Strategic Sourcing, Markups and Labor Demand Elasticities

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Abstract

We examine how multinational firms strategically source production to mitigate the consequences of wage bargaining with workers. When production in one country requires negotiating with workers over wages, firms allocate production of goods with high markups toward countries with relatively competitive labor markets. This strategy allows multinationals to raise the derived elasticity of labor demand for bargaining workers, reducing negotiated wages with little net change in the total volume of offshore production. Evidence from the automotive industry provides strong support that multinationals locate production of vehicles with higher markups more intensively in Mexico, away from UAW collective bargaining pressure. We use product-level data from the universe of production facilities in North America between 1988 and 2009 to estimate variable price elasticities of demand for different vehicles. We then use exogenous fluctuations in real exchange rates to distinguish the impact of bargaining pressure from other sourcing motives.

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1 Introduction

When considering the consequences of globalization it is important to recognize that multinational firms are the dominant players. The US Census Bureau reports that nearly 50% of US imports came from related parties in 2009. Selecting and managing a diverse product portfolio is an important component of how firms remain competitive.[1] Multinational enterprises must decide not only which products to manufacture, but where to produce them. In this paper we demonstrate that the sourcing behavior of multinational firms is influenced by the price elasticities of demand for their different products.

If domestic workers bargain over wages, while foreign labor markets are relatively more competitive, the optimal strategy for multinationals is to offshore production of goods with high price markups more intensively. We show that this strategy raises the derived elasticity of labor demand for domestic workers, allowing firms to negotiate more effectively against bargaining units and reduce negotiated wages. To find evidence of this behavior we examine the sourcing decisions of automobile manufacturers across the universe of North-American production facilities. These multinational firms strategically allocate production of vehicles with high price markups away from UAW workers.

We argue that understanding the relationship between worker bargaining pressure and foreign direct investment requires looking *within* multinational firms, and *across* product lines. Ignoring the micro-level demand characteristics for different product lines produced by the same firm clouds the relationship between multinational behavior and wage bargaining pressure. A multinational firm can improve its bargaining position without large changes in the total volume of foreign production. Instead a firm responds to changes in offshoring costs by moving particular products abroad, with reallocations of specific products back to domestic facilities. Even with small net changes in offshoring intensity for a firm, a strategic allocation across product lines enables a multinational to be more effective during wage negotiations.

Our empirical analysis of sourcing behavior centers on the automobile industry in North-America for two reasons. First, the labor force in the US and Canada belongs to a large bargaining unit, while plants in Mexico can hire workers from relatively more competitive markets. This difference is necessary to identify the effects of wage bargaining on sourcing behavior. Second, every multinational firm in the industry manufactures several classes of automobiles including sedans, trucks, passenger vans and compacts, with further product variety in trim characteristics such as transmission type, engine size and interior features. The elasticities of consumer demand differ across these product lines, allowing firms to manipulate the derived elasticity of

[1] Previous work has demonstrated that reductions in trade barriers alter the competitive environment and induce domestic producers to make selections regarding which of their products to continue selling. Eckel and Neary (2010) argue that the selection of products pushes firms to concentrate production on their core competency. See also Bernard et al. (2011) and Feenstra and Ma (2008).

labor demand by varying offshoring intensity across products.

The automotive industry permits a clear examination of sourcing behavior across product lines, yet this strategic mechanism is available to multinationals in many industries and countries. For instance, trade union density varies widely among OECD countries. In 2008 approximately 12% of the US labor force belonged to a union, while membership levels in Germany and Sweden were 19% and 68% respectively. OECD countries also account for a sizable portion of global investment activity: FDI into member nations constituted nearly 60% of global capital flows in 2008.[2] The combined variation in union pressure and FDI absorption by these countries suggests that the mechanism we highlight can have a substantial impact on multinational investment behavior.

We build a theoretical framework that incorporates offshoring possibilities for imperfectly competitive multinational firms. Domestic workers belong to a collective bargaining unit, but foreign labor markets are competitive. Multinational firms are also multiproduct firms, and must decide the intensity of foreign production for each product line. The offshoring environment is characterized by decreasing returns such that marginal costs of production are increasing in the intensity of foreign sourcing. Facing a collective bargaining agreement with domestic workers, multinational firms balance higher wages at home against rising costs to offshore production. The model offers two key predictions regarding sourcing behavior. First, multinational firms use bargaining workers to manufacture varieties with high price elasticities of demand more intensively. Second, reductions in offshoring costs lead to smaller increases foreign sourcing for varieties with relatively high price markups. Taken together these two results yield a set of predictions that allow us to distinguish sourcing behavior in response to wage bargaining from alternative motives to offshore production – including the possibility to pass-through trade costs onto consumers, to avoid market power held by shipping companies, or to cover fixed costs of offshore production.

Our empirical strategy occurs in two stages. First, we structurally estimate the demand elasticities, and thus price markups, for various models of automobiles from a trans-log expenditure system. The procedure builds from Feenstra and Weinstein (2010). Estimated elasticities vary with product market share and are consistent with homothetic consumer preferences. In the second stage we regress the fraction of total production that occurs in Mexico on the estimated markups for each model and measures of offshoring costs between the US, Canada, and Mexico.

Production data were collected from Ward's Automotive Yearbook at monthly intervals across the universe of North American auto plants by make and model. Information about production at each plant are

[2] http://stats.oecd.org/Index.aspx provides information about the shares of wage and salary earners that belong to trade unions, and FDI flows among member nations.

then linked to sales in the US. We couple plant-level production data with information collected from press releases regarding the initiation of talks between automakers and the UAW. For each bargaining action in the US and Canada, we observe which party benefited from negotiations, the event of a strike, mass layoffs, bankruptcy filing or the event of a bailout. We use these data to control for the endogenous bargaining actions of workers and multinational firms. Finally, we include measures of the real exchange rates between the Canada, Mexico and the US. Exchange rates affect offshoring costs of all goods simultaneously, circumventing a potential bias if unobserved differences in offshoring costs for specific varieties are correlated with their price markups. The panel of observations spans the years 1988 through 2009.

The raw data show a positive relationship between the price markup of a vehicle and its intensity of foreign production within the fleet of each car manufacturer, and within each vehicle class. To address concerns about endogeneity of markups and sourcing behavior we exploit the panel nature of our data and control for firm-, variety-, and time-specific characteristics. Looking within each vehicle model, the share of production located in Mexico is greater when price markups are relatively high. Additionally, when the *peso* depreciates, multinationals reallocate production of high markup vehicles to Mexico relatively less.[3] This strategic sourcing is consistent with multinationals responding to wage bargaining pressure. The evidence is robust to several specifications of price markups, as well as to controls for union action, production scale, number of plants, and inclusion of companies that use Mexico and Canada as export platforms to the US.

Lastly, we use production intensity in Canada to perform a falsification test. The UAW also maintains bargaining pressure in Canada. Given the differences in labor market structure across Mexico and Canada we expect opposing responses in offshoring to each country when exchange rates vary. Again we find that the sourcing behavior of multinationals is consistent with strategies to improve wage bargaining outcomes, rather than to avoid the burden of high transport costs.[4]

The next section of the paper discusses previous work on wage bargaining and multinational production. Section 3 presents a model of international production, wage bargaining and product market competition and section 4 characterizes the unique equilibrium allocation. Section 5 derives the relationship between labor demand elasticities and price markups. This section also derives the optimal sourcing behavior of multinational firms. In section 6 we outline our empirical strategy to test the predictions of the model and provide details about the data. The following sections present the empirical results. Section 8 concludes.

[3] One may be concerned about an endogenous relationship between exchange rates and price elasticities due to varying levels of pass-through. However Goldberg (1995) documents a positive relationship between exchange rate fluctuations and markups in the automotive industry, which works against finding that multinationals respond to bargaining pressure.

[4] Alchian and Allen (1964), Hummels (2004), and Auer and Chaney (2009) argue that the ability cover transport costs, or to pass them through to consumers, can vary with the consumer preferences for individual goods. Also Hummels et al. (2009) show that transport costs can vary with price markups because of market power held by shipping companies. Since production in both Canada and Mexico are subject to transport costs, the opposing response to changes in offshoring costs across countries supports the wage negotiation motives for foreign sourcing derived below.

2 Related Literature

The strategic behavior of multinationals derived below exploits the relationship between consumer demand elasticities, and the elasticity of labor demand for multinational firms. Rodrik (1997) discusses several mechanisms through which openness impacts workers by raising the elasticity of labor demand. First, he argues that the footloose nature of multinationals reduces job security for workers as firms can shift production across locations that experience different productivity shocks. In addition, a higher elasticity of labor demand reduces the ability of workers to bargain effectively with multinational employers, which can lead to lower wages and a reduction in non-pecuniary benefits attached to jobs.

The former mechanism has been demonstrated empirically by Fabbri et al. (2003) and Senses (2010). They find that multinational firms in the UK and US do exhibit a higher elasticity of labor demand than is observed among their domestic counterparts. Also see Slaughter (2001), Hasan et al. (2007), and Gorg et al. (2009). Muendler and Becker (2010) describe the margins by which multinationals substitute labor between plants in response to productivity differences. The latter mechanism by which multinational production can influence wage bargaining has received little empirical attention previously.

The preeminent paper addressing the implicit effects of union action on firm behavior is DiNardo (2004). We take the ability of workers to capture rents through collective bargaining action as given, and seek to explain how multinationals strategically respond by allocating the manufacture of individual products across borders. See Abowd and Lemieux (1993) for evidence that collective bargaining units are able to extract rents from automotive firms. In the most closely related analysis to ours, Staiger (1988) investigates the relationship between union bargaining and the international organization of production; his analysis focuses on the labor-intensity of production for different goods to determine the pattern of trade, instead of their price elasticities of demand. Similarly, Skaksen and Sorensen (2001) and Skaksen (2004) show theoretically that the ability of multinationals to mitigate the consequences of wage bargaining depends on the nature of the production technology, rather than demand characteristics.

The analysis below also complements a larger literature on multinational firms and labor market outcomes. By now it is well known that multinationals pay higher average wages than their domestic counterparts. See for example Aitken et al. (1996), Doms and Jensen (1998), Lipsey (2004) and Heyman et al. (2007). At a more aggregate level the US wage distribution exhibits a weak relationship with both outward FDI flows (Slaughter (2000)) and inward FDI flows (Blonigen and Slaughter (2001)). Rather than looking across skills or firm characteristics in a particular market, we are specifically interested in exposing the employment strategies that multinational enterprises use when participating in multiple labor markets.

3 Model

There are two countries in the world economy. Production can occur in either country, but consumption takes place only in the home country; thus our focus is on vertical production networks across borders. Wages differ across countries because domestic workers belong to a union that collectively bargains over wages, while foreign wages are set competitively.

The timing of the model is as follows: (1) multinational firms decide how intensively to use foreign production for each of their varieties in anticipation of relative wages; (2) multinational firms and the domestic union negotiate over wages; and (3) firms produce, set prices, and consumption ensues immediately. It is most convenient to describe the details of the model in reverse order.

3.1 Consumption

Consumer preferences in the home country are homothetic and reflect a taste for variety. For the entire number of products available, $\hat{N}$, we assume that consumer tastes give rise to the following trans-log expenditure function[5]

$$\ln E = a_0 + \sum_{n=1}^{\hat{N}} a_n \ln p_n + \frac{1}{2} \sum_{n=1}^{\hat{N}} \sum_{m=1}^{\hat{N}} b_{nm} \ln p_n \ln p_m \ . \tag{1}$$

Expenditures are homogeneous of degree one, which implies $\sum_{n=1}^{\hat{N}} a_n = 1$ and $\sum_{n=1}^{\hat{N}} b_{nm} = 0$. The parameters b_{nm} capture substitutability between goods and are symmetric so that $b_{nn} = -b(\hat{N}-1)/\hat{N}$ and $b_{nm} = b/\hat{N}$. From (1) the market share for a specific product n is

$$s_n = a_n + \sum_{m=1}^{\hat{N}} b_{nm} \ln p_m \ . \tag{2}$$

and its price elasticity of demand is

$$|\epsilon_n| = 1 + \frac{b(\hat{N}-1)}{s_n \hat{N}}. \tag{3}$$

Note that the price elasticities of demand are specific to each variety. Products with a low elasticity are those goods for which the observed market share is large. The price elasticity of demand for specific varieties reflect consumer tastes, and so are exogenous to multinational firms.

[5]See Diewert (1974) and Feenstra (2003) for details about the trans-log expenditure system. None of the predictions of the model depend on the use of the trans-log expenditure function; the only requirement on preferences is that the elasticity of demand varies across products.

3.2 Collective Bargaining

Domestic labor are members of a collective bargaining unit with total membership $\bar{U}$. Negotiations between the domestic union and multinational firms follow the standard Labor Demand model of collective bargaining. (Also called the Right-to-Manage model. See Dunlop (1950).) Negotiations take place over the wage level, where union members anticipate the employer's demand for labor. Given the negotiated wage, firms hire workers according to their optimal labor demand schedule. This model captures the fact that employers do not necessarily have a duty to bargain over employment levels. Instead, employers in the US have an obligation to bargain "in good faith" over the terms and conditions of employment under the National Labor Relations Act.

A theoretical alternative is the Strongly Efficient Bargaining model, where the union and firm negotiate over both wages and employment. The evidence is mixed on the relevance of each model: Brown and Ashenfelter (1986) and Card (1990) found little support for the efficient bargaining model, while Abowd (1989) cannot reject the possibility that negotiated wages reflect efficient bargaining among publicly traded corporations in the US. The Strongly Efficient Bargaining predicts that employment levels depend only on the reservation wage of union labor, and not the negotiated wage. We adopt the Labor Demand model given that our focus is on multinational firms that can respond to wage disparities by shifting the location of production and employment.[6]

Collective bargaining proceeds as follows. First, the union decides on the wage that maximizes the total (feasible) payoff to its members. Let $U(\omega) = \sum_{n=1}^{N} u_n(\omega)$ be the neoclassical domestic labor demand function of the multinational firm at the bargained wages ω, for each of their varieties, $n = 1....N$. Each domestic worker has an employment opportunity outside the union that pays a wage equal to r. Hence the maximum feasible wage is

$$\omega^B = \underset{\omega}{argmax} \quad U(\omega)\omega + \left(\bar{U} - U(\omega)\right) r \ , \tag{4}$$

subject to the employer earning non-negative profits.

Next the firm and union enter negotiations to settle on a wage between ω^B and r. The bargaining process is non-cooperative where the union and firm have respective bargaining powers ψ and $1 - \psi$. We assume that the requirement of union membership for domestic hiring is fully enforced; firms cannot hire workers outside the union, and so must pay all domestic workers the negotiated wage level.

[6]The labor demand model of collective bargaining abstracts from the practice of pattern bargaining by unions. It is common, especially for the UAW, that a union will enter negotiations with a single firm, and then use that bargaining outcome as a model for future wage negotiations. For our purposes the key feature of labor markets is that domestic workers collectively bargain, while foreign workers do not. Incorporating the sequence of pattern bargaining here would be a distraction. However we note that our characterization of wage negotiations between the union and a single employer is consistent with pattern bargaining taking place. For analyses of pattern bargaining see Creane and Davidson (2011) and Marshall and Merlo (2004).

3.3 Multinational Firms and Production

Multinational firms produce several varieties of the final consumption good. The pertinent example here is the automobile. Automobile firms produce several different classes of cars including sedans, compacts, trucks and passenger vans. Moreover there are several options of trim characteristics within class that include engine type, transmission type, wheel size and interior features.

Product markets are imperfectly competitive so that multinationals act as price competitors over varieties sold in the home market. Each firm takes consumer preferences across varieties as given, and sets prices optimally facing the trans-log expenditure system. Firm pricing behavior follows Feenstra (2003) and Feenstra and Weinstein (2010), with multinationals producing several individual varieties.

In anticipation of labor costs at home and abroad the multinational firm must decide where to produce its N different product lines. Multinational firms can use foreign sourcing at differing intensities for each of their varieties, $n = 1....N$. For any given product line, the marginal cost of production is increasing in the intensity of foreign production.[7] Without loss of generality, the only input to production is labor. In terms of productive efficiency foreign and domestic labor are perfectly substitutable. However, the use of foreign labor cannot be separated from transportation costs when offshoring production.

The cost of foreign labor is q, and the wage paid to domestic union labor is ω. Transportation costs for offshore production are in terms of additional foreign labor that must be hired. Let i denote the intensity of foreign production. Then the additional labor requirement necessary to offshore the fraction of production i, for variety n, is given by $\alpha\beta_n A(i)$. Increasing marginal costs due to foreign production imply $A'(i) > 0$. The schedule of offshoring costs can also vary across varieties according to β_n.[8] Given the share of production that occurs abroad, I_n, the unit cost function for any variety can be written

$$c_n(q, \omega, \beta_n, I_n) = (1 - I_n)\omega + \alpha\beta_n q \int_0^{I_n} A(i)di \ . \tag{5}$$

The cost function in (5) does not depend on the total volume of production, only the intensity of foreign production. None of the results derived below depend on the specification of constant returns to scale. This assumption is made for notational convenience and will be relaxed in the empirical analysis.

[7] See Keller and Yeaple (2009) for evidence of gravity effects, where the costs to offshore are increasing faster in technology intensive sectors, as would be the case in the automotive industry. The production technology is also similar to Grossman and Rossi-Hansberg (2008), except that the costs to offshore production differ according to the fraction of final goods that are performed abroad, rather than intermediate tasks.

[8] For now we assume that the price elasticity of demand, ϵ_n, and the offshorability of a product line, β_n, are independent. This will allow us focus on deriving the relationship between sourcing decisions and the elasticity of demand. We will relax the independence assumption below and discuss how our empirical strategy circumvents any unobservable relationship between the capability to offshore and the demand elasticity for a product.

4 Equilibrium

In this section we derive a sub-game perfect equilibrium that is characterized by the consumption price, the negotiated wage and the share of production that is sourced from the foreign country for each variety. Equilibrium is characterized by the vector $\{p_n^*(\cdot),\ \omega^*,\ I_n^*\}$ for all n. We proceed using backward induction.

4.1 Production and Consumption

In the final stage a multinational firm knows the costs to hire foreign labor, to hire domestic union workers, and to offshore tasks. The firm acts as a monopolist in setting the prices of its unique products. The profit maximizing price is a markup over unit costs with the familiar expression

$$p_n^*(q, \omega, \beta_n, I_n) = c_n(q, \omega, \beta_n, I_n) \left(\frac{|\epsilon_n|}{|\epsilon_n| - 1} \right). \tag{6}$$

4.2 Wage Bargaining

With collective bargaining enforced in the domestic labor market the multinational firm and the union must negotiate over wages. Firms seek a wage that maximizes profits. The union seeks to maximize the payoff to its members, see (4). Let $l_n(q)$ be the firm's foreign labor demand function for variety n, and $x_n(p_n)$ be the consumer demand function in the trans-log expenditure system. The non-cooperative outcome to the wage negotiations is given by the unique Nash bargaining solution, which yields

$$\omega^* = \underset{\omega}{argmax} \quad \left[U(\omega)\omega + \left(\bar{U} - U(\omega)\right) r\right]^{\psi} \left[\sum_{n=1}^{N} \left(p_n^* x_n(p_n^*) - \alpha \beta_n q l(q) \int_0^{I_n^*} A(i) di \right) - \omega U(\omega) \right]^{1-\psi}. \tag{7}$$

4.3 Sourcing Decisions

For each of its product lines the multinational determines the share of production to offshore, I_n^*. Cost minimization requires that the firm equalizes the marginal costs of production across locations. Minimizing (5) implies that the optimal sourcing decisions satisfy

$$\omega^* = \alpha \beta A'(I_n^*) q\ . \tag{8}$$

The equilibrium vector $\{p_n^*(\cdot),\ \omega^*,\ I_n^*\}$ is obtained at the intersection of equations (6), (7) and (8). The next section turns to our question of interest – How does the optimal sourcing behavior of multinationals vary across varieties with different elasticities of demand?

5 Product Portfolio and the Elasticity of Labor Demand

The firm determines which of its product lines to offshore in anticipation of the bargained wage for domestic union labor. Profits are strictly decreasing in the wages so that, all else equal, the best strategy for a multinational is to source production in a way that reduces the negotiated wage level in (7). Rodrik (1997) argues that global production networks may allow firms to negotiate lower wages with workers by raising the derived elasticity of demand. When the rents to be divided are highly sensitive to labor costs, bargaining workers cannot credibly seek higher wages. To see this formally, differentiate the equilibrium wage in (7) with respect to the labor demand elasticity, $\eta_\omega = \frac{d \ln U(\omega^*)}{d \ln \omega^*}$.

$$\frac{d\omega^*}{d|\eta_\omega|} = \frac{Z(\omega^*)^{\psi-1}}{[S.O.C.\omega^*]}(\omega^* - r)\psi \leq 0 \ , \tag{9}$$

where $Z(\omega^*)$ is the ratio of the union payoff to firm profits in equilibrium. (See appendix for a full derivation.) The inequality can be seen by noting that the second-order-condition is negative as the Nash solution to wage negotiations in (7) maximizes the product of firm profits and the union payoff.

The inequality in (9) demonstrates that union wages are decreasing in the elasticity of labor demand. For imperfectly competitive firms, producing N different varieties, the derived elasticity of labor demand is

$$\eta_\omega = \sum_{n=1}^{N} [K_n^u - 1]\sigma + K_n^u \epsilon_i \ , \tag{10}$$

where K_n^u is the share of total cost accounted for by union labor and σ is the Allen elasticity of substitution between inputs holding total costs constant. See de Meza (1982).[9] Clearly the labor demand elasticity is strictly increasing in the price elasticity of demand for each good. Hence equation (10) suggests an optimal sourcing strategy whereby multinationals vary the intensity of domestic production based on the price elasticity of demand for products, ϵ_n.[10] The following proposition describes how multinationals source production of varieties with different elasticities.

[9] To be precise, the result of de Meza is that the derived elasticity of factor demand under monopoly is $[K^u - 1]\sigma + \frac{K^u \epsilon}{1 + e\epsilon(1-m)}\epsilon$ where m is the price markup over industry average costs equal to $\epsilon/(\epsilon - 1)$, and e is the curvature of the elasticity of demand (i.e., the elasticity of the price elasticity of demand as quantity changes). With a homothetic demand system across products $\epsilon = 0$, and equation (10) holds. The fact that the derived elasticity of demand resembles the case of perfect competition (see Hammermesh (1993, pg. 24) reflects the assumption of homotheticity. Note that Maurice and Ferguson (1973), as cited by Fajnzylber and Maloney (2005), argued that the derived elasticity of labor demand has a tenuous relationship with the price elasticity of demand under monopoly. However, de Meza showed the relationship can be written in terms of ϵ and m. Krishna et al. (2001) established the derived labor demand under CES preferences and monopolistic competition. Here we relax the assumption of constant elasticity of demand and assume only that the price elasticity changes at a constant rate over all levels of quantity demanded.

[10] Multinationals can also raise the elasticity of labor demand by responding to idiosyncratic shocks in costs in way that raises elasticity of substitution between factors of production, σ. This strategy was the focus of analyses by Fabbri et al. (2003), Krishna et al. (2001) and Gorg et al. (2009). Also, Skaksen and Sorensen (2001) discuss union bargaining and FDI at various level of substitutability between foreign and domestic labor.

Proposition 1 *When domestic workers collectively bargain over wages, multinational firms will use foreign sources of production more intensively for product lines with relatively low price elasticities of demand.*

Proof. When deciding how to source products in the first stage the multinational treats ω^* as endogenous and chooses I_n^* to balance the costs savings from a lower negotiated wage at home against rising offshoring costs. That is, the objective of the firm is to choose the intensity of offshoring I_n^* that minimizes the bargained wage level in (7), subject to equation (10). Define the first-order-condition for offshoring intensity as $\Phi \equiv -\omega^* + \alpha\beta_n A(I_n^*)q = 0$. Applying the implicit function theorem we obtain

$$\frac{dI_n^*}{d\epsilon_n} = -\frac{\partial\Phi/\partial\epsilon_n}{\partial\Phi/\partial I_n^*} = -\frac{-\frac{\partial\omega^*}{\partial\eta_\omega}\frac{\partial\eta_\omega}{\partial\epsilon_n}}{[S.O.C.I_n^*]} \geq 0 \ .$$

The second order condition for I_n^* is positive in accordance with cost minimization. The inequality in (9) guarantees that $\frac{\partial\omega^*}{\partial\eta_\omega}$ is negative in nominal terms. Simple differentiation of (10) shows that $\frac{\partial\eta_\omega}{\partial\epsilon_n}$ is positive. Note that the price elasticities of demand for products are negative by definition; a higher value of ϵ_n corresponds to a more inelastic demand for variety n. This establishes the result. ■

Proposition 1 states that multinational firms will use domestic union labor to manufacture varieties with relatively more elastic demand. If one ignores the relationship between consumer price elasticities and factor demand elasticities, the result in proposition 1 may seem counterintuitive. Suppose that multinationals had no viable strategy to reduce the negotiated wage level. Then the best alternative for the firm would be to use domestic labor to produce varieties with low price elasticities, and pass the burden of wage bargaining through to consumers.

Instead, multinational firms internalize the relationship between the derived elasticity of labor demand and the price markups for specific product lines. As seen in equation (10), the elasticity of labor demand is greater for workers producing varieties with high price elasticities. When firms are highly responsive to wages in their hiring, the union cannot effectively negotiate high wage outcomes without large reductions in employment. At high elasticities of labor demand the optimal choice for the union is to accept relatively low wages, with greater employment of its members. Thus, multinational firms manage their product portfolios strategically across locations to reduce the wages needed to satisfy collective bargaining agreements.

The result in Proposition 1 states a causal relationship between the sourcing decisions of multinationals and price markups in the presence of wage bargaining. From an empirical point of view, the effect of a higher price markup must be separated from variety-specific offshoring costs in order to identify sourcing behavior. From a theoretical perspective there are motives other than reducing wage bargaining outcomes that might induce multinationals to use foreign sources to produce high markup goods; e.g., the "Washington

apples" effect where a high markup is necessary to justify incurring costs of foreign production, or passing the burden of transportation costs through to consumers. An alternative method to identify the sourcing strategies that multinationals use to mitigate wage bargaining pressure is to examine symmetric variation in offshoring costs.

Proposition 2 *Reductions in the cost to offshore the production of all goods, α, will lead to relatively smaller increases in foreign sourcing for varieties with low price elasticities of demand (i.e. high markups), if multinational firms face wage bargaining from the domestic labor force.*

Proof. The proof is relegated to the Appendix. ■

Proposition 2 describes differences in the ability of multinational firms to profit from inexpensive offshoring opportunities across product lines. When foreign production becomes less costly, the multinational firm tends to reallocate production abroad for all varieties. With decreasing returns in offshoring intensity, moving production away from domestic plants is more difficult for product lines that are initially manufactured more intensively in foreign facilities; given wage bargaining at home, proposition 1 ensures that these are the varieties with high price markups. Thus, reductions in offshoring costs lead to relatively smaller reallocations of high markup goods to foreign sources.

It is important to note that this is the opposite prediction than would be obtained if firms sourced production solely to cover fixed offshoring costs or to pass the burden of rising transportation costs.[11] Furthermore, Hummels et al. (2009) show that because of imperfectly competitive shipping markets, transport companies charge higher prices to ship products with high markups. The incentives for firms to move high markup goods abroad because of wage bargaining pressure are opposite to the incentives to avoid high-priced transport. Taken together propositions 1 and 2 yield a set of predictions that allow us to distinguish multinational sourcing behavior in response to wage bargaining from other potential motives.

Our empirical strategy, detailed below, uses exogenous changes in real exchange rates to identify the strategic relationship between sourcing behavior and price elasticities. As required by Proposition 2, exchange rate fluctuations simultaneously affect the costs for all products manufactured abroad. To see the benefit of this result suppose that the unobserved offshoring costs for specific varieties, β_n, were inversely related to consumer price elasticities, ϵ_n. Then we would observe a spurious positive relationship between price markups and offshoring intensity across products. The insights from Proposition 2 show how to circumvent this potential source of bias by using exchange rates that affect offshoring costs for all products.

[11] See Alchian and Allen (1964) and Hummels (2004) for discussions of the Washington apples effect across products with different qualities. Auer and Chaney (2009) argue that exchange rate pass-through can also vary according to consumer perceptions of quality. Similar arguments can be made for the elasticities of demand across different products.

6 Estimation

The key prediction of the model is that firms use their product lines strategically to ease wage bargaining pressures. Testing this prediction hinges upon consistent estimates of variety-specific price markups. We build from the procedure in Feenstra and Weinstein (2010) to estimate the price elasticities of demand, and thus markups, for the various products sold by multinational firms. The second step is to examine how firms respond to differences in markups when deciding where to source production.

6.1 Data

We employ data collected from *Ward's Automotive Yearbook* documenting monthly output from the universe of automobile plants across North America at the model level, for each month, spanning January 1988 through December 2009. For example, an observation records the number of Chevrolet Cavaliers produced at GM's Ramos Arizpe assembly plant in Mexico during May 1996. We define a variety within a firm as a specific model of car; e.g. Ford Taurus. Production at each plant is recorded only for cars that are sold in the US, consistent with the offshoring environment modeled above. We observe activity for all auto manufacturers that maintain a plant in North America. In our empirical analysis we distinguish between the Big 3 US firms (Chrysler, Ford and General Motors) and non-US manufacturers (Honda, Toyota, VW, etc.) which use plants in Mexico as export platforms to the US. These data allow us to (1) measure the intensity of foreign production and (2) measure product-level market shares, and thereby estimate price markups.[12]

We couple plant-level production data with information collected at the brand-month-country level from press releases regarding the initiation of talks between automakers and the UAW. For example, if workers in plants producing Buicks (the brand) are bargaining in the US, all varieties of Buicks (LeSabre, Regal, etc.) are facing UAW action. With each bargaining action in the US, we observe which party benefited from negotiations, the event of a strike, mass layoffs, bankruptcy filing or the event of a bailout. This will provide us with a detailed picture of the degree to which the UAW is pressuring an automaker. We use these data to control for the endogenous bargaining actions of workers and multinational firms.

Our identification strategy relies on exogenous changes in real exchange rates between the US and Mexico for identification. Producer price indexes for the production of automobiles and monthly nominal exchange rates between the US and Mexico were acquired from the *Banco de Mexico*.

(Insert table 1 near here)

[12] Blonigen and Soderbery (2010) discuss the importance of variety-level data when estimating elasticities and the benefits of product variety.

6.2 Estimating Markups and Elasticities

Firms sell to consumers with trans-log expenditure functions, implying price elasticities of demand given by

$$\epsilon_{ijt} = 1 - \frac{\partial \ln s_{ijt}}{\partial \ln p_{ijt}} = 1 + \frac{b(N_{it} - 1)}{s_{ijt} N_{it}},$$

where b is the translog substitution parameter, N_t the total varieties at time t, and s_{ijt} is variety i of product j's market share at t. Define μ as the elasticity of marginal costs with respect to output. In the theory we assume constant returns to scale, which implies $\mu = 0$. Here we relax the assumption of constant returns and require only that μ is constant. This modification to the cost function for multinationals (and therefore the prices they charge) does not alter the general predictions of our model, which allows for any form of price competition. Taking logs of the optimal pricing decision in equation (6), this iso-elastic cost structure yields the following pricing equation

$$\begin{aligned} \ln p_{ijt} &= \ln c'_{ijt}(\cdot) + \ln\left(1 + \frac{s_{ijt} N_{it}}{b(N_{it} - 1)}\right) \\ &= \frac{\mu_{i0}}{1+\mu} + \frac{\mu}{1+\mu} \ln s_{it} + \frac{\mu}{1+\mu} \ln E_{it} + \frac{1}{1+\mu} \ln\left[1 + \frac{s_{it} N_t}{b(N_t - 1)}\right] + \frac{\delta_{it}}{1+\mu}, \end{aligned}$$

under the assumption that $\ln c'_{ijt}(\cdot) = \mu_{i0} + \mu \ln\left(\frac{s_{ijt} E_{it}}{p_{ijt}}\right) + \delta_{ijt}$.

The log markup for each variety j, is given by $\ln\left(1 + \frac{s_{ijt} N_t}{b(N_t - 1)}\right)$. Feenstra and Weinstein (2010) demonstrate that a tractable method of estimating variable markups for each variety can be obtained by differencing the pricing and demand equations, by time and reference variety, and assuming errors are uncorrelated across independent product lines. Doing so yields the following estimating equation averaged over time,

$$\overline{Y}_i = \frac{\mu(b-1) - 1}{b(1+\mu)} \overline{X}_{1it} + \frac{\mu}{b(1+\mu)} \overline{X}_{2it} - \frac{1}{b} \overline{X}_{3it} + \frac{1}{1+\mu} \overline{Z}_{1it} + \frac{1}{b(1+\mu)} \overline{Z}_{2it} + \overline{\xi}_i. \tag{11}$$

The over-bar indicates averaging over time of the variables constructed by first and reference differencing, Δ^k, as follows:

$$\begin{aligned} Y_{ijt} &\equiv \left[\Delta^k ln(p_{ijt})\right]^2 \ , \\ X_{1it} &\equiv \Delta^k ln(s_{ijt}) \Delta^k ln(p_{ijt}) \ , \ X_{2it} \equiv \Delta^k ln(s_{ijt}) \Delta^k s_{ijt} \ , \\ Z_{1it} &\equiv \Delta^k ln\left(1 + \frac{s_{ijt} N_t}{b(N_t - 1)}\right) \Delta^k ln(p_{ijt}) \ , \ Z_{2it} \equiv \Delta^k ln\left(1 + \frac{s_{ijt} N_t}{b(N_t - 1)}\right) \Delta^k ln(s_{ijt}) \ , \text{ and} \\ u_{ijt} &\equiv \frac{1}{b(1+\mu)} (\Delta^k \epsilon_{ijt})(\delta_{ijt}). \end{aligned}$$

We use a nonlinear technique to estimate equation (11), which allows us to calculate elasticities of demand and markups for each product.[13] The estimator is conceptually identical to Feenstra (1994). It relies on heteroskedasticity of variety-level shares and prices to structurally identify the underlying supply and demand elasticities. Table 1 presents the average markup across firms and Table 2 displays the distribution within goods of the markup received from each variety. The estimator produces consistent estimates of market elasticities without the need of variety characteristics or instruments as in most industrial organization strategies (see Berry, Levinsohn and Pakes (1995) and Goldberg (1995) for comparison). We find considerable variation in the estimated elasticities and markups across products.[14] On average, high volume models such as compact cars tend to receive a lower markup when compared to more specialized varieties such as luxury vehicles or SUVs. With estimates of price markups in hand, the second step is to relate them to the production decisions of multinationals in the North-American auto industry.

6.3 Estimating the Impact of Price Markups on Sourcing Behavior

Our model predicts that producer, p, chooses the intensity of foreign production for each specific variety, i, based on its price markup and offshoring costs. With competitive labor markets in Mexico, and UAW pressure in the US and Canada, the pertinent measure of offshoring is the fraction of production for each variety that occurs in Mexico, $FracProdMex$. For each time period, t, we estimate the following

$$FracProdMex_{itp} = \beta_1 Markup_{itp} + \beta_2 \left(Markup_{itp} \times MexExch_t\right) + X_{itp}\Gamma + \gamma_i + \gamma_t + \zeta_{itp}. \qquad (12)$$

In our preferred specification the estimated price markup for each variety is measured using a five-month moving average, including two months ahead and two behind; none of the results depend on this specification. In the theoretical section we assumed that the production process exhibits constant returns to scale. Using the fraction, rather than the volume, of production that occurs in Mexico allows for more general production technologies. The model predicts that β_1 is positive, as car manufacturers allocate production of vehicles with high markups away from UAW workers. The model also predicts that firms respond to changes in offshoring costs, i.e. exchange rates ($MexExch_t$), differently depending on the markup of a variety. We

[13] Our markup estimator is slightly different than Feenstra and Weinstein (2010); they use industry-level data, and so rely on assumptions about how market shares are distributed across firms, and within countries, to establish consistency. With data at the product level within firms, we can relax these assumptions to establish consistency for estimated markups.

[14] Other methods to estimate price elasticities are available from Berry, Levinsohn and Pakes (1995) and Goldberg (1995). The former develops a random coefficient logit technique to estimate price elasticities and markups when consumers make discrete choices over highly differentiated goods. The latter describes a nested discrete choice structure of automobile purchases and utilizes observed consumer behavior to estimate markups. We estimate markups from translog expenditure structure, which does not rely on consumer or physical product characteristics during estimation. Note that Berry, Levinsohn and Pakes (1995) and Goldberg (1995) also examine the automobile industry. The estimated markups obtained here do not differ substantially from the estimates using either alternative method.

define the US-Mexico exchange rate as *pesos* per dollar, so that the predicted sign of β_2 is negative.

The terms γ_i and γ_t represent product and time fixed effects respectively. We estimate the model with fixed effects at several levels of aggregations (e.g., vehicle class and year fixed effects). However our preferred estimation strategy is the most disaggregated specification with variety fixed effects for each car model and month-by-year fixed effects. Given potential endogenous changes in market structure and product variety, we prefer to look within month and model for identification.

The vector X_{itp} comprises several time-specific, variety-specific, and producer-specific controls. The time varying controls include the real exchange rate between the US and Mexico, an indicator for months during the *peso* crisis beginning in December 1994 and ending January 1997, indicators for financial bailouts and bankruptcies of US auto manufactures. Note that month-by-year fixed effects subsume other time-specific variables of interest such as the Canada-US and North American free trade agreements, and monthly exchange rate levels. At the variety-level we account for the share of an individual product line in each manufacturer's total production; Eckel and Neary (2010) argue that firms will manage varieties at their core competency differently than fringe product lines. Finally, we include producer-level measures of the total number of foreign production facilities owned, monthly indicators for UAW action for any of the firm's product lines, and measures of total market share.

7 Empirical Results

7.1 Preliminary Evidence

The UAW possessed great influence upon US auto manufacturers with ranks upwards of 1 million at the beginning of our sample in 1988, and experienced a decline in membership to approximately 0.5 million members in 2009.[15] Across our entire sample, collective bargaining pressure is the reality of doing business for every car manufacturer. Figures 1 and 2 illustrate how automotive firms respond to union pressure by managing their product portfolio across borders.[16]

(Insert Figures 1 and 2 near here)

In figure 1, for each model within the fleets of Chrysler, Ford and GM, we plot the fraction of production that takes place in Mexico against estimated price markups. The raw data are consistent with strategic sourcing behavior: for each manufacturer there is a strong upward relationship between offshoring intensity and the estimated markup. These multinational firms allocate production of cars with high price markups

[15] Source: http://www.thetruthaboutcars.com/2011/04/uaw-membership-increases/.

[16] For clarity we suppress observations where offshoring intensity is either one and zero in figures 1 and 2. However in our regression analysis below we include all observations.

away from UAW workers. Even though these car companies differ across their core product lines, the effects of price markups are evident within firms who each face union bargaining.

Vehicles differ in several characteristics besides the price markup charged to consumers. Figure 2 groups car models according to their vehicle class (i.e., sedan, compact, SUV, light truck), and plots offshoring intensity against estimated markups. Across all vehicle classes there is positive relationship, consistent with the predictions of the model. In addition, looking within vehicle classes we see a positive relationship between foreign production and markups. Firms appear to take advantage of their full product variety in an attempt to ease bargaining pressure, rather than just vehicle class.

Figures 1 and 2 highlight the need for micro-level data to understand the relationship between multinational production and collective bargaining. Price markups vary at the variety-level, granting all firms a strategy to manage wage negotiations. Given the correlations in figures 1 and 2, we proceed to the regression results from equation (12) and use variation in offshoring costs, via real exchange rate fluctuations, to identify the causal implications of multinational firms strategically managing their product portfolio.

7.2 Estimation Results

Proposition 2 argues that a reduction in the cost to offshore production for all products will lead to smaller increases in foreign production intensity for varieties with relatively high price-markups. Hence the key prediction from the model is that the interaction between exchange rates and estimated price markups is negative. Evidence also in support of strategic sourcing behavior is a positive coefficient on the price markup variable, as firms locate higher fractions of their high markup models in Mexico to alleviate wage bargaining in the US and Canada. Table 3 provides the estimates from equation (12) for the Big 3 US auto manufactures. We report Newey-West standard errors in parentheses, which account for the first-stage estimation of markups.

For each specification in table 3, an appreciation of the dollar interacts negatively with estimated markups. In columns (1) through (4) we present estimates using fixed effects for vehicle class and brand (e.g., GMC or Mercury). In these specifications we identify firm behavior looking across similar varieties of automobiles. When the dollar exchange rate appreciates firms shift production towards Mexico. However the estimates in row three demonstrate that the reallocation of high markup cars to Mexico is significantly smaller, consistent with proposition 2. Columns (5) through (7) implement our preferred estimation strategy with model-specific and month-by-year fixed effects. Looking within car model the increase in foreign sourcing as offshoring costs fall is smaller when markups are relatively high. The coefficient estimates in columns (5) through (7) imply that, given a depreciation of the *peso* by a one standard deviation, the increase in foreign sourcing is

approximately 0.5 percent smaller for varieties with a price markup one percentage point above the mean, and nearly 2 percent for a good with markup one standard deviation above the mean. The estimate is significant with high degrees of confidence and stable to the inclusion of controls for producer-specific features, union action, and other measures of offshoring costs.[17]

The coefficient estimates on the control variables are also as anticipated. Owning more plants in Mexico is positively associated with offshoring intensity. Clearly the choice of having a foreign production facility is endogenous to the sourcing behavior across product lines. A unique feature of our data is the monthly measures of production. This fine level of observation allows us to examine the sourcing behavior of multinational firms using short-run variation, and control for production capacity which was fixed in previous time periods. In columns (1) and (3), the share of production for a specific model in each company is negatively associated with Mexican production; multinational firms may be less likely to offshore products near their core competency. At face value, the coefficient on UAW action suggests that firms move production out of Mexico to mollify union workers when they take action. However the endogeneity issue surrounding this variable makes the coefficient on collective bargaining action impossible to interpret.

As was evident in figures 1 and 2, there is a positive coefficient on the markup variable. However, the estimated coefficient is volatile across similar regression models, suggesting that other unobserved product features that are correlated with the markup may be at play. The fact that exchange rates exogenously affect the cost to offshore all varieties simultaneously allows us to circumvent any potential bias from a correlation between markups and variety-specific offshoring costs. The interaction between offshoring costs and price markups (row three in table 3) provides the best evidence of strategic sourcing behavior. Using exchange rate fluctuations for identification also distinguishes the influences of wage bargaining from the potential "Washington apples" effect. Alchian and Allen (1964) argued that if fixed costs are required in production (say to maintain offshore facilities), then firms may only choose to offshore goods with high price markups, where the fixed investments can be recovered more easily. When the *peso* depreciates, the incentives to offshore high markup varieties to cover fixed costs grow, while the wage bargaining motives dictate that offshoring of high markup varieties should be relatively smaller. The negative coefficients on $Markup_{itp} \times MexExch_t$ in table 3 support the wage bargaining motives derived above.

Using exchange rates to measure variation in offshoring costs does raise concerns about a potential source of bias. We want to be sure that the estimated relationship between exchange rates and markups reflects sourcing behavior, rather that an underlying correlation due to varying levels of pass-through. Goldberg

[17]Month-by-year fixed in columns (5)-(7) subsume the effects of monthly exchange rate levels, the peso crisis and time trends estimated in columns (1)-(4).

(1995) shows there is a systematic relationship between markups and exchange rate fluctuations within the automobile industry: when offshoring costs fall so do demand elasticities, leading to higher markups. The positive correlation between exchange rate movements and markups biases the estimates against finding evidence that firms source production in response to wage bargaining pressure.[18]

In the theory presented above multinational firms originate solely in the home market. However the automotive industry comprises several non-US companies that use Mexican production facilities as export platforms to the United States. The motives for non-US manufacturers, such as Toyota and Honda, to build production in North America include the opportunity to avoid transportation costs from their domestic facilities. Yet, when producing in North America foreign manufacturers still face a trade-off between offshoring costs in Mexico, and collective bargaining in the US. Table 4 presents the results from estimating equation (12) including observations from every car company that maintains a production facility in North America.

Strategic sourcing behavior across varieties with different price markups is still evident when the sample includes non-US auto manufacturers. The coefficient on the interaction between exchange rates and markups is stable at -0.005 across specifications, implying an average partial effect that is similar in magnitude to the estimates when only the Big 3 US firms are included in the sample. Even foreign companies that maintain production facilities outside North America still allocate production between the US and Mexico in a way that mitigates the consequences of wage bargaining with workers.[19]

In tables 3 and 4 we take advantage of the high frequency of observations in the data to examine sourcing behavior. One may be concerned that monthly changes in offshoring intensity are due to factors other than attempts to reduce negotiated wages. In table 5 we aggregate to the annual level and estimate equation (12) using model and year fixed effects. Looking across years multinational firms organize production such that high markup vehicles are produced in Mexico, away from UAW workers. Sourcing behavior on an annual basis is consistent with multinationals attempting to improve their wage bargaining position.

7.3 Alternative Specifications

Our empirical strategy exploits the fact that production in Mexico is not subject to UAW bargaining pressure. The fact that the North American auto industry is comprised of three countries, with only two subject to collective bargaining with workers, allows us to perform a falsification test for the strategic behavior of

[18] Moreover, looking across countries Goldberg (1995) finds that the level of exchange rate pass-through is similar for cars in the same vehicle class. By looking at sourcing behavior within car model, the presence of the bias in our estimates is likely to be small.

[19] Foreign auto manufactures within the US have chosen to locate largely in Right-to-Work states where union membership cannot be held as a condition of employment. Thus it is an empirical question whether or not foreign firms are similarly responsive to differences in labor market structure across countries. Note that by aggregating sourcing locations to the country level our estimates are biased against finding strategic behavior when foreign companies are included.

multinational firms. Shifting production of high markup cars to Canada is not a viable strategy to reduce negotiated wages. When the US exchange rate appreciates firms have no reason to reallocate production of low markup goods to Canada more intensively, as they do to Mexico when the *peso* becomes less expensive.

In table 6 we report estimates from equation (12) using the fraction of production that takes place in Canada as the dependent variable. For each specification we continue to use model-level and month-by-year fixed effects. In columns (1) through (4) we see that the sourcing behavior to Canada is the opposite of how automotive firms use Mexican production facilities. As expected, when offshoring costs fall multinational firms increase Canadian production more for varieties with high price markups. (See row three.)

The relationship between demand elasticities and trade costs has been the subject of recent attention in trade theory. Krugman (1980) argued that trade of goods with low markups is more responsive to changes in transport costs. Chaney (2008) shows the opposite is true when firms differ in productivity. As we consider the sourcing of different product lines, within firms, it is not clear which prediction would be most relevant. Regardless, the opposing signs on the interaction term of markups with the US-Mexico exchange rate in tables 3 and 4, and the US-Canada exchange rate in table 6, is irreconcilable with a pure trade cost effect in either Krugman (1980) or Chaney (2008). Given the differences in labor market structure, the opposing signs across countries are consistent with firms responding to wage bargaining.

The model above demonstrates that the relationship between worker bargaining pressure and foreign direct investment requires looking *across* product lines *within* multinational firms. This point is made clear in columns (5) and (6) of table 6; we ignore the micro-level demand characteristics for different product lines and consider only firm-level sourcing decisions. Multinational firms do not appear to respond to the presence of bargaining pressure without accounting for variety-level characteristics. Changes in the exchange rate have no discernible effect on the total offshoring intensity of each firm. Instead a multinational firm responds to changes in offshoring costs by moving the production of particular varieties abroad, and reallocating the production of other lines back to domestic facilities. Even with small net changes in offshoring intensity for a firm, its strategic allocation across product lines enables the multinational to be more effective during wage negotiations. Furthermore, we may not expect to see a systematic relationship between wage bargaining pressure and offshoring intensity across different average industry-level markups. As long as firms sell multiple products they will source production based on the relative markups for the specific goods in their portfolio.

Ideally, the regression in (12) would be estimated with fixed effects for both the manufacturer and the model of car produced. However, no model of car is produced by multiple companies, limiting the degrees of freedom available. We estimated the model using a normalization for all US auto manufacturers relative to

the behavior of a specific firm (GM). Differences in the propensity to use foreign sources is irrelevant after accounting for the number of foreign plants owned by each company. The effects of the price markup are also unchanged. Foreign plants are typically owned by the parent firm so that nominal fluctuations in exchange rates could be more meaningful to multinationals; although our preferred specification uses variation is real exchange rates, we examined nominal exchange rates and found identical results. As a final check we stratified the sample by quintiles of vehicle markups and examined the differential impacts of changes in offshoring costs. The effect of an exchange rate appreciation among vehicles in the bottom quintile of price markup is an order of magnitude larger than the effect for vehicles at the top quintile of markups, consistent with firms responding to wage bargaining pressure.

8 Conclusion

In the presence of wage bargaining pressure we have shown that the sourcing behavior of multinational firms is influenced by the price elasticities of demand for different products. The optimal strategy for multinationals is to offshore production of goods with high price markups more intensively. Employing bargaining workers to produce goods with high price elasticities increases the derived elasticity of demand for labor, which leads to lower negotiated wages. Our results highlight the need for information at the micro-level to understand the relationship between multinational production and collective bargaining. Ignoring the characteristics of individual product lines produced by the same firm clouds the relationship between multinational firm behavior and union pressure.

Our empirical analysis of sourcing behavior examined the automobile industry in North-America. We first estimated price markups for specific vehicles and then related the markup to offshore production intensity. The estimation strategy exploited differences in labor market structure across countries, and exogenous exchange rate fluctuations, to identify the differential response in offshoring intensity across varieties with different markups. The evidence is in strong support of firms sourcing production of individual vehicles in a manner that mitigates the consequences of wage bargaining.

While the focus of this analysis has been sourcing behavior at the product-level, strategic allocation of products can have a substantial effect on multinational behavior in the global economy. First of all, multinational firms are almost always multiproduct firms. Second, union density varies widely among nations that attract large amounts of foreign direct investment. As a result multinational firms face several opportunities to use their product portfolio to manage wage negotiations.

Appendix

A - Wage Bargaining and the Elasticity of Labor Demand:

Derivation the inequality in (9)

Define the ratio between the union payoff and firm profits at wage ω as

$$Z(\omega) = \frac{[U(\omega)\omega + (\bar{U} - U(\omega))r]}{\left[\sum_{n=1}^{N}\left(p_n^* x_n(p_n^*) - \alpha\beta_n q l(q)\int_0^{I_n^*} A(i)di\right) - \omega U(\omega)\right]}$$

The first-order-condition for the Nash bargaining solution to the collective bargaining agreement is

$$\psi Z(\omega^*)^{\psi-1}\left[U'(\omega^*)(\omega^* - r) + U(\omega^*)\right] + (1-\psi)Z(\omega^*)^{\psi}\left[\sum_{n=1}^{N}\left(MP_n^u - \omega^*\right)u_n'(\omega^*) - U(\omega^*)\right] = 0 \qquad \text{(A.1)}$$

Note that optimal hiring decision by the firm will equate the marginal product of union labor, MP_n^u, to the negotiated wage, ω^*. Substituting $MP_n^u - \omega^* = 0$ and then multiplying both sides of (A.1) by $\omega^*/U(\omega^*)$ we obtain

$$\psi Z(\omega^*)^{\psi-1}\left[\frac{U'(\omega^*)\omega^*}{U(\omega)}(\omega^* - r) + \omega^*\right] - (1-\psi)Z(\omega^*)^{\psi}\omega^* = 0 \qquad \text{(A.2)}$$

The elasticity of labor demand is $\eta_\omega = \frac{U'(\omega^*)\omega^*}{U(\omega)} < 0$. The we can apply the implicit function theorem to (A.2) to establish the result.

$$\frac{d\omega^*}{d\eta_\omega} = -\frac{Z(\omega^*)^{\psi-1}}{[S.O.C.\omega^*]}(\omega^* - r)\psi \geq 0$$

B - Foreign Sourcing and Changes in Offshoring Costs across Products:

Proof of Proposition 2

Proposition 2 states that $\frac{d^2 I_n^*}{d\epsilon_n d\alpha} \leq 0$. To prove this begin by differentiating the result from proposition 1 to obtain

$$\frac{d^2 I_n^*}{d\epsilon_n d\alpha} = \frac{\left[\frac{\partial^2\omega^*}{\partial\alpha\partial\eta_\omega}\frac{\partial\eta_\omega}{\partial\epsilon_n} + \frac{\partial\omega^*}{\partial\eta_\omega}\frac{\partial^2\eta_\omega}{\partial\alpha\partial\epsilon_n}\right][SOC.I_n^*] - \left[\frac{SOC.I_n^*}{\partial\alpha}\right]\left[\frac{\partial\omega^*}{\partial\eta_\omega}\frac{\partial\eta_\omega}{\partial\epsilon_n}\right]}{[SOC.I_n^*]^2} \qquad \text{(B.1)}$$

We will proceed in parts to sign each component above.

1.

From (5), the second-order-condition for cost minimization is $\alpha\beta_n A'(I_n^*)q > 0$. It follows that

$$\frac{SOC.I_n^*}{\partial\alpha} = \beta_n A'(I_n^*)q > 0. \tag{B.2}$$

2.

From (10), the relationship between the derived elasticity of labor demand and the price elasticity of demand for a specific product is $\frac{\partial\eta_\omega}{\partial\epsilon_n} = K_n^u$, which is simply the cost share of domestic union labor. Hence

$$\frac{\partial^2\eta_\omega}{\partial\alpha\partial\epsilon_n} = \frac{\partial K_n^u}{\partial\alpha} < 0 \tag{B.3}$$

3.

The remaining component is $\frac{\partial^2\omega^*}{\partial\alpha\partial\eta_\omega}$. We can apply the envelope theorem to the Nash Bargaining solution for wage negotiations in (7) to derive

$$\frac{\partial\omega^*}{\partial\alpha} = Z(\omega)^\psi(1-\psi)\left[\sum_{n=1}^{N} -\beta_n q \int_0^{I_n^*} A(i)diL(q)\right] \tag{B.4}$$

The next step is to take the cross-partial derivative of (B.4) with respect to η_ω. But there is no exogenous difference in the derived elasticity of labor demand (i.e. no differences in ϵ_n). Differentiating (B.4) with respect to η_ω captures only the changes in endogenous hiring decisions. So by another application of the envelope theorem, we have

$$\frac{\partial^2\omega^*}{\partial\alpha\partial\eta_\omega} = 0. \tag{B.5}$$

Substituting the signs of each component into equation (B.1) we have the following

$$\frac{d^2I_n^*}{d\epsilon_n d\alpha} = \frac{[0+(+)(-)](+) \ - \ [(+)][(+)(+)]}{(+)} < 0 \tag{B.6}$$

Since $\frac{dI_n^*}{d\alpha}$ is negative always, the inequality in (B.6) states that the changes in foreign sourcing intensity as offshoring costs vary is smaller for products with low elasticities of demand. Or equivalently, when offshoring costs decrease the intensity of foreign sourcing will increase relatively less for goods that have high markups. **Q.E.D.**

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Figure 1: Offshoring Intensity and Price Markups within Auto Manufacturers

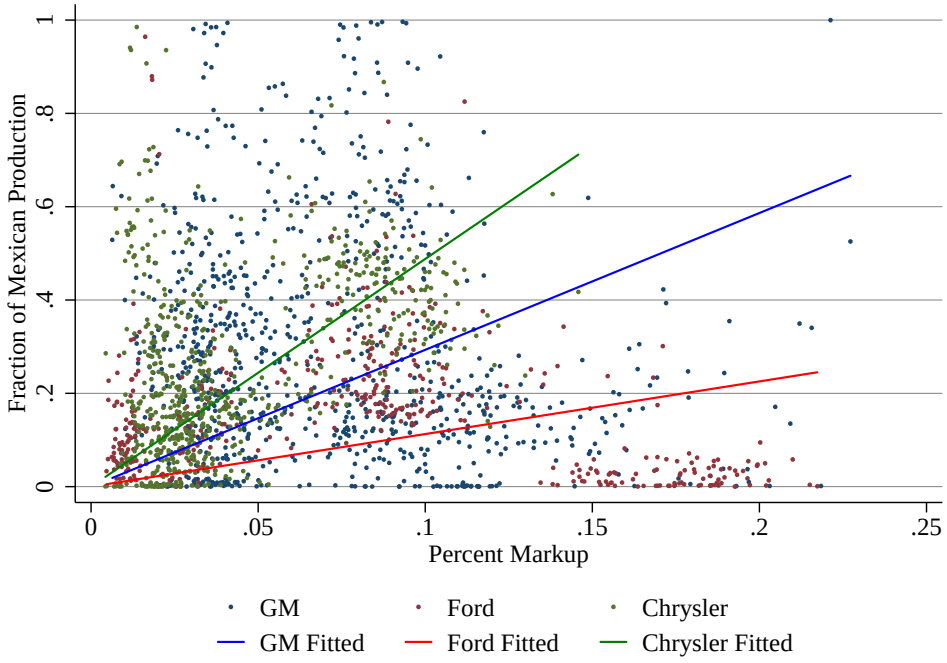

Figure 2: Offshoring Intensity and Price Markups within Vehicle Class

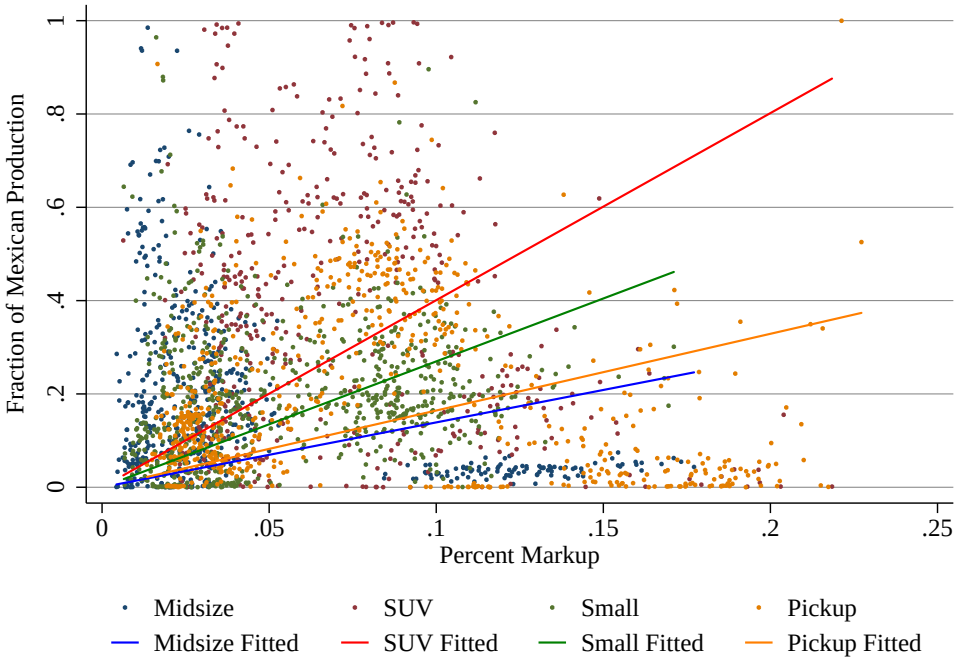

Table 1: Summary Statistics Across Firms

	Big 3			Non-US Companies		
Variable	Mean	Min	Max	Mean	Min	Max
$\frac{MexicanPeso}{\$US}$	6.847	0.213	14.670	6.847	0.213	14.670
NAFTA	0.710	0.000	1.000	0.862	0.000	1.000
Peso Crisis	0.147	0.000	1.000	0.117	0.000	1.000
Bankruptcy	0.002	0.000	1.000	0.000	0.000	0.000
UAW Action in the US	0.201	0.000	1.000	0.012	0.000	1.000
Plants in Mexico	1.831	0.000	3.000	0.550	0.000	2.000
Monthly Company Production (00000s)	3.237	0.007	5.851	0.692	0.000	2.560
Markup	1.159	1.000	4.400	1.103	1.000	5.432
Observations	22879			7633		

Table 2: Summary Statistics Across Vehicle Class

	Large	Luxury	Midsize	Pickup	Small	SUV	Van
Monthly Sales in the US	7037.88	3128.04	10555.01	16583.04	10127.50	6166.24	7852.97
Fraction of Monthly Production							
Canada	0.43	0.08	0.17	0.07	0.13	0.12	0.22
Mexico	0.00	0.01	0.05	0.10	0.26	0.07	0.00
US	0.57	0.90	0.78	0.83	0.61	0.81	0.78
Fraction of Monthly Production Given at Least One Plant in Mexico Produces the Class							
Canada	.	0.23	0.14	0.05	0.07	0.09	.
Mexico	.	0.42	0.13	0.18	0.38	0.16	.
US	.	0.35	0.73	0.77	0.55	0.75	.
Plants							
Canada	3.4	3.7	3.0	2.8	2.6	2.7	3.5
Mexico	1.7	1.5	1.4	1.5	1.4	1.5	1.8
US	16.2	17.5	13.8	13.4	11.1	12.9	15.9
Markup Percentile							
10th	1.017	1.011	1.007	1.004	1.007	1.010	1.183
50th	1.035	1.054	1.024	1.025	1.032	1.038	1.642
90th	1.072	1.152	1.091	1.155	1.096	1.132	2.814
Variety Substitutability (b)	2.773	0.434	0.748	0.499	0.810	0.362	0.068

Notes: Reported values are averaged over each variety (model) in a given month, except for Markup Percentile which describes the distribution of markups within the given product.

Table 3: Price Markups and Sourcing Behavior – The Big 3

	Fraction of Model Production in Mexico						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Markup	0.015***	0.004	0.015**	0.003	0.014***	0.007**	0.007**
	(0.006)	(0.003)	(0.006)	(0.004)	(0.004)	(0.003)	(0.003)
MexExch	0.037***	0.035***	0.016	0.014			
	(0.010)	(0.010)	(0.017)	(0.017)			
MexExch × Markup	−0.011***	−0.011***	−0.011***	−0.010***	−0.002***	−0.002***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Plants in Mexico	0.007*	0.008**	0.020***	0.021***	0.010***	0.009***	0.009***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)
$\frac{\text{Production of Model}}{\text{Production by Company}}$	−0.192***		−0.185***		−0.161**		
	(0.070)		(0.070)		(0.078)		
Total Company Production		−0.005**		−0.004		−0.012***	−0.012***
		(0.002)		(0.004)		(0.003)	(0.003)
Peso Crisis × Markup							−0.014
							(0.018)
Peso Crisis × Markup × MexExch							0.019
							(0.025)
UAW Action in the US	−0.044***	−0.044***	−0.046***	−0.047***	−0.014***	−0.016***	−0.016***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Bankruptcy	−0.020	−0.024	−0.015	−0.019	0.026	0.020	0.020
	(0.047)	(0.047)	(0.048)	(0.048)	(0.016)	(0.016)	(0.016)
Bailout	0.018	0.011	0.030	0.026	−0.016	−0.020	−0.020
	(0.054)	(0.054)	(0.055)	(0.055)	(0.023)	(0.022)	(0.022)
Trend	0.001***	0.001***					
	(0.000)	(0.000)					
Trend^2	−0.000**	−0.000*					
	(0.000)	(0.000)					
Trend^3	0.000**	0.000*					
	(0.000)	(0.000)					
Model FE	No	No	No	No	Yes	Yes	Yes
MonthXYear FE	No	No	No	No	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	No	No	No
Month FE	No	No	Yes	Yes	No	No	No
Product Class FE	Yes	Yes	Yes	Yes	No	No	No
Brand FE	Yes	Yes	Yes	Yes	No	No	No
R^2	0.177	0.177	0.179	0.178	0.004	0.004	0.004
N	22760	22760	22760	22760	22760	22760	22760

Notes: Newey West Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01.

Table 4: Price Markups and Sourcing Behavior – All North American Producers

	Fraction of Model Production in Mexico						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Markup	0.009**	0.010***	0.013***	0.014***	0.021***	0.020***	0.020***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
MexExch	0.010	0.010	−0.018***	−0.012*			
	(0.006)	(0.006)	(0.006)	(0.007)			
MexExch × Markup	−0.005***	−0.005***	−0.006***	−0.006***	−0.004***	−0.005***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Peso Crisis × Markup							−0.008
							(0.016)
Peso Crisis × Markup × MexExch							0.011
							(0.022)
Plants in Mexico	0.009***	0.010***	0.013***	0.014***	0.011***	0.011***	0.011***
	(0.003)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
$\frac{\text{Production of Model}}{\text{Production by Company}}$	0.001		0.004		−0.098***		
	(0.007)		(0.007)		(0.013)		
Total Company Production		−0.012***		−0.013***		−0.001	−0.001
		(0.002)		(0.003)		(0.002)	(0.002)
UAW Action in the US	−0.042***	−0.043***	−0.043***	−0.045***	−0.011***	−0.011***	−0.011***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Bankruptcy	−0.000	−0.019	−0.001	−0.019	0.013	0.011	0.011
	(0.047)	(0.047)	(0.047)	(0.047)	(0.017)	(0.016)	(0.016)
Bailout	0.042	0.023	0.051	0.036	−0.032	−0.037	−0.037
	(0.054)	(0.054)	(0.055)	(0.054)	(0.025)	(0.025)	(0.025)
Trend	−0.000	0.002					
	(0.001)	(0.001)					
Trend^2	0.000	−0.000					
	(0.000)	(0.000)					
Model FE	No	No	No	No	Yes	Yes	Yes
MonthXYear FE	No	No	No	No	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	No	No	No
Month FE	No	No	Yes	Yes	No	No	No
Product Class FE	Yes	Yes	Yes	Yes	No	No	No
Brand FE	Yes	Yes	Yes	Yes	No	No	No
R^2	0.415	0.416	0.418	0.419	0.038	0.033	0.033
N	30129	30129	30129	30129	30129	30129	30129

Notes: Newey West Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01.

Table 5: Price Markups and Sourcing Behavior at Yearly Aggregation – The Big 3

	Fraction of Model Production in Mexico				
	(1)	(2)	(3)	(4)	(5)
Markup	0.011*	0.021*	0.012*	0.012*	0.013**
	(0.006)	(0.012)	(0.006)	(0.006)	(0.006)
MexExch	0.014	0.025	0.023	0.021	0.021
	(0.015)	(0.017)	(0.016)	(0.017)	(0.017)
MexExch × Markup	−0.003**	−0.003**	−0.003**	−0.003**	−0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Peso Crisis				0.008	0.010
				(0.014)	(0.015)
Peso Crisis X Markup					−0.008
					(0.007)
Plants in Mexico		0.013*	0.013**	0.014**	0.014**
		(0.007)	(0.007)	(0.006)	(0.006)
$\frac{\text{Production of Model}}{\text{Production by Company}}$		−0.285			
		(0.312)			
Total Company Production			−0.000	−0.000	−0.000
			(0.001)	(0.001)	(0.001)
UAW Action in the US	0.006	0.006	0.006	0.005	0.005
	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)
NAFTA	0.003	−0.004	−0.003	−0.012	−0.013
	(0.012)	(0.011)	(0.011)	(0.020)	(0.020)
Bankruptcy	0.073**	0.063*	0.062*	0.065*	0.065*
	(0.036)	(0.036)	(0.036)	(0.037)	(0.037)
Bailout	−0.081**	−0.089**	−0.089**	−0.088**	−0.088**
	(0.038)	(0.039)	(0.039)	(0.039)	(0.039)
Trend	0.009	0.013*	0.012*	0.011	0.011
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Trend^2	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Trend^3	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Model FE	Yes	Yes	Yes	Yes	Yes
R^2	0.023	0.028	0.027	0.027	0.027
N	2001	2001	2001	2001	2001

Notes: Newey West Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01.

Table 6: Alternate Specifications

	Fraction of Model Production in Canada				Fraction of Firm Production in Mexico	
	(1)	(2)	(3)	(4)	(5)	(6)
Markup	0.113***	0.116***	0.104***	0.103***		
	(0.039)	(0.039)	(0.039)	(0.038)		
CanExch × Markup	0.077***	0.080***	0.082***	0.081***		
	(0.029)	(0.029)	(0.030)	(0.029)		
Plants in Canada		0.025***	0.026***	0.023***		
		(0.003)	(0.003)	(0.003)		
$\frac{\text{Production of Model}}{\text{Production by Company}}$		−0.240***				
		(0.057)				
Total Company Production			−0.009**	−0.006*		−0.008***
			(0.003)	(0.003)		(0.003)
UAW Action in the Canada				0.113***		
				(0.010)		
UAW Action in the US	−0.033***	−0.038***	−0.039***	−0.028***	−0.001	−0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Bankruptcy	−0.043	−0.029	−0.032	−0.039	−0.066*	−0.074**
	(0.027)	(0.026)	(0.026)	(0.025)	(0.036)	(0.036)
Bailout	−0.032	0.001	−0.002	−0.039	−0.021	−0.032
	(0.059)	(0.058)	(0.059)	(0.059)	(0.037)	(0.037)
MexExch					0.003	0.003
					(0.011)	(0.012)
NAFTA					−0.011	−0.013*
					(0.007)	(0.007)
Peso Crisis					0.004	0.003
					(0.005)	(0.005)
Trend					0.001**	0.000
					(0.000)	(0.000)
Trend^2					−0.000	−0.000
					(0.000)	(0.000)
Trend^3					0.000**	0.000
					(0.000)	(0.000)
Plants in Mexico						0.010**
						(0.005)
Model FE	Yes	Yes	Yes	Yes	No	No
MonthXYear FE	Yes	Yes	Yes	Yes	No	No
Brand FE	No	No	No	No	Yes	Yes
R^2	0.068	0.076	0.075	0.102	0.216	0.225
N	22760	22760	22760	22760	2652	2652

Notes: Newey West Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01.