rises.

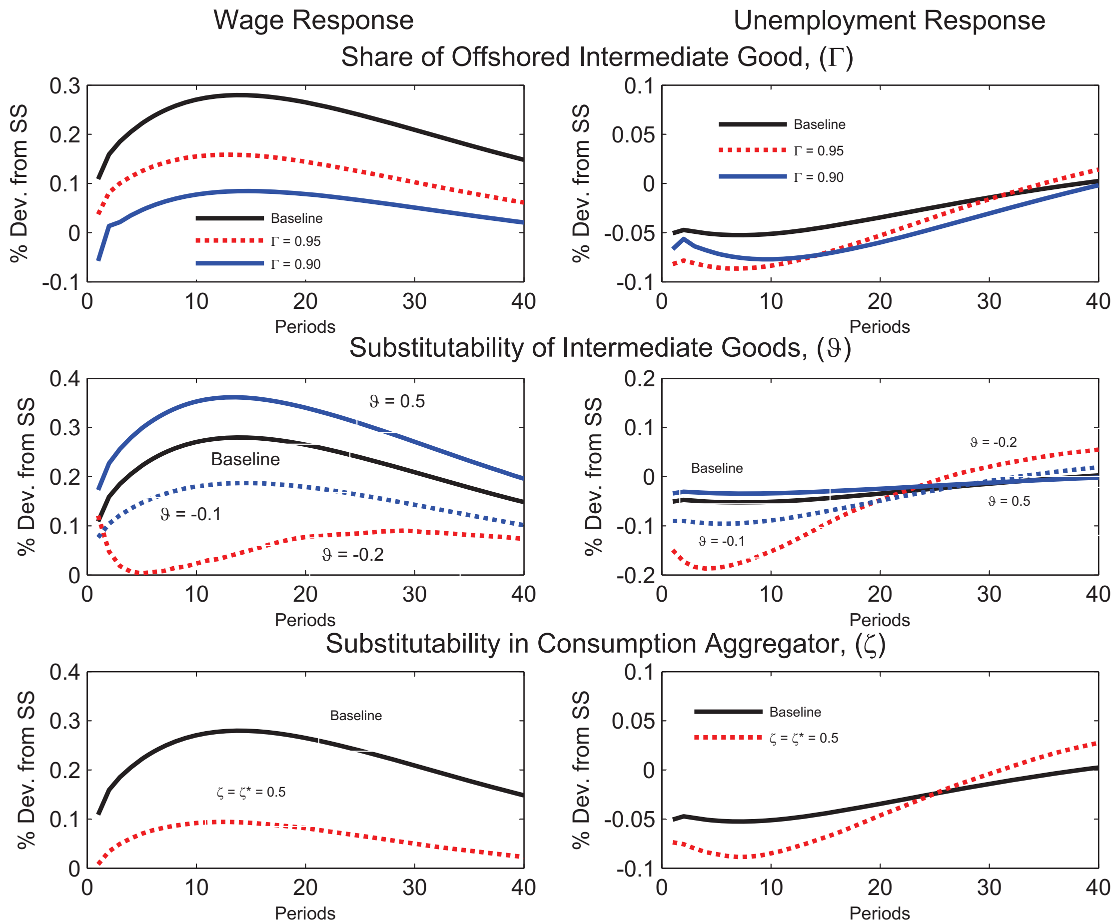

Figure 5: Impact of threat effect on the Home labor market in response to a temporary technology shock to Home intermediate goods production.

We close with two additional observations. First, comparing Figure 5 to Figure 6 makes it clear that the degree of real wage rigidity introduced by the threat effect is more sensitive to the technology and preference parameters than it is to the parameterization of the Foreign labor market. This is somewhat reassuring given the uncertainty of the calibration of the Foreign labor market. The Foreign labor market parameter with the largest influence over the main result is the bargaining share, but even when we (generously) assume that Foreign workers have the same degree of bargaining power as workers in the Home country the threat of offshoring still endogenously produces a fair amount of wage ridigity—for example, it dampens the wage response on impact by nearly as much when $\eta^* = \eta$ as in the baseline calibration with $\eta^* = 0.5\eta$. Second, comparing the left column to right column in each of the two figures reveals that the response of the real wage is more sensitive to the magnitude of the threat effect than the response of unemployment. In fact, the unemployment response is relatively robust across all parameter configurations.

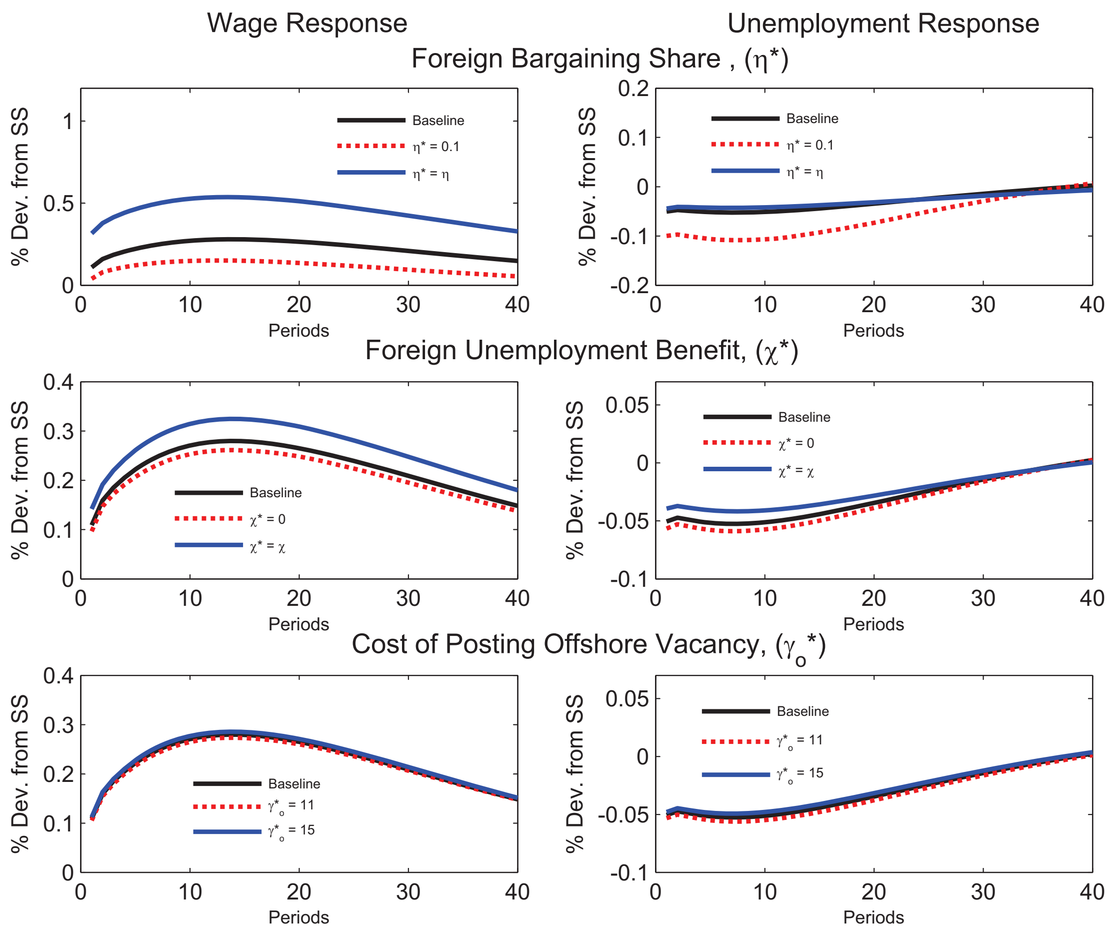

Figure 6: Impact of threat effect on the Home labor market in response to a temporary technology shock to Home intermediate goods production.

7 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.

While stylized, our framework offers a tractable way to capture firms' outside option to relocate jobs abroad in labor market negotiations using a sequence of labor markets. We find that the threat of offshoring on labor market allocations can be sizeable even when the number of offshorable jobs is very small, supporting the idea that offshoring could have important implications that go beyond those which stem from actual observed offshoring behavior. To be precise, our results indicate that it is the "offshorability" of domestic jobs, or the mere possibility that a job can be shipped over seas, that matters most significantly. Our baseline results show that the threat of offshoring lowers domestic wages notably and reduces the number of jobs while increasing the unemployment rate in the Home economy. We also show that the threat of offshoring mitigates the response of the domestic economy to underlying shocks, with the threat of offshoring operating like a real rigidity. Finally, we show that the threat of offshoring generates important spillover effects to workers in the country to which the offshoring occurs. Importantly, the effect form the threat of offshoring occur mainly in the short run, stemming from the inability of firms to adjust entry. To the degree that entry is unimpeded in the long run, the threat of offshoring has only a minimum effect of the economy.

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A Details of the Firm's Problem

A.1 Foreign Firm

The foreign firm chooses $n^*_{\text{D},t}$, $v^*_{\text{D},t}$, and $k^*_{\text{D},t}$ to solve the following problem

$$\Pi^*_t = \sum_{t=0}^{\infty} \beta^t \frac{\lambda^*_t}{\lambda^*_0}[f(y^*_{\text{D},t}) - w^*_{\text{D},t} n^*_{\text{D},t} - r^{*k}_{\text{D},t} k^*_{\text{D},t} - \gamma^*_{\text{D}} v^*_{\text{D},t}]$$

subject to:

$$y^*_{\text{D},t} = z^*_{\text{D},t} g(n^*_{\text{D},t}, k^*_{\text{D},t})$$

$$n^*_{\text{D},t} = (1-\rho^{*o})(1-\rho^{*n}) n^*_{\text{D},t-1} + v^*_{\text{D},t} k^f(\theta^*_{\text{D},t})$$

$$v^*_{\text{D},t} = (1-\rho^{*o})\rho^{*n} n^*_{\text{D},t-1} + (1-\rho^{*o})(1-k^f(\theta^*_{\text{D},t-1})) v^*_{\text{D},t-1} + ne^*_{\text{D},t}$$

Let $\mu^*_{\text{D},t}$ and $\lambda^*_{\text{D},t+1}$ be the multipliers on the laws of motion for jobs and vacancies, respectively. The first order conditions for are:

$$\lambda^*_{\text{D},t} = -\gamma^* + k^f(\theta^*_{\text{D},t})\mu^*_{\text{D},t} + (1-k^f(\theta^*_{\text{D},t}))E_t[\Xi^*_{t+1|t}(1-\rho^{*o})\lambda^*_{\text{D},t+1}]$$

$$\mu^*_{\text{D},t} = f_{n^*_{\text{D}},t} - w^*_{\text{D},t} + E_t\left[\Xi^*_{t+1|t}\left((1-\rho^{*o})\rho^{*n}\lambda^*_{\text{D},t+1} + (1-\rho^{*o})(1-\rho^{*n})\mu^*_{\text{D},t+1}\right)\right]$$

$$f_{k^*_{\text{D}},t} = r^{k*}_{\text{D},t}$$

A.2 Home Multinational

The Home multinational chooses $n_{\text{D},t}$, $v_{\text{D},t}$, $n^*_{\text{O},t}$, $v^*_{\text{O},t}$, $k_{\text{D},t}$, and $k^*_{\text{O},t}$ to solve the following problem

$$\Pi_t = \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0}[f(y_{\text{D},t}, (1-\Upsilon)y^*_{\text{O},t}) - w_{\text{D},t} n_{\text{D},t} - q_t w^*_{\text{O},t} n^*_{\text{O},t} - r^k_{\text{D},t} k_{\text{D},t} - q_t r^{k*}_{\text{O},t} k^*_{\text{O},t} - \gamma_{\text{D}} v_{\text{D},t} - \gamma^*_{\text{O}} \widetilde{v}^*_{\text{O},t}]$$

subject to:

$$y_{\text{D},t} = z_{\text{D},t} g(n_{\text{D},t}, k_{\text{D},t})$$

$$y^*_{\text{O},t} = z^*_{\text{O},t} g(n^*_{\text{O},t}, k^*_{\text{O},t})$$

$$n_{\text{D},t} = (1-\rho^o)(1-\rho^n) n_{\text{D},t-1} + k^f(\theta_{\text{D},t}) v_{\text{D},t}$$

$$n^*_{\text{O},t} = (1-\rho^{*o})(1-\rho^{*n}) n^*_{\text{O},t-1} + k^f(\theta^*_{\text{O},t}) \widetilde{v}^*_{\text{O},t}$$

$$v_{\mathrm{D},t} = (1-\rho^o)\rho^n n_{\mathrm{D},t-1} + (1-k^f(\theta_{\mathrm{D},t-1}))(1-\Omega^F k^f(\theta^*_{\mathrm{O},t-1}))(1-\rho^o)v_{\mathrm{D},t-1} + ne_{\mathrm{D},t}$$

$$v^*_{\mathrm{O},t} = (1-\rho^{*o})\rho^{*n} n^*_{\mathrm{O},t-1} + (1-k^f(\theta^*_{\mathrm{O},t-1}))(1-\rho^{*o})v^*_{\mathrm{O},t-1} + ne^*_{\mathrm{O},t}$$

$$\widetilde{v}^*_{\mathrm{O},t} = v^*_{\mathrm{O},t} + \Omega^F(1-k^f(\theta_{\mathrm{D},t}))v_{\mathrm{D},t}$$

Associate the multipliers $\mu_{\mathrm{D},t}$, and $\mu^*_{\mathrm{O},t}$ to the Home and offshored employment constraints, respectively, and the multipliers $\lambda_{\mathrm{D},t}$ and $\lambda^*_{\mathrm{O},t}$ to the Home and offshored vacancy constraints, respectively. The first-order conditions are

$$\begin{aligned}\lambda_{\mathrm{D},t} &= -\gamma_d + k^f(\theta_{\mathrm{D},t})\mu_{\mathrm{D},t} - \Omega^F(1-k^f(\theta_{\mathrm{D},t}))(\gamma^*_{\mathrm{O}} - k^f(\theta^*_{\mathrm{O},t})\mu^*_{\mathrm{O},t}) \\ &\quad + (1-k^f(\theta_{\mathrm{D},t}))(1-\Omega^F k^f(\theta^*_{\mathrm{O},t}))(1-\rho^o)E_t[\Xi_{t+1|t}\lambda_{\mathrm{D},t+1}]\end{aligned}$$

$$\mu_{\mathrm{D},t} = f_{n_{\mathrm{D}},t} - w_{\mathrm{D},t} + E_t\left[\Xi_{t+1|t}\left((1-\rho^o)\rho\lambda_{\mathrm{D},t+1} + (1-\rho^o)(1-\rho^n)\mu_{\mathrm{D},t+1}\right)\right]$$

$$f_{k_{\mathrm{D}},t} = r^k_{\mathrm{D},t}$$

$$\lambda^*_{\mathrm{O},t} = -\gamma^*_o + k^f(\theta^*_{\mathrm{O},t})\mu^*_{\mathrm{O},t} + (1-k^f(\theta^*_{\mathrm{O},t}))(1-\rho^{*o})E_t[\Xi_{t+1|t}\lambda^*_{\mathrm{O},t+1}]$$

$$\mu^*_{\mathrm{O},t} = f_{n^*_{\mathrm{O}},t} - q_t w^*_{\mathrm{O},t} + E_t\left[\Xi_{t+1|t}\left((1-\rho^{*o})\rho^{*n}\lambda^*_{\mathrm{O},t+1} + (1-\rho^{*o})(1-\rho^{*n})\mu^*_{\mathrm{O},t+1}\right)\right]$$

$$f_{k^*_{\mathrm{O}},t} = q_t r^{k*}_{\mathrm{O},t}$$

B Details of the Household's Problem

B.1 Home Household

The household in the Home country searches in the domestic labor market for jobs operated by the Home multinational. The Foreign household's problem is to choose sequences of c_t, k_{t+1}, b_{t+1}, $s_{\mathrm{H},t}$, and $n_{\mathrm{H},t+1}$ to maximize:

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

subject to:

$$p_t c_t + k_{t+1} - (1-\delta)k_t + \int p_{bt,t+1} b_{t+1} = w_{\mathrm{H},t} n_{\mathrm{D},t} + r_t^k k_t + (1 - k^w(\theta_{\mathrm{D},t}))s_{\mathrm{D},t}\chi + b_t + d_t$$

$$n_{\mathrm{D},t} = (1-\rho^o)(1-\rho^n)n_{\mathrm{D},t-1} + k^w(\theta_{\mathrm{D},t})s_{\mathrm{D},t}$$

Defining λ_t and μ_t as the multipliers on the budget constraint and the law of motion for employment, respectively, the first order conditions for c_t, k_{t+1}, b_{t+1}, $s_{\mathrm{D},t}$, and $n_{\mathrm{D},t}$, are:

$$u'(c_t) - p_t \lambda_t = 0$$

$$\lambda_t - \beta E_t (1 - \delta + r_{t+1}^k)\lambda_{t+1} = 0$$

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

$$(1 - k^w(\theta_{\mathrm{D},t}))(-h_t' + \lambda_t \chi) + \mu_{\mathrm{D},t} k^w(\theta_{\mathrm{D},t}) = 0$$

$$-h_t' + \lambda_t w_{\mathrm{D},t} - \mu_{\mathrm{D},t} + \beta(1-\rho^o)(1-\rho^n)E_t \mu_{\mathrm{D},t+1} = 0$$

Combining the first order conditions on c_t and b_{t+1} gives the consumption Euler equation

$$\frac{u'(c_t)}{p_t} = \beta E_t \left[\frac{1}{p_{bt,t+1}} \frac{u'(c_{t+1})}{p_{t+1}} \right]$$

which defines the one period ahead stochastic discount factor, $E_t \left[\Xi_{t+1|t} \right] = \beta E_t \left[\frac{u'(c_{t+1})}{u'(c_t)} \frac{p_t}{p_{t+1}} \right]$.

Combining the first order conditions on k_{t+1} and b_{t+1} gives an arbitrage condition between bond and physical capital holdings

$$\frac{1}{p_{bt,t+1}} = E_t \left[1 - \delta + r_{t+1}^k \right]$$

Combining the first order conditions for $s_{\mathrm{D},t}$, and $n_{\mathrm{D},t}$ gives rise to a standard optimal search condition for domestic households

$$\frac{1 - k^w(\theta_{\mathrm{D},t})}{k^w(\theta_{\mathrm{D},t})}(h_t' - \lambda_t \chi) = \lambda_t w_{\mathrm{D},t} - h_t' + (1-\rho^o)(1-\rho^n)\beta E_t \left[\frac{1 - k^w(\theta_{\mathrm{D},t+1})}{k^w(\theta_{\mathrm{D},t+1})}(h_{t+1}' - \lambda_{t+1}\chi) \right]$$

B.2 Foreign Household

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^*, k_{t+1}^*, b_{t+1}^*, $s_{\mathrm{O},t}^*$, $s_{\mathrm{D},t}^*$, $n_{\mathrm{O},t+1}^*$, and $n_{\mathrm{D},t+1}^*$ to maximize:

$$E_0 \sum_{t=0}^{\infty} \beta^{*t} \left[u^*(c_t^*) - h^*((1-k^w(\theta_{\mathrm{D},t}^*))(1-\Omega^W)s_{\mathrm{D},t}^* + (1-k^w(\theta_{\mathrm{O},t}^*))\widetilde{s}_{\mathrm{O},t}^* + n_{\mathrm{D},t}^* + n_{\mathrm{O},t}^*) \right]$$

subject to:

$$p_t^* c_t^* + k_{d,t+1}^* + k_{o,t+1}^* - (1-\delta^*)(k_{d,t}^* + k_{o,t}^*) + \int p_{bt,t+1} b_{t+1}^* = w_{\mathrm{O},t}^* n_{\mathrm{O},t}^* + w_{\mathrm{D},t}^* n_{\mathrm{D},t}^*$$
$$+ r_{d,t}^{*k} k_{d,t}^* + r_{o,t}^{*k} k_{o,t}^* + ((1-k^w(\theta_{\mathrm{D},t}^*))(1-\Omega^W)s_{\mathrm{D},t}^* + (1-k^w(\theta_{\mathrm{O},t}^*))\widetilde{s}_{\mathrm{O},t}^*)\chi^* + b_t^* + d_t^*$$

$$n_{\mathrm{D},t}^* = (1-\rho^{*o})(1-\rho^{*n}) n_{\mathrm{D},t-1}^* + k^w(\theta_{\mathrm{D},t}^*) s_{\mathrm{D},t}^*$$

$$n_{\mathrm{O},t}^* = (1-\rho^{*o})(1-\rho^{*n}) n_{\mathrm{O},t-1}^* + k^w(\theta_{\mathrm{O},t}^*) \widetilde{s}_{\mathrm{O},t}^*$$

$$\widetilde{s}_{\mathrm{O},t}^* = s_{\mathrm{O},t}^* + \Omega^W (1-k^w(\theta_{\mathrm{D},t}^*)) s_{\mathrm{D},t}^*$$

Defining λ_t^* and μ_t^* as the multipliers on the budget constraint and the law of motion for employment, respectively, the first order conditions for c_t^*, k_{t+1}^*, b_{t+1}^*, $s_{\mathrm{D},t}^*$, $s_{\mathrm{O},t}^*$, $n_{\mathrm{D},t}^*$, and $n_{\mathrm{O},t}^*$, are:

$$u'^*(c_t^*) - p_t^* \lambda_t^* = 0$$

$$\lambda_t^* - \beta^* E_t (1-\delta^* + r_{d,t+1}^{k*}) \lambda_{t+1}^* = 0$$

$$\lambda_t^* - \beta^* E_t (1-\delta^* + r_{o,t+1}^{k*}) \lambda_{t+1}^* = 0$$

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

$$(1-k^w(\theta_{\mathrm{D},t}^*))(1-\Omega^W k^w(\theta_{\mathrm{O},t}^*)) \left(-h_t^{*\prime} + \lambda_t^* \chi^*\right)$$
$$+ k^w(\theta_{\mathrm{D},t}^*) \mu_{\mathrm{D},t}^* + k^w(\theta_{\mathrm{O},t}^*) \Omega^W (1-k^w(\theta_{\mathrm{D},t}^*)) \mu_{\mathrm{O},t}^* = 0$$

$$(1-k^w(\theta_{\mathrm{O},t}^*)) \left(-h_t^{*\prime} + \lambda_t^* \chi^*\right) + k^w(\theta_{\mathrm{O},t}^*) \mu_{\mathrm{O},t}^* = 0$$

$$-h_t^{*\prime} + \lambda_t^* w_{\mathrm{D},t}^* - \mu_{\mathrm{D},t}^* + \beta(1-\rho^{*o})(1-\rho^{*n}) E_t \mu_{\mathrm{D},t+1}^* = 0$$

$$-h_t^{*\prime} + \lambda_t^* w_{\text{O},t}^* - \mu_{\text{O},t}^* + \beta(1-\rho^{*o})(1-\rho^{*n})E_t \mu_{\text{O},t+1}^* = 0$$

Combining the first order conditions on c_t^* and b_{t+1}^* gives the consumption Euler equation

$$\frac{u'^*(c_{t*})}{p_t^*} = \beta E_t \left[\frac{1}{p_{bt,t+1}^*} \frac{u'^*(c_{t+1}^*)}{p_{t+1}^*} \right]$$

which defines the one period ahead stochastic discount factor, $E_t \left[\Xi_{t+1|t}^* \right] = \beta E_t \left[\frac{u'^*(c_{t+1}^*)}{u'^*(c_t^*)} \frac{p_t^*}{p_{t+1}^*} \right]$.

Combining the first order conditions on k_{t+1}^* and b_{t+1}^* gives an arbitrage condition between bond and physical capital holdings

$$\frac{1}{p_{bt,t+1}^*} = E_t \left[1 - \delta^* + r_{d,t+1}^{*k} \right]$$

$$\frac{1}{p_{bt,t+1}^*} = E_t \left[1 - \delta^* + r_{o,t+1}^{*k} \right]$$

C Wage Bargaining

The wage is determined via bargaining between workers and firms over the total surplus of a match, which is defined as

$$\left(\mathbf{W}_{\mathrm{I},t} - \mathbf{U}_{\mathrm{I},t}\right)^{\eta} \left(\mathbf{J}_{\mathrm{I},t} - \mathbf{V}_{\mathrm{I},t}\right)^{1-\eta}$$

for $i \in (d, o)$ in either the Home or Foreign country, depending on whether it is a Home or Foreign domestic match or an offshore international match. In what follows, we first derive the definitions of the value functions for workers and firms and then, using these value functions, solve for the resulting Nash wage given by the above generalized sharing rule for each of the three labor markets.

C.1 Value Functions

C.1.1 Households

For the Home household, define $\mathbf{V}(n_{\mathrm{D},t-1})$ as the value function associated with the optimal plan that solves the household's problem.

The envelope condition is $\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t-1}) = (1-\rho^{o})(1-\rho^{n})\mu_{\mathrm{D},t}$ where $\mu_{\mathrm{D},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for employment. From the first order condition on $n_{\mathrm{D},t}$ we can express the envelope condition as

$$\frac{\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t-1})}{(1-\rho^{o})(1-\rho^{n})} = \lambda_t w_{\mathrm{D},t} - h_t' + (1-\rho^{o})(1-\rho^{n})\beta E_t\left[\frac{\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t+1})}{(1-\rho^{o})(1-\rho^{n})}\right]$$

Define $\mathbf{W}_{\mathrm{D},t}$ as

$$\begin{aligned}
\mathbf{W}_{\mathrm{D},t} \quad &\equiv \quad \frac{\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t-1})}{\lambda_t(1-\rho^{o})(1-\rho^{n})} = w_{\mathrm{D},t} - \frac{h_t'}{\lambda_t} + (1-\rho^{o})(1-\rho^{n})\beta E_t\left[\Xi_{t+1|t}\frac{\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t+1})}{\lambda_{t+1}(1-\rho^{o})(1-\rho^{n})}\right] \\
&= \quad w_{\mathrm{D},t} - \frac{h_t'}{\lambda_t} + (1-\rho^{o})(1-\rho^{n})\beta E_t\left[\Xi_{t+1|t}\mathbf{W}_{\mathrm{D},t+1}\right]
\end{aligned}$$

For the Foreign household, define $\mathbf{V}^*(n^*_{\mathrm{D},t-1}, n^*_{\mathrm{O},t-1})$ as the value function associated with the optimal plan that solves the household problem.

The envelope condition with respect to domestic employment in the Foreign country is $\mathbf{V}^*_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1}, n^*_{\mathrm{O},t-1}) = (1-\rho^{*o})(1-\rho^{*n})\mu^*_{\mathrm{D},t}$ where $\mu^*_{\mathrm{D},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for employment for domestic jobs. From the first order condition on $n^*_{\mathrm{D},t}$ we can express the envelope condition as

$$\frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1}, n^*_{\mathrm{O},t-1})}{(1-\rho^{*o})(1-\rho^{*n})} = \lambda^*_t w^*_{\mathrm{D},t} - h^{*\prime}_t + (1-\rho^{*o})(1-\rho^{*n})\beta E_t\left[\frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{F},t}, n^*_{\mathrm{O},t})}{(1-\rho^{*o})(1-\rho^{*n})}\right]$$

Define $\mathbf{W}^*_{\mathrm{D},t}$ as

$$\begin{aligned}\mathbf{W}^*_{\mathrm{D},t} &\equiv \frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1}, n^*_{\mathrm{O},t-1})}{\lambda^*_t(1-\rho^{*o})(1-\rho^{*n})} = w^*_{\mathrm{D},t} - \frac{h^{*\prime}_t}{\lambda^*_t} + (1-\rho^{*o})(1-\rho^{*n})E_t\left[\Lambda^*_{t+1|t}\frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t+1}, n^*_{\mathrm{O},t+1})}{\lambda^*_{t+1}(1-\rho^{*o})(1-\rho^{*n})}\right] \\ &= w^*_{\mathrm{D},t} - \frac{h^{*\prime}_t}{\lambda^*_t} + (1-\rho^{*o})(1-\rho^{*n})\beta E_t\left[\Lambda^*_{t+1|t}\mathbf{W}^*_{\mathrm{D},t+1}\right]\end{aligned}$$

The envelope condition with respect to offshore employment is $\mathbf{V}^*_{n^*_{\mathrm{O}}}(n^*_{\mathrm{D},t-1}, n^*_{\mathrm{O},t-1}) = (1-\rho^{*o})(1-\rho^{*n})\mu^*_{\mathrm{O},t}$ where $\mu^*_{\mathrm{O},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for employment for offshore jobs. From the first order condition on $n^*_{\mathrm{O},t}$ we can express the envelope condition as

$$\frac{\mathbf{V}_{n^*_{\mathrm{O}}}(n^*_{\mathrm{D},t-1}, n^*_{\mathrm{O},t-1})}{(1-\rho^{*o})(1-\rho^{*n})} = \lambda^*_t w^*_{\mathrm{O},t} - h^{*\prime}_t + (1-\rho^{*o})(1-\rho^{*n})E_t\left[\frac{\mathbf{V}_{n^*_{\mathrm{O}}}(n^*_{\mathrm{D},t}, n^*_{\mathrm{O},t})}{(1-\rho^{*o})(1-\rho^{*n})}\right]$$

Define $\mathbf{W}^*_{\mathrm{O},t}$ as

$$\begin{aligned}\mathbf{W}^*_{\mathrm{O},t} &\equiv \frac{\mathbf{V}_{n^*_{\mathrm{O}}}(n^*_{\mathrm{D},t-1}, n^*_{\mathrm{O},t-1})}{\lambda^*_t(1-\rho^{*o})(1-\rho^{*n})} = w^*_{\mathrm{O},t} - \frac{h^{*\prime}_t}{\lambda^*_t} + (1-\rho^{*o})(1-\rho^{*n})E_t\left[\Lambda^*_{t+1|t}\frac{\mathbf{V}_{n^*_{\mathrm{O}}}(n^*_{\mathrm{D},t+1}, n^*_{\mathrm{O},t+1})}{\lambda^*_{t+1}(1-\rho^{*o})(1-\rho^{*n})}\right] \\ &= w^*_{\mathrm{O},t} - \frac{h^{*\prime}_t}{\lambda^*_t} + (1-\rho^{*o})(1-\rho^{*n})E_t\left[\Lambda^*_{t+1|t}\mathbf{W}^*_{\mathrm{O},t+1}\right]\end{aligned}$$

Finally, note that free entry into the labor force drives the value of search to zero in all markets across all countries, so that

$$\mathbf{U}_{\mathrm{D},t} = \mathbf{U}^*_{\mathrm{D},t} = \mathbf{U}^*_{\mathrm{O},t} = 0$$

C.1.2 Firms

For the Foreign firm, define $\mathbf{V}^*(n^*_{\mathrm{D},t-1}, v^*_{\mathrm{D},t-1})$ as the value function associated with the optimal plan that solves the firms problem.

The envelope condition with respect to domestic employment is $\mathbf{V}^*_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1}, v^*_{\mathrm{D},t-1}) = (1-\rho^{*o})(1-\rho^{*n})\mu^*_{\mathrm{D},t}$ where $\mu^*_{\mathrm{D},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for employment for domestic jobs. From the first order condition on $n^*_{\mathrm{D},t}$ we can express the envelope condition as

$$\frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1}, v^*_{\mathrm{D},t-1})}{(1-\rho^{*o})(1-\rho^{*n})} = f_{n^*_{\mathrm{D}},t} - w^*_{\mathrm{D},t} + (1-\rho^{*o})E_t\left[\Xi^*_{t+1|t}\left(\rho^{*n}\lambda^*_{\mathrm{D},t+1} + (1-\rho^{*n})\frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t}, v^*_{\mathrm{D},t})}{(1-\rho^{*o})(1-\rho^{*n})}\right)\right]$$

The envelope condition with respect to domestic vacancy postings is $\mathbf{V}_{v^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1}, v^*_{\mathrm{D},t-1}) = (1-\rho^{*o})(1-k^f(\theta^*_{\mathrm{D},t-1}))\lambda^*_{\mathrm{D},t}$ where $\lambda^*_{\mathrm{D},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for vacancies for domestic jobs. From the first order condition on $v^*_{\mathrm{D},t}$ we can express the envelope condition as

$$\begin{aligned}\frac{\mathbf{V}_{v^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1},v^*_{\mathrm{D},t-1})}{(1-\rho^{*o})(1-k^f(\theta^*_{\mathrm{D},t-1}))} &= -\gamma^*_d+(1-\rho^{*o})(1-k^f(\theta^*_{\mathrm{D},t}))E_t\left[\Xi^*_{t+1|t}\frac{\mathbf{V}_{v^*_{\mathrm{D}}}(n^*_{\mathrm{D},t},v^*_{\mathrm{D},t})}{(1-\rho^{*o})(1-k^f(\theta^*_{\mathrm{D},t}))}\right]\\ &\quad +k^f(\theta^*_{\mathrm{D},t})\frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1},v^*_{\mathrm{D},t-1})}{(1-\rho^{*o})(1-\rho^{*n})}\end{aligned}$$

Define $\mathbf{J}^*_{\mathrm{D},t}\equiv\frac{\mathbf{V}_{n^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1},v^*_{\mathrm{D},t-1})}{(1-\rho^{*o})(1-\rho^{*n})}$ and $\mathbf{V}^*_{\mathrm{D},t}\equiv\frac{\mathbf{V}_{v^*_{\mathrm{D}}}(n^*_{\mathrm{D},t-1},v^*_{\mathrm{D},t-1})}{(1-\rho^{*o})(1-k^f(\theta^*_{\mathrm{D},t-1}))}$. We can re-write the above two expressions in terms of value equations as

$$\mathbf{J}^*_{\mathrm{D},t}=f_{n^*_{\mathrm{D}},t}-w^*_{\mathrm{D},t}+(1-\rho^{*o})E_t\left\{\Xi^*_{t+1|t}\left(\rho^{*n}\mathbf{V}^*_{\mathrm{D},t+1}+(1-\rho^{*n})\mathbf{J}^*_{\mathrm{D},t+1}\right)\right\}$$

and

$$\begin{aligned}\mathbf{V}^*_{\mathrm{D},t} &= -\gamma^*_d+k^f(\theta^*_{\mathrm{D},t})\mathbf{J}^*_{\mathrm{D},t}+(1-\rho^{*o})(1-k^f(\theta^*_{\mathrm{D},t}))E_t\left\{\Xi^*_{t+1|t}\mathbf{V}^*_{\mathrm{D},t}\right\}\\ &= r^{k^*}_{\mathrm{D},t}k^{k^*}_{\mathrm{D},t}\end{aligned}$$

Note that in the above equation the first line represents the value of an open vacancy in the short run, that is, prior to imposing free entry, while the second line represents the value of an open vacancy after imposing free entry.

For the Home multinational, define $\mathbf{V}(n_{\mathrm{D},t-1},v_{\mathrm{D},t-1},n^*_{\mathrm{O},t-1},v^*_{\mathrm{O},t-1})$ as the value function associated with the optimal plan that solves the firms problem.

The envelope condition with respect to domestic employment is $\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t-1},v_{\mathrm{D},t-1},n^*_{\mathrm{O},t-1},v^*_{\mathrm{O},t-1})$ $=(1-\rho^o)(1-\rho^n)\mu_{\mathrm{D},t}$ where $\mu_{\mathrm{D},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for employment for domestic jobs. From the first order condition on $n_{\mathrm{D},t}$ we can express the envelope condition as

$$\begin{aligned}\frac{\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t-1},v_{\mathrm{D},t-1},n^*_{\mathrm{O},t-1},v^*_{\mathrm{O},t-1})}{(1-\rho^o)(1-\rho^n)} &= f_{n_{\mathrm{D}},t}-w_{\mathrm{D},t}\\ +E_t\left[\Xi_{t+1|t}\left((1-\rho^o)\rho^n\lambda_{\mathrm{D},t+1}+(1-\rho^o)\right.\right.&\left.\left.(1-\rho^n)\frac{\mathbf{V}_{n_{\mathrm{D}}}(n_{\mathrm{D},t},v_{\mathrm{D},t},n^*_{\mathrm{O},t},v^*_{\mathrm{O},t})}{(1-\rho^o)(1-\rho^n)}\right)\right]\end{aligned}$$

The envelope condition with respect to offshore employment is $\mathbf{V}_{n^*_{\mathrm{O}}}(n_{\mathrm{D},t-1},v_{\mathrm{D},t-1},n^*_{\mathrm{O},t-1},v^*_{\mathrm{O},t-1})$ $=(1-\rho^{*o})(1-\rho^{*n})\mu^*_{\mathrm{O},t}$ where $\mu^*_{\mathrm{O},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for employment for offshore jobs. From the first order condition on $n^*_{\mathrm{O},t}$ we can express the envelope condition as

$$\begin{aligned}\frac{\mathbf{V}_{n^*_{\mathrm{O}}}(n_{\mathrm{D},t-1},v_{\mathrm{D},t-1},n^*_{\mathrm{O},t-1},v^*_{\mathrm{O},t-1})}{(1-\rho^{*o})(1-\rho^{*n})} &= f_{n^*_{\mathrm{O}},t}-q_tw^*_{\mathrm{O},t}\\ +E_t\left[\Xi_{t+1|t}\left((1-\rho^{*o})\rho^{*n}\lambda^*_{\mathrm{O},t+1}+(1-\rho^{*o})\right.\right.&\left.\left.(1-\rho^{*n})\frac{\mathbf{V}_{n^*_{\mathrm{O}}}(n_{\mathrm{D},t},v_{\mathrm{D},t},n^*_{\mathrm{O},t},v^*_{\mathrm{O},t})}{(1-\rho^{*o})(1-\rho^{*n})}\right)\right]\end{aligned}$$

The envelope condition with respect to domestic vacancy postings is $\mathbf{V}_{v_{\mathrm{D}}}(n_{\mathrm{D},t-1},v_{\mathrm{D},t-1},n^*_{\mathrm{O},t-1},$ $v^*_{\mathrm{O},t-1})=(1-k^f(\theta_{\mathrm{D},t-1}))(1-\Omega^Fk^f(\theta^*_{\mathrm{O},t-1}))(1-\rho^o)\lambda_{\mathrm{D},t}$ where $\lambda_{\mathrm{D},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for vacancies for domestic jobs. From the first order condition on $v_{\text{D},t}$ we can express the envelope condition as

$$\frac{\mathbf{V}_{v_{\text{D}}}(n_{\text{D},t-1}, v_{\text{D},t-1}, n^*_{\text{O},t-1}, v^*_{\text{O},t-1})}{(1-k^f(\theta_{\text{D},t-1}))(1-\Omega^F k^f(\theta^*_{\text{O},t-1}))(1-\rho^o)} = -\gamma + k^f(\theta_{\text{D},t})\mu_{\text{D},t}$$
$$+\Omega^F(1-k^f(\theta_{\text{D},t}))\left(-\gamma^*_{\text{O}} + k^f(\theta^*_{\text{O},t})\mu^*_{\text{O},t}\right)$$
$$+(1-k^f(\theta_{\text{D},t}))(1-\Omega^F k^f(\theta^*_{\text{O},t}))(1-\rho^o)E_t\left[\Lambda_{t+1|t}\frac{\mathbf{V}_{v_{\text{D}}}(n_{\text{D},t}, v_{\text{D},t}, n^*_{\text{O},t}, v^*_{\text{O},t})}{(1-k^f(\theta_{\text{D},t}))(1-\Omega^F k^f(\theta^*_{\text{O},t}))(1-\rho^o)}\right]$$

The envelope condition with respect to offshore vacancy postings is $\mathbf{V}_{v^*_{\text{O}}}(n_{\text{D},t-1}, v_{\text{D},t-1}, n^*_{\text{O},t-1}, v^*_{\text{O},t-1}) = (1-k^f(\theta^*_{\text{O},t-1}))(1-\rho^{*o})\lambda^*_{\text{O},t}$ where $\lambda^*_{\text{O},t}$ is the Lagrangian multiplier associated with the constraint on the time t perceived law of motion for vacancies for offshored jobs. From the first order condition on $v^*_{\text{O},t}$ we can express the envelope condition as

$$\frac{\mathbf{V}_{v^*_{\text{O}}}(n_{\text{D},t-1}, v_{\text{D},t-1}, n^*_{\text{O},t-1}, v^*_{\text{O},t-1})}{(1-k^f(\theta^*_{\text{O},t-1}))(1-\rho^{*o})} = \gamma^*_{\text{O}} + k^f(\theta^*_{\text{O},t})\mu^*_{\text{O},t}$$
$$+(1-k^f(\theta^*_{\text{O},t}))(1-\rho^{*o})E_t\left[\Xi_{t+1|t}\frac{\mathbf{V}_{v^*_{\text{O}}}(n_{\text{H},t}, v_{\text{H},t}, n^*_{\text{O},t}, v^*_{\text{O},t})}{(1-k^f(\theta^*_{\text{O},t}))(1-\rho^{*o})}\right]$$

Define $\mathbf{J}_{\text{D},t} \equiv \frac{\mathbf{V}_{n_{\text{D}}}(n_{\text{D},t-1}, v_{\text{D},t-1}, n^*_{\text{O},t-1}, v^*_{\text{O},t-1})}{(1-\rho^o)(1-\rho^n)}$, $\mathbf{V}_{\text{D},t} \equiv \frac{\mathbf{V}_{v_{\text{D}}}(n_{\text{D},t-1}, v_{\text{D},t-1}, n^*_{\text{O},t-1}, v^*_{\text{O},t-1})}{(1-k^f(\theta_{\text{D},t-1}))(1-\Omega^F k^f(\widetilde{\theta}^*_{\text{O},t-1}))(1-\rho^o)}$, $\mathbf{J}^*_{\text{O},t} \equiv \frac{\mathbf{V}_{n^*_{\text{O}}}(n_{\text{D},t-1}, v_{\text{D},t-1}, n^*_{\text{O},t-1}, v^*_{\text{O},t-1})}{(1-\rho^{*o})(1-\rho^{*n})}$, and $\mathbf{V}^*_{\text{O},t} \equiv \frac{\mathbf{V}_{v^*_{\text{O}}}(n_{\text{D},t-1}, v_{\text{D},t-1}, n^*_{\text{O},t-1}, v^*_{\text{O},t-1})}{(1-k^f(\theta^*_{\text{O},t-1}))(1-\Omega^F k^f(\widetilde{\theta}^*_{\text{O},t-1}))(1-\rho^{*o})}$. We can re-write the above expressions in terms of value equations as

$$\mathbf{J}_{\text{D},t} = f_{n_{\text{D}},t} - w_{\text{D},t} + (1-\rho^o)E_t\left[\Xi_{t+1|t}\left(\rho^n\mathbf{V}_{\text{D},t+1} + (1-\rho^n)\,\mathbf{J}_{\text{D},t+1}\right)\right]$$

$$\begin{aligned}\mathbf{V}_{\text{D},t} &= -\gamma + k^f(\theta_{\text{D},t})\mathbf{J}_{\text{D},t} \\ &\quad +\Omega^F(1-k^f(\theta_{\text{D},t}))\left(-\gamma^*_{\text{O}} + k^f(\theta^*_{\text{O},t})\mathbf{J}^*_{\text{O},t}\right) \\ &\quad +(1-k^f(\theta_{\text{D},t}))(1-\Omega^F k^f(\theta^*_{\text{O},t}))(1-\rho^o)E_t\left\{\Xi_{t+1|t}\mathbf{V}_{\text{D},t+1}\right\} \\ &= r^k_{\text{D},t}k^k_{\text{D},t}\end{aligned}$$

$$\mathbf{J}^*_{\text{O},t} = f_{n^*_{\text{O}},t} - q_t w^*_{\text{O},t} + (1-\rho^{*o})E_t\left[\Xi_{t+1|t}\left(\rho^{*n}\mathbf{V}^*_{\text{O},t+1} + (1-\rho^{*n})\,\mathbf{J}^*_{\text{O},t+1}\right)\right]$$

$$\begin{aligned}\mathbf{V}^*_{\text{O},t} &= -\gamma^*_{\text{O}} + k^f(\theta^*_{\text{O},t})\mathbf{J}^*_{\text{O},t} + (1-k^f(\theta^*_{\text{O},t}))(1-\rho^{*o})E_t\left\{\Xi_{t+1|t}\mathbf{V}^*_{\text{O},t+1}\right\} \\ &= q_t r^{k^*}_{\text{O},t}k^{k^*}_{\text{O},t}\end{aligned}$$

Where, again, the first equality in the expressions for $\mathbf{V}_{\text{D},t}$ and $\mathbf{V}^*_{\text{O},t}$, respectively, is the short-run wage that obtains prior to imposing free entry and the second equality in each expression is the wage that obtains after imposing free entry.

C.2 Bargained Wages

The bargained wage is that which solves the following generalized Nash sharing rule for each of the three respective labor markets

$$\eta\left[\frac{\partial \mathbf{W}_{\text{I},t}}{w_{i,t}}-\frac{\partial \mathbf{U}_{\text{I},t}}{w_{i,t}}\right]\left(\mathbf{J}_{\text{I},t}-\mathbf{V}_{\text{I},t}\right)+(1-\eta)\left[\frac{\partial \mathbf{J}_{\text{I},t}}{w_{i,t}}-\frac{\partial \mathbf{V}_{\text{I},t}}{w_{i,t}}\right]\left(\mathbf{W}_{\text{I},t}-\mathbf{U}_{\text{I},t}\right)=0$$

C.2.1 Domestic Jobs with the Home Multinational Firm

The sharing rule reduces to

$$\left(\mathbf{W}_{\text{D},t}-\mathbf{U}_{\text{D},t}\right)=\frac{\eta}{1-\eta}\left(\mathbf{J}_{\text{D},t}-\mathbf{V}_{\text{D},t}\right)$$

We begin by solving the wage in the short run, that is prior to imposing free entry. Substitute in equations xx, xx, xx, and xx, for the definitions of yy, yy, yy, and yy, respectively.

In the short run, the stock of physical capital and the number of firms is assumed to be fixed.

$$\begin{aligned}
w_{d,t} \quad = \quad & (1-\eta)\frac{h'(lfp_t)}{u'(c_t)}+\eta f_{n_{d,t}} \\
& +\eta\left(\gamma-k^f(\theta_{\text{D},t})\left(\mathbf{J}_{\text{D},t}-(1-\rho^o)E_t\left[\Xi_{t+1|t}\mathbf{V}_{\text{D},t+1}\right]\right)\right) \\
& +\eta\Omega(1-k^f(\theta_{\text{D},t}))\left(\gamma^*-k^f(\theta^*_{\text{O},t})\left(\mathbf{J}^*_{\text{O},t}-(1-\rho^o)E_t\left[\Xi_{t+1|t}\mathbf{V}_{\text{D},t+1}\right]\right)\right)
\end{aligned}$$

The Long run home wage is given by

$$w_{\text{D},t} \quad = \quad (1-\eta)\frac{h'_t}{u'_t}+\eta\left(f_{n_{\text{D}},t}-r^k_t k_{d,t}+(1-\rho^o)E_t\left[\Xi_{t+1|t}r^k_{t+1}k_{d,t+1}\right]\right)$$

C.2.2 Offshore Jobs with the Home Multinational Firm

The sharing rule reduces to

$$\left(\mathbf{W}^*_{\text{O},t}-\mathbf{U}^*_{\text{O},t}\right)=\frac{\eta^*}{1-\eta^*}\frac{1}{q_t}\left(\mathbf{J}^*_{\text{O},t}-\mathbf{V}^*_{\text{O},t}\right)$$

We begin by solving the wage in the short run, that is prior to imposing free entry. Substitute in equations xx, xx, xx, and xx, for the definitions of yy, yy, yy, and yy, respectively.

$$\begin{aligned}
w^*_{\text{O},t} \quad = \quad & (1-\eta^*)\frac{h'^*_t}{u'^*_t}+\eta^*\frac{1}{q_t}f_{n^*_{\text{H}},t} \\
& +\eta^*\frac{1}{q_t}\left(\gamma^*_{\text{O}}-k^f(\theta^*_{\text{O},t})\left(\mathbf{J}^*_{\text{O},t}-(1-\rho^{*o})E_t\left[\Xi_{t+1|t}\mathbf{V}^*_{\text{O},t+1}\right]\right)\right) \\
& +\eta^*\frac{1}{q_t}(1-\rho^{o*})(1-\rho^{n*})E_t\left[\frac{\Xi^*_{t+1|t}q_t-\Xi_{t+1|t}q_{t+1}}{q_{t+1}}\left(\mathbf{J}^*_{\text{O},t+1}-\mathbf{V}^*_{\text{O},t+1}\right)\right]
\end{aligned}$$

The offshore wage is given by

$$
\begin{aligned}
w^*_{\text{O},t} &= (1-\eta^*)\frac{h'^*_t}{u'^*_t} + \eta^*\frac{1}{q_t}\left(f^*_{n^*_{\text{O}},t} - q_t r^{k*}_t k^*_{o,t} + (1-\rho^{o*})E_t\left[\Xi^*_{t+1|t} q_{t+1} r^{k*}_{t+1} k^*_{o,t+1}\right]\right) \\
&\quad -\eta^*\frac{1}{q_t}(1-\rho^{o*})E_t\left[\frac{\Xi^*_{t+1|t} q_t - \Xi_{t+1|t} q_{t+1}}{q_{t+1}}\left((1-\rho^{n*})\mathbf{J}^*_{\text{O},t+1} + \rho^{n*} q_{t+1} r^{k*}_{t+1} k^*_{o,t+1}\right)\right]
\end{aligned}
$$

C.2.3 Domestic Jobs with the Foreign Firm

The sharing rule reduces to

$$
\left(\mathbf{W}^*_{\text{D},t} - \mathbf{U}^*_{\text{D},t}\right) = \frac{\eta^*}{1-\eta^*}\left(\mathbf{J}^*_{\text{D},t} - \mathbf{V}^*_{\text{D},t}\right)
$$

We begin by solving the wage in the short run, that is prior to imposing free entry. Substitute in equations xx, xx, xx, and xx, for the definitions of yy, yy, yy, and yy, respectively.

$$
\begin{aligned}
w^*_{\text{D},t} &= (1-\eta^*)\frac{h'^*_t}{u'^*_t} + \eta^* f^*_{n^*_{\text{D}},t} \\
&\quad +\eta^*\left(\gamma^*_{\text{D}} - k^f(\theta^*_{\text{D},t})\left(\mathbf{J}^*_{\text{D},t} - (1-\rho^{*o})E_t\left[\Xi^*_{t+1|t}\mathbf{V}^*_{\text{D},t+1}\right]\right)\right)
\end{aligned}
$$

The foreign wage is given by

$$
w^*_{\text{D},t} = (1-\eta^*)\frac{h'^*_t}{u'^*_t} + \eta^*\left(f^*_{n^*_{\text{D}},t} - r^{k*}_t k^*_{d,t} + (1-\rho^{o*})E_t\left[\Xi^*_{t+1|t} r^{k*}_{t+1} k^*_{d,t+1}\right]\right)
$$