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Strategic sourcing and wage bargaining ☆

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ABSTRACT

We examine how multinational firms strategically source production to mitigate the consequences of wage bargaining with workers. When wage bargaining pressure differs across countries, firms allocate production of goods with high markups toward countries with relatively competitive labor markets, limiting the rents available to workers with strong bargaining power. We use product-level data from the universe of automotive production facilities in North America at a monthly frequency between 1988 and 2009 to structurally estimate variable price elasticities of demand for different vehicles. From the theory we derive an empirical strategy that allows us to distinguish the impact of wage bargaining pressure from other sourcing motives. We find robust evidence that multinational firms strategically source their products across countries in response to differences in wage bargaining pressure.

1. Introduction

Despite the popular concern in developed nations that multinational firms source increasing amounts of production from developing countries with low-wage levels, there is little evidence that offshoring activities respond to observed international wage differences.[1] In fact, many studies have reported a puzzling finding that multinationals source production from countries with relatively high wage levels, not lower.[2] These results seem to suggest that multinational firms do not take advantage of opportunities to reduce their wage bill when deciding where to source production. Yet, a common approach when examining foreign sourcing decisions by multinationals is to consider wages that are determined in competitive settings. In reality, multinationals often have to bargain with workers over wages, and the bargaining power held by the labor force often differs across countries. Rather than simple differences in competitive *wage levels*, we argue that multinationals respond strategically to differences in *wage bargaining pressure* when deciding whether to locate production in a developing country.

The impact of wage bargaining pressure on global investment decisions, as distinct from wage levels, may be important to policy makers in the developing world. Many developing nations pursue economic strategies designed to attract inbound foreign investment. And while market wages are not under the direct control of policy makers, the

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[1] See for example the seminal analysis in Aitken et al. (1996). Subsequent studies have shown that the strongest and most consistent predictors of foreign investment are country size and the relative distance between investment partners. Rather than international wage differences, Blonigen et al. (2007), Bergstrand and Egger (2007) and Blonigen and Piger (2011) argue that gravity models that include measures of host and parent country GDP levels and distance perform best as explaining multiple measures of foreign investment. In addition, di Giovanni (2005) shows that a key mode of FDI, cross-border M&A, does not have a robust relationship with international wage differences. Similarly, Chakrabarti (2001) finds no robust impact of host country wage levels on FDI flows.

[2] Wei (2000) finds that inbound FDI stocks are larger in high wage countries. Also, Blonigen et al. (2003) use differences in average skill between countries to proxy for differences in competitive wage levels, and show that large differences between home and destination countries' skill endowments are unexpectedly associated with smaller measures of foreign affiliate sales.

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institutional policies that support workers' rights to form collective bargaining units, create mediation and arbitration procedures, or require the hiring of union workers are each within the policy scope of developing nations.[3] It is important to recognize that shifts in these policies can alter the inflow of investment from abroad.

This paper examines a new mechanism by which multinational firms respond strategically to wage bargaining pressure, by choosing to offshore different products within their portfolio based on the price markups that they charge consumers. A multinational firm can improve its bargaining position without large changes in the total volume of foreign production, the stock of foreign investment, or even in foreign and domestic employment levels. Instead, multinational firms can take advantage of offshoring possibilities by moving particular products abroad, and allocating specific products to domestic facilities. A strategic allocation across product lines enables the multinational to be more effective during wage negotiations. To be specific, 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. This strategy makes the rents to be divided highly sensitive to labor costs, and as a result bargaining workers cannot effectively seek higher wages.[4]

In practice we do see anecdotal evidence of firms engaging in strategic sourcing behavior across products in response to wage bargaining pressure. In the North American automotive industry, unionized workers (i.e., the UAW) face concerns about production to Mexico, where bargaining power among the labor force is much lower. A 2011 resolution by the UAW explicitly sets the strengthening union bargaining power of in developing countries, such as Mexico, as one of its own bargaining initiatives[5]:

> *"Our continued ability to win contracts that improve the compensation and working conditions of our members can be strengthened by negotiating international standards of conduct that limit the ability of employers to pit workers in one country against workers in another."*

Relative differences in bargaining power across countries have important implications for international investment decisions outside North America as well. The Italian automaker Fiat recently had to contend with its domestic union workers when it purchased a production facility in Serbia, a developing country where wage bargaining pressure is much lower. The Italian union workers fought the automaker specifically over which vehicles would be produced in the Serbian plant, citing the fact that Fiat had not hired Italian workers in many years to produce newly released models which typically have higher markups.[6] These specific anecdotes in North America and Europe each suggest that multinational firms do respond strategically to differences in wage pressure across countries, and that one of their key strategies lies within how they manage the sourcing decisions for different products. Our goal is to first provide a rigorous analysis of such sourcing behavior, and then use direct measures of offshore production and price markups for various products to empirically identify strategic sourcing by multinational firms.

We build a theoretical framework that incorporates offshoring possibilities for imperfectly competitive multinational firms. Domestic workers belong to a union that collective bargains over wages, but foreign labor markets are competitive. Multinational firms are also multiproduct firms, and must decide the intensity of foreign production for each product line. Consumer tastes vary across products so that firms select different markups for different goods in their portfolio. For any given set of products that a firm produces, we show that the optimal strategy for multinational firms is to use bargaining workers to manufacture products with low price markups more intensively.

The second component of our analysis tests the predictions of the model by examining the sourcing decisions of automobile manufacturers across the universe of North-American production facilities. Our empirical analysis of sourcing behavior centers on the automobile industry in North-America for two reasons. First, the labor force for this industry belongs to a large union in the US and Canada, while plants in Mexico can hire workers from relatively more competitive markets. The Canadian Auto Workers union and the United Auto Workers union in the US are among the largest collective bargaining groups in the world, and since the US–Canada Auto Pact in 1965 these two unions have engaged in highly coordinated bargaining actions.[7] On the other hand, unionization of Mexican autoworkers is relatively decentralized, with membership often limited to a single plant or specific company in a geographic region. The Mexican labor force has historically low and rapidly declining union membership (Fairris and Levine, 2004), and has little ability to extract rents, especially in northern regions where automotive production is highly concentrated (Shaiken and Herzenberg, 1987).[8] These differences in bargaining pressure across countries within the automotive sector allow us to identify strategic responses of multinational firms in their foreign sourcing decisions.

A second reason to focus on the automotive industry is that every multinational firm in the industry manufactures several classes of automobiles including sedans, trucks, passenger vans and compacts. The elasticities of consumer demand (and thus markups) differ across these product lines, allowing firms to manipulate wage bargaining outcomes by varying offshoring intensity across products. We use variation in price markups within and across products over time, to identify the varying incentives of firms to offshore production because of strategic wage considerations.

Our empirical strategy occurs in two stages. In the first stage, we structurally estimate the demand elasticities, and thus price markups, for various models of automobiles from a translog expenditure system. The procedure builds from Feenstra and Weinstein (2010). Given our product-level sales data we are able to relax many of the structural assumptions implicit in their methodology regarding the distribution of market shares. The estimated elasticities for each product line (i.e., each model of automobile) are time varying and are consistent with homothetic consumer preferences. Our estimated elasticities from the translog expenditure system are highly consistent with demand

[3] Furthermore, developing nations often enter agreements about labor market standards and collective bargaining rights along with international trade and investment agreements. For example, Mexico and the US entered the North American Agreement on Labor Organization (NAALC), which was the labor side-agreement that was signed with the North American Free Trade Agreement.

[4] Rodrik (1997) makes a complementary argument that globalization could allow multinational firms to shift production across locations, which raises the derived elasticity of labor demand and therefore affects wage bargaining outcomes. Our approach is distinct in that we show how firms can strategically manipulate bargaining outcomes by allocating specific products across locations, rather than moving large production volumes to developing countries. The strategy we describe is also distinct in that multinational firms respond specifically to differences in wage bargaining pressure, and does not rely on differences in wage levels across countries. Previous studies have examined labor demands given the fact that multinationals are relatively footloose; i.e., with foreign production capacity in place a multinational can respond to productivity shocks by shifting the volume of production across plants more easily, leading to higher elasticities of labor demand. This footloose nature of multinationals has been demonstrated empirically by Fabbri et al. (2003) and Senses (2010). The former finds that multinational firms in the UK exhibit a higher elasticity of labor demand than is observed among their domestic counterparts, while the latter shows that increase exposure to offshoring in recent decades has raised the elasticity of labor demand for production workers in the US. Also see Slaughter (2001), Hasan et al. (2007), and Gorg et al. (2009).

[5] See page 52 of the 2011 Approved Resolution to the Special Convention on Collective bargaining, within the section on International Corporate Conduct.

[6] Many details of the ongoing feud between Fiat and Italian union workers is discussed in the *Financial Times* story "Fiat: Marchionne's gamble" from 2012. Moreover, Fiat's acquisition of a large stake in the US automaker Chrysler in 2010 has put new pressure on Italian workers to ease their bargaining position, and accept more flexible labor contracts. The ultimatum given to Italian union workers by Fiat, that they must accept American style contracts, has led to comparisons of the its CEO Sergio Marchionne to the so called 'English union buster' Margaret Thatcher.

[7] See Abowd and Lemieux (1993) for evidence that collective bargaining units in the U.S. are able to extract significant rents from automotive firms.

[8] There is further evidence that this limited bargaining power among Mexican workers has had a substantial impact on real wages in Fairris (2003).

elasticities obtained for automobiles from other standard approaches, and none of our results depend on the methodology used to estimate price markups.[9] In the second stage of our empirical strategy, 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. From the theory we develop an empirical specification that allows us to distinguish sourcing behavior in response to differences in wage pressure from alternative motives to offshore production – including the possibility to pass-through exchange rate movements onto consumers, avoid market power held by shipping companies, or cover fixed costs of offshore production. Production and sales data come from Ward's Automotive Yearbook at monthly intervals across the universe of North American auto plants by make and model, which generates a panel of observations spanning 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 each vehicle class, for each of the Big 3 US auto manufacturers. To address concerns about endogeneity of markups and sourcing behavior we exploit the panel nature of our data and control for firm-, product-, and time-specific characteristics. Looking within each vehicle model, the share of production located in Mexico is greater when price markups are relatively high. Consistent with the predictions of the model, we also show that when the *peso* depreciates, multinationals reallocate production of vehicles with higher markups toward Mexico relatively less.[10] As exchange rates vary, we observe reallocations of specific vehicles in response to wage pressures on the order of several thousands of automobiles per year. In short, the estimated effects suggest that strategies of multinational firms to exploit international differences in wage bargaining pressure constitutes a substantial amount of economic activity.

The evidence in support of multinationals making offshoring decisions in response to differences in wage pressure across countries is robust to several specifications of price markups, as well as to controls for union actions over time, production scale, number of plants, and inclusion of companies that use Mexico and Canada as export platforms to the US. As a final check of our results we use production intensity in Canada, where bargaining pressure is also strong, to perform a falsification test. 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.[11]

2. Related literature

Our analysis of offshoring behavior amid union bargaining is distinct from previous studies in that we consider firms' strategic behavior across product lines with varying price markups, rather than firms seeking to exploit differences in their production technologies; see for example contributions by Staiger (1988), Skaksen and Sorensen (2001), Skaksen (2004), and Lommerud et al. (2006, 2009). Perhaps the closest analysis to ours is Lommerud et al. (2012), which demonstrates that differences in bargaining power between North and South countries can affect technology transfers within multinational firms, as opposed to the allocation of specific product lines within multinational firms. Rather than consider differences in bargaining power across countries, a separate literature has also examined how globalization affects the bargaining power held by union workers within a particular country; see Brock and Dobbelaere (2006), Dumont et al. (2006), and Ranjan (2013).

This study also contributes to the burgeoning literature on multiproduct firms in open economies by examining offshoring decisions by multinational firms. 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.[12] Yet, 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, and Markusen (2002) shows that foreign affiliate sales have grown faster than exports in recent decades. In this paper we demonstrate that the sourcing behavior of multinational firms is influenced by the price elasticities of demand for their different products, and has substantial effects on the scale of production across countries.

3. Theory

3.1. The 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 products 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.

3.1.1. Consumption

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

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

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 $b_{nn} = -b\left(\hat{N}-1\right)/\hat{N}$ and $b_{nm} = b/\hat{N}$.[13] From Eq. (1) the market share for a specific product n is

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

[9] We adopt the translog expenditure system primarily for ease of exposition. Assuming homothetic preferences, which are consistent with translog expenditures, simplifies the model and allows us to highlight the strategic sourcing behavior of multinationals in response to wage bargaining.

[10] 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.

[11] Alchian and Allen (1964), Hummels and Skiba (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 is subject to transport costs, the opposing response to changes in offshoring costs across countries supports the wage negotiation motives for foreign sourcing derived below.

[12] Eckel and Neary (2010) argue that the selection of products encourages firms to concentrate production on their core competency. See also Bernard et al. (2011) and Feenstra and Ma (2008).

[13] See Diewert (1974) and Feenstra (2003) for details about the translog expenditure system. None of the predictions of the model depend on the use of the translog expenditure function; the only requirement on preferences is that the elasticity of demand varies across products. Note that we have implicitly set the log of consumer utility to zero, with the implication that Eq. (1) is equivalent to the expenditure required to obtain a single unit of utility.

and its price elasticity of demand is given by the following identity

$$|\epsilon_n| \equiv 1 + \frac{b\left(\hat{N}-1\right)}{s_n \hat{N}}. \quad (3)$$

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

3.1.2. Collective bargaining

Domestic workers are members of union with total membership $\overline{U}$. 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 model predicts that employment levels depend only on the reservation wage of union labor, and not on the negotiated wage. We adopt the Labor Demand model given that our focus is on multinational firms that can respond to wage pressure by shifting the location of production and employment.[14]

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, across all of their products, $n = 1....N$. Each domestic worker has an employment opportunity outside the union that pays a wage equal to r, which is exogenous to negotiated wages. Hence the maximum feasible wage is

$$\omega^B = \underset{\omega}{argmax} \quad U(\omega)\omega + (\overline{U}-U(\omega))r, \quad (4)$$

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-ψ. 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. Note that each firm will pay the same negotiated wage level to all workers in the domestic country who manufacture any of its product lines, but wage levels may vary across firms.

3.1.3. Multinational firms and offshore production

In the first stage, multinational firms decide whether to locate production at home or abroad for each product in its portfolio. The pertinent example here is the automobile. Automakers produce several different classes of cars including sedans, compacts, trucks and passenger vans. Each of these products can be individually produced by either domestic or foreign labor.[15] Given their choice of a product portfolio, firms decide scale of production for each product in each location taking into account the differences in wage bargaining pressure across countries.

Product markets are imperfectly competitive so that multinationals act as price competitors over products sold in the home market. Each firm takes consumer preferences across products as given, and sets prices optimally facing the translog expenditure system. Firm pricing behavior follows Feenstra (2003) and Feenstra and Weinstein (2010), with multinationals producing several individual products. Note that we generally allow the consumer demand elasticities, and thus firm pricing behavior, to vary within and across vehicle classes. For example, firms account for the fact that two different models of sedans may be closer substitutes for consumers than are two different models of trucks, and they will choose prices accordingly.

Multinational firms can use foreign sourcing at differing intensities for each of their products, $n = 1....N$. Let i_n denote the intensity of foreign production for product n. The only input to production is labor, and in terms of productive efficiency, foreign and domestic labor are perfectly substitutable. However, the use of foreign labor cannot be separated from offshoring costs associated with foreign production. The cost of foreign labor is q. Given that firms may be able to strategically manipulate negotiated wages through their offshoring decisions for all products, the domestic union wage can be written as, $\omega(\mathcal{I})$, where $\mathcal{I}$ denotes the vector of offshoring decisions across all products within a particular multinational firm.

Offshoring costs are in terms of additional foreign labor that must be hired. We denote product-specific offshoring costs as β_n, while α is an offshoring cost that affects all product simultaneously. For example, CAFE standards set import barriers in the US based on specific emission levels of vehicles (corresponding to β_n), but exchange rate fluctuations affect the cost of importing all vehicles simultaneously (corresponding to α). Thus, the labor requirement necessary to offshore the fraction of production i_n, for product n, is given by $\alpha\beta_n i_n$. Then, given the share of production that occurs abroad, i_n, the unit cost function for any product can be written

$$c_n(q, \omega, \beta_n, \alpha, i_n) = (1-i_n)\omega(\mathcal{I}) + i_n\alpha\beta_n q. \quad (5)$$

Note that this specification of offshoring costs does not depend on the total volume of production, only the amount of foreign production. However, 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. We have also abstracted from fixed costs necessary to engage in offshore production. Again, this is simply for notational convenience; for interior solutions (i.e., where some offshoring takes place for product n) fixed costs will not influence wage bargaining at the margin. In our empirical analysis we will account for the possibility of fixed offshoring costs, and also control for the presence of existing foreign plants established by multinationals.

[14] 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).

[15] Note that our interest here is in the different sourcing decisions that firms make for each product within their portfolio when countries differ in wage bargaining pressure, which is distinct from the question of optimal product scope; i.e., which products multinational firms will choose to be part of their portfolio. For analyses of the choice of optimal product scope in an open economy see Eckel and Neary (2010), Bernard et al. (2011) and Feenstra and Ma (2008). We could add an additional stage to the model in which firms choose their product scope, as well as the domestic and foreign production scales for each product, but it would be a distraction. We leave the analysis of optimal product scope under wage bargaining pressure to future study.

3.2. Equilibrium

In this section we derive a sub-game perfect equilibrium that is characterized by the consumption price, the negotiated wage for each firm and the share of production that is sourced from the foreign country for each product. Equilibrium is characterized by the vector $\{p_n^*, \omega_n^*, i_n^*\}$ for all $n \in \hat{N}$, but note that ω_n does not vary across products within a firm that hires workers from the same union. We proceed using backward induction.

3.2.1. 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

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

3.2.2. Wage bargaining

With collective bargaining enforced in the domestic labor market the multinational firm and union labor must negotiate over wages. Each union seeks to maximize the payoff to its members; see Eq. (4). Firms seek a wage that maximizes profits across all product lines. Note that the total expenditure on product n is Es_n and so the total output of product n is given by Es_n/p_n. The non-cooperative outcome to the wage negotiations for a single firm is given by the unique Nash bargaining solution, which yields

$$\omega^*(\mathcal{I}) = \underset{\omega}{argmax} \quad \left[U(\omega(\mathcal{I}))\omega(\mathcal{I}) + (\bar{U} - U(\omega(\mathcal{I})))r\right]^{\psi}\left[\sum_{n=1}^{N} Es_n - \left(\frac{Es_n}{p_n}\right)c_n\right]^{1-\psi}. \tag{7}$$

All union workers who manufacture products $n = 1 \ldots N$ within the same firm will earn the same wage determined by Eq. (7). Generally Eq. (7) applies to all firms that face bargaining pressure, so that a repeated application of the Nash bargaining solution across firms determines wages for all products $\hat{N}$.

3.2.3. Sourcing decisions

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

$$\omega^*(\mathcal{I}) - \frac{d\omega^*(\mathcal{I})}{di_n^*}(1 - i_n^*) = \alpha\beta_n q. \tag{8}$$

The term $\frac{d\omega^*(\mathcal{I})}{di_n^*}$ represents the strategic ability of multinational firms to reduce domestic wages by offshoring specific products more intensively. A repeated application of Eq. (8) across all products determines sourcing decisions for all $n \in \hat{N}$.

The equilibrium vector $\{p_n^*, \omega_n^*, i_n^*\}$ lies at the intersection of Eqs. (6), (7) and (8) for each product and firm, respectively.

3.3. Strategic sourcing, price markups and wage bargaining

Multinational firms make their foreign sourcing decisions in anticipation of wage bargaining with union workers. In this section we first provide some simple intuition for the channel by which offshore production impacts negotiated wages. We then turn to our question of interest – How does the optimal sourcing behavior of forward-looking multinationals vary across products with different price markups?

3.3.1. Some intuition

Rodrik (1997) popularized the argument that established global production networks may allow multinational firms to negotiate lower wages with workers. He argues that the ability to shift production between locations raises the derived elasticity of labor demand, and when the rents to be divided are highly sensitive to labor costs, bargaining workers cannot effectively seek higher wages. To see this relationship formally, we differentiate the equilibrium wage in Eq. (7) with respect to the labor demand elasticity, $\eta_\omega = \frac{d \ln U(\omega^*)}{d \ln \omega^*}$:

$$\frac{d\omega^*}{d|\eta_\omega|} = \frac{(\omega^* - r)\psi}{A(\omega^*, i^*)} Z(\omega^*)^{\psi-1} \leq 0, \tag{9}$$

where $Z(\omega^*) > 0$ is the ratio of the union payoff to firm profits in equilibrium, and $A(\omega^*, i^*) < 0$ is an expression equivalent to the second-order-condition from the Nash bargaining solution for negotiated wages. (See Appendix A, B, C for a full derivation.)

The inequality in Eq. (9) demonstrates that — given sourcing decisions by firms — union wages are decreasing in the elasticity of labor demand. For imperfectly competitive firms, each producing N different products, this derived elasticity of labor demand is

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

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).[16]) We see in Eq. (10) that, rather than taking η_ω as given, the derived elasticity of labor demand depends on the sourcing behavior of multinational firms, proportional to the cost share of union labor for each product it produces, K_n^u. Hence, Eq. (10) suggests that forward-looking multinationals can affect wage bargaining outcomes by strategically varying the intensity of domestic production based on the price elasticity of demand for products, ϵ_n.[17]

3.3.2. Optimal sourcing strategies

The optimal sourcing decision of multinational firms is described by Eq. (8), where firms choose the fraction of foreign production for each product in anticipation of wage negotiations and pricing decisions. Here we are interested in how this strategic sourcing behavior differs for products with different price markups. Differentiating Eq. (8), with respect to price markups (or equivalently, ϵ_n) for a given multinational firm we obtain the following proposition:

[16] 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 Eq. (10) holds. The fact that the derived elasticity of demand resembles the case of perfect competition (see Hamermesh (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 that 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. In the empirical evaluation we also estimate models without assuming homothetic preferences to gauge robustness and still find identical results.

[17] Multinationals can also raise the elasticity of labor demand by responding to idiosyncratic shocks in costs in a 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 levels of substitutability between foreign and domestic labor. Lommerud et al. (2006) as firm makes a similar argument.

Proposition 1. *When domestic workers collectively bargain over wages, multinational firms will use foreign sources of production more intensively for product lines with relatively high price markups, all else equal.*

Proof. The proof is relegated to the Appendix. ■

Proposition 1 states that multinational firms will use domestic union labor to manufacture products with relatively lower price markups. If one ignores the relationship between consumer price elasticities and factor demand elasticities, the result in Proposition 1 may seem counterintuitive. Suppose that multinational firms 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 products with high markups, 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 Eq. (10), the elasticity of labor demand is greater for workers producing products 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.[18]

The result in Proposition 1 describes a strategic relationship between foreign sourcing decisions and differences in wage bargaining pressure across countries, but makes no prediction about wage levels. Firms are forward-looking to their sourcing decisions, and consider how offshoring the manufacture of certain products will impact negotiated wage levels. The simultaneity of firm offshoring decisions and negotiated wages implies that we must consider country-level differences in wage bargaining pressure to identify strategic sourcing behavior, whereas considering country-level differences in wages may lead to spurious conclusions. Consistent with this requirement, our empirical analysis below analyzes the sourcing behavior of multinational firms in the automotive industry in North America, where workers in the US and Canada have a strong union presence relative to Mexican workers.

To identify strategic sourcing behavior of multinational firms, the influence of price markups must also be separated from variation in production and offshoring costs that may be correlated with price markups in the data (i.e., holding all else equal). For the automotive industry, a salient reason that product-specific offshoring costs (β_n) might be correlated with price markups (ϵ_n) is the presence of CAFE standards for shipments of automobiles from Mexico. CAFE standards explicitly tie the import (offshoring) costs to the type of vehicle being imported. As a result, there is a potentially confounding correlation between the model specific costs to offshore production, and the markup charged for each model, which is not evident at the firm-level. Specifically, CAFE standards limit imports in accordance with the emissions level of vehicles. Since compact cars tend to emit lower volumes of CO_2, CAFE standards were less restrictive on imports of compacts. Moreover, compacts tend to have relatively lower markups, implying the potential for an underlying positive correlation between markups and offshoring costs.[19] We will focus on variation in markups *within* models over time to identify the strategic sourcing behavior of multinational firms who face differences in bargaining power across countries.[20]

Finally, it is important to recognize that although firms produce multiple product lines, each with different potential offshoring costs (β_n), they negotiate wages for workers across these product lines simultaneously. One result of this fact is that firms will not generally respond to shocks to offshoring costs for all products (α) in the same manner that they will respond to shocks to product-specific costs (β_n). Moreover, even though a change in α, due to, say, exchange rate fluctuations, impacts the costs to offshore all products symmetrically, the strategic response across products with different price markups is *not* symmetric. The next proposition makes this point formally.

Proposition 2. *When multinational firms face relatively strong wage bargaining from domestic workers, reductions in the cost to offshore all products, α, will lead to increases in the offshoring of all products, but relatively smaller increases in foreign sourcing for high markup goods within multinational firm's product portfolio.*

Proof. The proof is relegated to the Appendix. ■

The asymmetric response by firms across their product lines due to endogenous bargaining gives us a strategy to empirically identify strategic reallocations within product lines over time. Intuitively, for products with low markups – and thus high price elasticities – consumers are more responsive to changes in prices that arise following a reduction in offshoring costs. Thus, as the reduction in offshoring costs leads to a reduction in prices, there is a relatively larger increase in the sales of products with low markups. Firms will anticipate the fact that low markup goods will contribute relatively more to the increase in the rents available during wage negotiations. In order to soften the relative bargaining position of domestic workers following this transition, firms will act strategically by moving low markup goods to foreign facilities more intensively. As Proposition 2 states, although firms will increase offshoring of all products, the increases in foreign sourcing will be relatively smaller for products with high price markups.

The asymmetric response to simultaneous fluctuations offshoring costs, such as changes in real exchange rates, allows us to identify the strategic relationship between sourcing behavior and price elasticities. It is important to note that the asymmetric response in Proposition 2 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.[21] 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. Another possibility is that firms respond differently to changing offshoring costs across products with different price-markups because of the potential pass-though of exchange rate fluctuations. Goldberg (1995) shows that there is a systematic relationship between markups and exchange rate movements within the automobile industry: when offshoring costs fall so do demand elasticities, leading to higher markups – the implication being that we should observe larger increases in offshoring for high-markup goods as offshoring costs, as opposed to smaller increases that result from strategic wage bargaining motives.

[18] It is important to note that luxury vehicles and SUVs tend to have higher price markups on average, and are among the more technologically complex models to produce. Keller and Yeaple (2009) argue that technologically complex products are more difficult to offshore at the margin. We include fixed effects for different types of vehicles in our empirical analysis to account for differences in production techniques. However the fact that high markup goods are those that are also more difficult to offshore would only work against finding support for Proposition 1.

[19] Note that in the cross section, a positive correlation markups and product-specific offshoring costs will induce less offshoring of high markup goods in the cross section, working against finding evidence for Proposition 1.

[20] From a theoretical perspective there are alternative channels that might induce multinationals to use foreign sources to produce high markup goods as described in Proposition 1. For example, the "Washington apples" effect where a high markup is necessary to justify incurring costs of foreign production, or the potential to pass through transportation costs to consumers. Model-specific fixed effects will account for these incentives as well.

[21] See Alchian and Allen (1964) and Hummels and Skiba (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.

The key prediction to be tested is the strategic response of firms to differences in price markups described in Proposition 1. However, the potential confounding influences empirically of differences in offshoring costs across products or the presence of fixed offshoring costs, necessitate that we look at variation in markups within products over time. Proposition 2 is particularly relevant in this case as it describes how the offshoring of different products responds to variation in offshoring costs over time. Thus, taken together, Propositions 1 and 2 yield a set of predictions that allow us to distinguish multinational sourcing behavior in response to wage bargaining pressure from other potential motives.

4. Empirical analysis

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 product-specific price markups, which must be separated from the costs of production when only price and quantity data are observed. Because firms choose prices jointly with their production and offshoring decisions, we must simultaneously estimate consumer demand and producer supply elasticities, given production of identical products in different countries. Here we build from the procedure developed in Feenstra and Weinstein (2010) to estimate the price elasticities of demand, and thus markups, for the various products sold by multinational firms, but note that other common methods generate nearly identical results.[22] We obtain time varying price markups across products (vehicles). The second step in our empirical strategy is to exploit this panel of information to examine how firms respond to wage bargaining pressure when deciding where to source the manufacture of products with different markups.

4.1. 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 product within a firm as a specific model of car; e.g., Ford Taurus. Production at each plant is recorded for all cars that are sold in the US. 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 and Canada as export platforms to the US. These data allow us to (1) measure the intensity of foreign production for each model and (2) measure market shares for each model, and thereby estimate price markups.[23]

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 Chevrolets (the brand) are bargaining in the US, all products of Chevrolet (Cavalier, Camaro, etc.) produced in the US are facing UAW action. With each bargaining action in the US, we observe which party initiated the 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 estimation strategy relies on exogenous fluctuations in real exchange rates between the US and Mexico and variation of markups within products for identification (Tables 1 and 2 document the variation of our controls). 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*. Additionally, *Ward's*, also contains information about production within Mexican plants that is sold to Mexican consumers, by month and by model. The variable $\frac{\text{Production for Mexico}}{\text{Production for US \& Mexico}}$ will be used as a control for potential selection biases that might arise if firms produce particular vehicle types to serve the Mexican auto market.

4.2. Estimating markups and elasticities

To ease the exposition of the model we have indexed each of a multinational firm's products by n, such that elasticities of substitution across products from Eq. (1) are symmetric across products. In reality, consumers are likely to view two different sedans and two different trucks as having varying levels of substitutability, and firms will adjust their price markups accordingly. Thus we generalize the estimation of markups across car models and within vehicle classes. Rather than the single index n, we denote each car model i as belonging to a particular vehicle class j, where the elasticity of substitution across products b_j varies across classes. Firms sell to consumers with translog expenditure functions, implying price elasticities of demand for model i of class j given by

$$\epsilon_{ijt} = 1 - \frac{\partial \ln s_{ijt}}{\partial \ln p_{ijt}} = 1 + \frac{b_j\left(N_{jt}-1\right)}{s_{ijt}N_{jt}},$$

where b_j is the translog substitution parameter, N_{jt} the total number of products in class j offered at time t, and s_{ijt} is product i of class j's market share at time t. Define μ_j as the elasticity of marginal costs with respect to output. In the theory we assume constant returns to scale, which implies $\mu_j = 0$ for all j. Here we relax the assumption of constant returns and require only that μ_j 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 Eq. (6), along with an iso-elastic cost structure yields the following pricing equation

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

[22] Other methods to estimate price elasticities (specifically in the case of automobiles) are available from Berry et al. (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 et al. (1995) and Goldberg (1995) also examine the automobile industry. Importantly, these alternative estimators are purely static by construction. We thus prefer the translog approach as it is a panel estimator that takes into account the times series of data within vehicle models. This is a key feature of our strategy which identifies strategic sourcing by looking within vehicle models over time. Additionally, the translog approach allows us to take advantage of the monthly variation in our data, while the alternative methods do not. That being said, we have also estimated markups using the approach in Berry et al. (1995). The two different approaches yield estimates that are positively correlated over the whole sample, and we obtain qualitatively similar results with the alternative estimates.

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

Table 1
Summary statistics across firms.

	Big 3				Non-US companies			
Variable		Mean	Min	Max		Mean	Min	Max
$\frac{Mex}{US}$ *ExchangeRate*		2.123	0.009	7.500		3.041	0.009	7.500
NAFTA		0.710	0.000	1.000		0.862	0.000	1.000
Peso crisis		0.097	0.000	1.000		0.080	0.000	1.000
Bankruptcy		0.002	0.000	1.000		0.000	0.000	0.000
UAW action in the US		0.232	0.000	1.000		0.013	0.000	1.000
Plants in Mexico		1.831	0.000	3.000		0.550	0.000	2.000
Monthly company production (00000s)		3.211	0.007	5.851		0.467	0.000	1.367
$\frac{\text{Production for Mexico}}{\text{Production for US \& Mexico}}$		0.010	0.000	0.998		0.022	0.000	0.994
Markup		1.159	1.000	4.400		1.103	1.000	5.432
Observations	22,879				7633			

Notes: Reported variables are averaged over the vehicle models in our sample. $\frac{Mex}{US}$ *ExchangeRate* is the real 100 Peso per US dollar exchange rate. NAFTA, Peso crisis, Bankruptcy and UAW action in the US are indicator variables recording whether a particular model experienced the event in a particular month. Plants in Mexico count the total plants each company has in Mexico. Markup are the estimated markups described in more detail below.

given the specification of marginal costs as $\ln\ c'_{ijt}(\cdot) = \mu_{i0} + \mu_j \ln\left(\frac{s_{ijt}E_{jt}}{p_{ijt}}\right) + \delta_{ijt}$.

The percentage markup for each variety i is given by $\frac{s_{ijt}N_{jt}}{b_j(N_{jt}-1)}$. Feenstra and Weinstein (2010) demonstrate that a tractable method of estimating variable markups for each product can be obtained by differencing the pricing and demand equations with respect to time and a reference product. The estimator is conceptually identical to Feenstra (1994). Intuitively, the estimation procedure considers changes in market share of models over time within specific vehicle classes as their prices change, and then compares the changes in market shares to a reference model. Formally, the procedure structurally identifies the elasticities of demand from the estimating equation,

$$\overline{Y}_{ij} = \frac{\mu_j\left(b_j-1\right)-1}{b_j\left(1+\mu_j\right)}\overline{X}_{1ij} + \frac{\mu_j}{b_j\left(1+\mu_j\right)}\overline{X}_{2ij} - \frac{1}{b_j}\overline{X}_{3ij} + \frac{1}{1+\mu_j}\overline{Z}_{1ij} + \frac{1}{b_j\left(1+\mu_j\right)}\overline{Z}_{2ij} + \overline{\xi}_{ij}. \tag{11}$$

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

$$Y_{ijt} \equiv \left[\Delta^k ln\left(p_{ijt}\right)\right]^2,$$

$$X_{1ijt} \equiv \Delta^k ln\left(s_{ijt}\right)\Delta^k ln\left(p_{ijt}\right), X_{2ijt} \equiv \Delta^k ln\left(s_{ijt}\right)\Delta^k s_{ijt}, X_{3ijt} \equiv \Delta^k ln\left(p_{ijt}\right)\Delta^k s_{ijt},$$

$$Z_{1ijt} \equiv \Delta^k ln\left(1+\frac{s_{ijt}N_{jt}}{b_j\left(N_{jt}-1\right)}\right)\Delta^k ln\left(p_{ijt}\right),$$

$$Z_{2ijt} \equiv \Delta^k ln\left(1+\frac{s_{ijt}N_{jt}}{b_j\left(N_{jt}-1\right)}\right)\Delta^k ln\left(s_{ijt}\right), \text{ and}$$

$$\xi_{ijt} \equiv \frac{1}{b_j\left(1+\mu_j\right)}\left(\Delta^k \epsilon_{ijt}\right)\left(\Delta^k \delta_{ijt}\right).$$

We use nonlinear least squares to estimate Eq. (11), and the resulting structural estimates allow us to calculate elasticities of demand and markups for each product. Our markup estimator differs slightly from Feenstra and Weinstein (2010); they use industry-level data, and so rely on assumptions about how product market shares are distributed across firms, and within countries. With data at the product level within firms, we can relax their assumptions about the market structure of the industry (i.e., we do not rely on Herfindahls to estimate Eq. (11)).

Table 1 presents the average markup across firms and Table 2 displays the distribution of markups across models within vehicle classes. We find considerable variation in the estimated elasticities and markups both within and across products and vehicle classes. On average, high volume models such as compact cars tend to receive a lower markup when compared to more specialized cars such as luxury vehicles or SUVs.[24] Notably, the patterns of our estimated markups are quite similar to those obtained from alternate methodologies.[25] 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.

4.3. Estimating the impact of price markups on sourcing behavior

Our model predicts that producer, p, chooses the intensity of foreign production for each model, i, in vehicle class j, 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 product destined for the US market that occurs in Mexico (denoted *FracProdMex*).

Corresponding to the predictions of the model, Fig. 1 looks within firms, over time and across vehicle classes. There we plot the average offshoring intensity across vehicle models within a class against their markups estimated in each month, for each of the Big 3 automotive companies.

While these simple plots do not control for any differences in characteristics across models, time or markets, the patterns are roughly consistent with predictions of the model. For both GM and Ford there is a strong positive relationship between the estimated markup and the propensity to locate manufacturing in Mexico. The raw patterns for Chrysler are less clear. Without controlling for additional features of their product portfolio there is seemingly no relationship between price markup and sourcing behavior of their production in Mexico.

In order to address the confounding scenarios discussed above, for each time period, t, we estimate the following:

$$FracProdMex_{ijtp} = \gamma_1 Markup_{ijtp} + \gamma_2\left(Markup_{ijtp} \times MexExch_t\right) + X_{ijtp}\Gamma + \phi_i + \phi_t + \zeta_{ijtp}. \tag{12}$$

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 and straightforward comparisons over time. The model predicts that γ_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 car

[24] Notably, the relatively high markup estimates for Vans are a direct consequence of the effects of the 2007 financial crisis, which coincided with the exit of a particular model of van (the Dodge Caravan). These anomalous estimates are limited to the crisis period exclusively, and all subsequent results in this paper are robust to discarding data during the crisis.

[25] Specifically, Berry et al. (1995) yields similar patterns of price markup estimates and qualitatively similar results in the following specifications.

Table 2
Summary statistics across vehicle class.

	Large	Luxury	Midsize	Pickup	Small	SUV	Van
Monthly sales in the US	7037.88	3128.04	10,555.01	16,583.04	10,127.50	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	
Number of 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
Markup standard deviation							
Within class	0.022	0.069	0.035	0.055	0.036	0.088	0.069
Within model	0.015	0.036	0.014	0.019	0.020	0.056	0.040
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 and Standard deviations which describe the distribution of markups within the given product.

model. We define the US–Mexico exchange rate as *pesos* per dollar, so that the predicted sign of γ_2 is negative.

The terms ϕ_i and ϕ_t represent product and time fixed effects respectively. We will 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 model fixed effects for each car model and month-by-year fixed effects. Given potential endogenous changes in market structure, we prefer to look within month for identification. Furthermore, using model fixed effects accounts for differences in production techniques and specific offshoring costs across products, β_n.

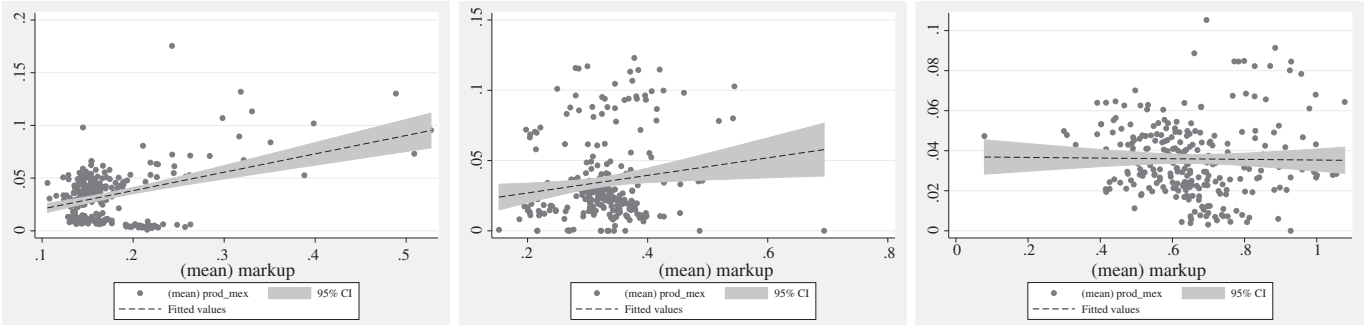
The vector X_{ijtp} comprises several time-specific, model-specific, and producer-specific controls. The time varying controls include the real exchange rate between the US and Mexico, an indicator for months during the *peso* crisis beginning in December 1994 and ending January 1997, indicators for 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 model-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 products 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 (e.g., explicit wage bargaining) for any of the firm's product lines, and the fraction of production destined for the Mexican market.

5. Empirical results

5.1. 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 (γ_2) 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 pressure in the US and Canada (i.e., $\gamma_1 > 0$). Table 3 provides the estimates from Eq. (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. All of our results are also robust to clustering standard errors at the firm-level.

In Columns (1) through (5) we present estimates using fixed effects for vehicle class (e.g., Truck) and brand (e.g., Chevrolet). In these specifications we identify firm behavior looking across similar types of automobiles in a manner similar to Fig. 1 above. Foreign sourcing is relatively higher for products that have high markups, consistent with the



(a) GM (b) FORD (c) CHRYSLER

Fig. 1. Fraction of production in Mexico against Markup.

Table 3
Price markups and sourcing behavior — The Big 3.

	Fraction of model production in Mexico								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Markup	0.006*	0.026***	0.015***	0.025***	0.015***	0.008***	0.014***	0.009***	0.010***
	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
MexExch	0.032***	0.034***	0.033***	0.016	0.015				
	(0.010)	(0.010)	(0.010)	(0.016)	(0.016)				
MexExch × Markup	−0.012***	−0.013***	−0.013***	−0.013***	−0.013***	−0.003***	−0.002***	−0.002***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\frac{\text{Production of model}}{\text{Production by company}}$		−0.192***		−0.188***			−0.109		
		(0.068)		(0.068)			(0.075)		
Total company production			−0.001		−0.001			−0.010***	−0.010***
			(0.002)		(0.003)			(0.003)	(0.003)
$\frac{\text{Production for Mexico}}{\text{Production of model}}$		0.935***	0.936***	0.934***	0.936***		0.199**	0.211**	0.211**
		(0.053)	(0.053)	(0.053)	(0.053)		(0.089)	(0.087)	(0.087)
Plants in Mexico		0.004	0.005	0.012**	0.013***		0.009***	0.009***	0.009***
		(0.004)	(0.004)	(0.005)	(0.005)		(0.003)	(0.003)	(0.003)
Peso crisis × Markup									−0.015
									(0.018)
Peso crisis × Markup × $\frac{Mex}{US}$									0.019
									(0.025)
UAW Action in the US		−0.042***	−0.042***	−0.045***	−0.045***		−0.015***	−0.016***	−0.016***
		(0.003)	(0.003)	(0.003)	(0.003)		(0.003)	(0.003)	(0.003)
Bankruptcy		−0.025	−0.027	−0.024	−0.025		0.025	0.021	0.021
		(0.041)	(0.041)	(0.042)	(0.042)		(0.016)	(0.016)	(0.016)
Bailout		0.013	0.009	0.024	0.022		−0.014	−0.017	−0.017
		(0.049)	(0.048)	(0.050)	(0.050)		(0.022)	(0.022)	(0.022)
Trend	0.001**	0.000*	0.000*						
	(0.000)	(0.000)	(0.000)						
Trend^2	−0.000	−0.000	−0.000						
	(0.000)	(0.000)	(0.000)						
Trend^3	0.000	0.000	0.000						
	(0.000)	(0.000)	(0.000)						
Model FE	No	No	No	No	No	Yes	Yes	Yes	Yes
Month × Year FE	No	No	No	No	No	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	No	No	No	No
Month FE	No	No	No	Yes	Yes	No	No	No	No
Product class FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Brand FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No
R^2	0.101	0.150	0.149	0.151	0.151	0.000	0.008	0.009	0.009
N	22,879	22,760	22,760	22,760	22,760	22,879	22,760	22,760	22,760

Notes: Newey West Standard errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01. Columns 1–9 regress the fraction of a vehicle model's production in Mexico on Markup and the pesos per dollar exchange rate (*MexExch*), along with additional controls including; the importance of the model within the company ($\frac{\text{Production for Mexico}}{\text{Production of model}}$), Mexican consumption of the model ($\frac{\text{Production for Mexico}}{\text{Production of model}}$), UAW bargaining affecting the US, whether the firm faced a bankruptcy or bailout, and the Peso crisis period.

predictions in Proposition 1. When the dollar exchange rate appreciates, firms shift production toward Mexico. However the estimates in row three demonstrate that the reallocation of high markup cars to Mexico is significantly smaller, consistent with Proposition 2. These results are robust to the inclusion of the various institutional and firm level controls described above.

While these results coincide with our theoretical framework, there is a possibility for confounding factors in the data. For instance, CAFE standards explicitly tie the import (offshoring) costs to the type of vehicle being imported. As a result, there is a potentially confounding correlation between the model specific costs to offshore production, and the markup charged for each model, which is not evident at the firm-level. We note, however, that an underlying positive correlation between price markups and demand elasticities due to CAFE standards only works against finding evidence in support of Proposition 1. To account for these issues, Columns (6) through (9) implement our preferred estimation strategy with model-specific and month-by-year fixed effects. This methodology should control for any heterogeneity in the levels of model-specific offshoring costs. Even when these fixed effects are included, we obtain estimates consistent with firms choosing their sourcing strategies in response to differences in wage bargaining pressure across countries.

The coefficient estimates in Columns (6) through (9) imply that, given a one standard deviation depreciation of the *peso*, the increase in foreign sourcing is nearly two percent smaller for a good with a 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.[26] Put differently, the estimated effects in Table 3 imply that variation in exchange rates lead to reallocations of specific vehicles in response to wage pressures on the order of several thousands of automobiles per year for each automotive manufacturer.

The negative coefficient on the interaction between markups and exchange rate distinguishes the influences of wage bargaining from the potential "Washington apples" effect. Extending the Alchian and Allen (1964) intuition to offshoring, if fixed costs are required in production (say to maintain offshore facilities), then firms may only choose to offshore goods with high quality (i.e., low demand elasticity/high markup), 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 $Markup_{ijtp} \times MexExch_t$ in Table 3 support the wage bargaining motives derived above. We also want to be sure that the estimated relationship between exchange rates and markups reflects strategic sourcing behavior, rather that an underlying correlation due to varying levels of pass-through in the automotive industry documented by Goldberg (1995). She finds that there is a positive correlation between exchange rate movements and markups on

[26] Month-by-year fixed in Columns (6)–(9) subsume the effects of monthly exchange rate levels, the peso crisis and time trends estimated in Columns (1)–(5).

Table 4
Price markups and sourcing behavior — All North American producers.

	Fraction of model production in Mexico								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Markup	0.015***	0.024***	0.024***	0.023***	0.024***	0.022***	0.025***	0.025***	0.026***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
MexExch	0.018**	0.019***	0.018**	0.011	0.009				
	(0.007)	(0.007)	(0.007)	(0.012)	(0.012)				
MexExch × Markup	−0.006***	−0.008***	−0.008***	−0.008***	−0.008***	−0.005***	−0.005***	−0.005***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\frac{\text{Production of model}}{\text{Production by company}}$		0.003		0.003			−0.021**		
		(0.009)		(0.009)			(0.010)		
Total company production			−0.005***		−0.008***			0.001	0.001
			(0.002)		(0.003)			(0.002)	(0.002)
$\frac{\text{Production for Mexico}}{\text{Production of model}}$		0.858***	0.855***	0.860***	0.858***		0.394***	0.401***	0.401***
		(0.047)	(0.047)	(0.047)	(0.047)		(0.052)	(0.052)	(0.052)
Plants in Mexico		0.002	0.002	0.004	0.004		0.008***	0.008***	0.008***
		(0.003)	(0.003)	(0.004)	(0.004)		(0.002)	(0.002)	(0.002)
Peso crisis × Markup									−0.013
									(0.016)
Peso crisis × Markup × $\frac{Mex}{US}$									0.012
									(0.022)
UAW action in the US		−0.041***	−0.041***	−0.043***	−0.044***		−0.012***	−0.012***	−0.012***
		(0.003)	(0.003)	(0.003)	(0.003)		(0.002)	(0.002)	(0.002)
Bankruptcy		−0.013	−0.019	−0.014	−0.026		0.010	0.010	0.010
		(0.041)	(0.041)	(0.042)	(0.042)		(0.016)	(0.016)	(0.016)
Bailout		0.031	0.024	0.036	0.028		−0.031	−0.031	−0.031
		(0.049)	(0.049)	(0.050)	(0.050)		(0.024)	(0.024)	(0.024)
Trend	0.001***	0.001***	0.001***						
	(0.000)	(0.000)	(0.000)						
Trend^2	−0.000	−0.000	−0.000						
	(0.000)	(0.000)	(0.000)						
Trend^3	0.000	0.000	−0.000						
	(0.000)	(0.000)	(0.000)						
Model FE	No	No	No	No	No	Yes	Yes	Yes	Yes
Month × Year FE	No	No	No	No	No	Yes	Yes	Yes	Yes
Year FE	No	No	No	Yes	Yes	No	No	No	No
Month FE	No	No	No	Yes	Yes	No	No	No	No
Product class FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No
Brand FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No
R^2	0.360	0.400	0.400	0.401	0.401	0.030	0.058	0.057	0.057
N	30,512	30,129	30,129	30,129	30,129	30,512	30,129	30,129	30,129

Notes: Newey West standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Columns 1–9 regress the fraction of a vehicle model's production in Mexico on Markup and the pesos per dollar exchange rate (*MexExch*), along with additional controls including; the importance of the model within the company ($\frac{\text{Production for Mexico}}{\text{Production of model}}$), Mexican consumption of the model ($\frac{\text{Production for Mexico}}{\text{Production of model}}$), UAW bargaining affecting the US, whether the firm faced a bankruptcy or bailout, and the Peso crisis period.

automobiles, which would only bias against us obtaining evidence that firms source production in response to wage bargaining pressure. Moreover, when looking across countries Goldberg (1995) finds that the level of exchange rate pass-through is similar for automobiles in the same vehicle class; since our preferred empirical strategy examines sourcing behavior within specific car models over time, the presence of any adverse bias in our estimates is likely small.

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. When included in the estimation, 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. We also control for institutional events. Brands facing direct union pressure through UAW bargaining events tend to scale back offshoring. Additionally, we consider the possibility that certain models are produced in Mexico to serve the Mexican auto market directly. While this does not directly confound our empirics as we define the fraction of production in Mexico for only those vehicles destined for the US market, it is possible that Mexican demand may be the underlying motive for offshoring. Fortunately, we also observe production of automobiles in Mexico that are destined for sale in the Mexican market. As expected there is a positive relationship between the fraction of production done in Mexico and the amount of production destined for Mexico. It is worth noting that the evidence in support of strategic sourcing behavior is robust to the inclusion or exclusion of any of these alternative control variables.

5.2. Alternative specifications

Our preferred estimates are those that take advantage of the high frequency of observation because, even though firms may not be physically running production of specific cars up or down within each month, multinationals do hold large inventories of products across countries. (Alessandria et al., 2010) argue that much of the time variation in international trade is the result of an inventory management problem, and provide evidence that importing firms tend to hold much larger inventory stocks. We observe automobiles produced by any given plant only when it is imported into the US. So, although US automakers may not physically run up or shut down production on a month-to-month basis, they can manage imports from their inventories

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*	0.022**	0.012*	0.013*	0.013*
	(0.006)	(0.010)	(0.007)	(0.007)	(0.007)
MexExch	0.014	0.025	0.024	0.021	0.022
	(0.015)	(0.017)	(0.016)	(0.018)	(0.018)
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 × Markup					−0.008
					(0.006)
Plants in Mexico		0.013*	0.013**	0.014**	0.014**
		(0.007)	(0.007)	(0.006)	(0.006)
$\frac{\text{Production for Mexico}}{\text{Production for US \& Mexico}}$		0.013	0.085	0.085	0.085
		(0.375)	(0.357)	(0.356)	(0.355)
$\frac{\text{Production of model}}{\text{Production by company}}$		−0.344			
		(0.308)			
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)	(0.009)	(0.009)	(0.009)	(0.009)
NAFTA	0.003	−0.005	−0.004	−0.013	−0.013
	(0.012)	(0.012)	(0.012)	(0.021)	(0.021)
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**	−0.087**	−0.087**
	(0.038)	(0.039)	(0.039)	(0.039)	(0.039)
Trend	0.010	0.014*	0.013*	0.012	0.012
	(0.006)	(0.007)	(0.007)	(0.008)	(0.008)
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	0.029	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. Columns 1–5 regress the fraction of a vehicle model's production in Mexico on yearly averages of Markup and the pesos per dollar exchange rate (*MexExch*), along with additional controls including; the importance of the model within the company ($\frac{\text{Production for Mexico}}{\text{Production of model}}$), Mexican consumption of the model ($\frac{\text{Production for Mexico}}{\text{Production of model}}$), UAW bargaining affecting the US, whether the firm faced a bankruptcy or bailout, and the Peso crisis period.

each month which then impacts the future relative demands for foreign and domestic workers. In either case, our evidence of strategic sourcing behavior of firms is not sensitive to considering production within a particular time frame. In Table 5 we aggregate to the annual level and estimate Eq. (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. The estimates of sourcing behavior on an annual basis remain consistent with multinationals attempting to improve their wage bargaining position.

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 Eq. (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 varies between −0.005 and −0.008 across specifications and is statistically significant at the 1% level, 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.[27]

5.3. Falsification

Our empirical strategy exploits the fact that production in Mexico is not subject to as strong of bargaining pressure as there is present in the US. The fact that the North American auto industry is comprised of three countries, with only the US and Canada subject to strong collective bargaining with workers, allows us to perform a falsification test for the strategic behavior of multinational firms. Shifting production of high markup cars to Canada is not a viable strategy to reduce negotiated wages where the Canadian Auto Workers union coordinates bargaining efforts with the UAW. When the US exchange rate appreciates firms have no strategic reason to reallocate production of low markup goods to Canada more intensively. Rather, we expect multinationals to respond to movement in the Canadian exchange rate consistent with motives to avoid high-cost transport or to manage pass-through of exchange rates to import prices. Hence for sourcing decisions in Canada, we expect a null or positive coefficient on the interaction of the markups and exchange rates.

[27] 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.

Table 6
Alternate specifications.

	Fraction of model				Fraction of firm	
	Production in Canada				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
Month × Year 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	22,760	22,760	22,760	22,760	2652	2652

Notes: Newey West standard errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Columns 1–4 regress the fraction of a vehicle model's production in Mexico on Markup and the Canadian per US dollar exchange rate(*CanExch*) as a counterfactual, while Columns 5–6 redo the regressions above less controls for strategic sourcing (e.g. Markup). Various controls include; the importance of the model within the company ($\frac{\text{Production for Mexico}}{\text{Production of model}}$), UAW bargaining affecting the US or Canada, whether the firm faced a bankruptcy or bailout, and the Peso crisis and NAFTA periods.

In Table 6 we report estimates from Eq. (12) using the fraction of production that takes place in Canada as the dependent variable. For each specification we continue to use our preferred specification with 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, as the exchange rate markup interaction is now positive and significant.

Finally, 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, in which 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.

5.4. Other robustness checks

Ideally, the regression in Eq. (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 have 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 are 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.

In our preferred specifications we have relied on variation in markups within models over time, primarily to circumvent concerns about unobserved differences in offshoring costs across vehicles and

concerns about pass-through of exchange rates differing across vehicle classes. An alternative strategy to address such endogeneity concerns is to instrument for current markups with lags. The IV strategy with lagged values generate nearly identical results.[28] 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.

6. 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. There are two insights to take away from our analysis. First, differences in wage bargaining pressure across countries can be just as important as differences in average wage levels in determining where multinationals firms choose to locate production. Second, the impact of wage pressure on offshoring decisions depends on the composition of products within firms. 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 Eq. (9)

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

$$Z(\omega)=\frac{U(\omega)\omega+(\overline{U}-U(\omega))r}{\sum_{n=1}^{N}\left[p_n^*x_n(p_n^*)-\alpha\beta_n q l(q) i_n^*\right]-\omega U(\omega)}$$

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

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

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 Eq. (A.1) by $\omega^*/U(\omega^*)$ we obtain

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

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

$$\frac{d\omega^*}{d\eta_\omega}=-\frac{Z(\omega^*)^{\psi-1}}{A(\omega^*,i^*)}(\omega^*-r)\psi\geq 0$$

where $A(\omega^*, i^*)$ is equivalent to the second-order-condition from the Nash bargaining solution for negotiated wages in Eq. (7). The inequality above follows immediately from the fact that $A(\omega^*, i^*)<0$, as negotiated wages are the solution to the maximization problem in Eq. (7), and thus the second order condition is negative.

Appendix B. Differences in foreign sourcing across products: Proof of Proposition 1

When deciding how to source products in the first stage the multinational treats ω^* and p^* as endogenous and chooses i_n^* to balance the costs savings from a lower negotiated wage at home against offshoring costs. Define the first-order-condition for offshoring intensity as $\Phi\equiv-\omega^*+\alpha\beta_n q+\frac{\partial\omega^*}{\partial i_n^*}(1-i^*)=0$. (For notational convenience, we suppress the dependence of ω^* on i_n.) Substituting optimal prices and negotiated wages and then applying the implicit function theorem we obtain

$$\frac{di_n^*}{d|\epsilon_n|}=-\frac{\partial\Phi/\partial\epsilon_n}{\partial\Phi/\partial i_n^*}=-\frac{-\frac{\partial\omega^*}{\partial|\epsilon_n|}+(1-i_n^*)\frac{\partial^2\omega^*}{\partial i_n^*\partial|\epsilon_n|}}{-2\frac{\partial\omega^*}{\partial i_n^*}+(1-i_n^*)\frac{\partial^2\omega^*}{\partial i_n^{*2}}} \tag{B.1}$$

Without loss of generality, set the reservation wage for union workers to zero; $r=0$. It will be convenient for notational purposes to define the term $\theta_m\equiv\frac{(1-i_m^*)\omega^*}{(1-i_m^*)\omega^*+i_m^*\alpha\beta_m q}$, which is the cost share of domestic union labor for product m. Note the following results:

$$\frac{\partial\theta_m}{\partial i_m^*}=\frac{-\frac{\alpha\beta_m q}{\omega^*}}{(1-i_m^*)\omega^*+i_m^*\alpha\beta_m q}<0, \tag{B.2}$$

and

$$\frac{\partial^2\theta_m}{\partial i_m^{*2}}=-\alpha\beta_m q\left(\frac{1-\frac{\alpha\beta_m q}{\omega^*}}{(1-i_m^*)\omega^*+i_m^*\alpha\beta_m q}\right)\leq 0. \tag{B.3}$$

We will proceed in parts to sign each component of $\frac{di_n^*}{d|\epsilon_n|}$ in Eq. (B.1).

[28] We have estimated the model with varying sets of lags from 1 to 6 months, and obtain identical results. Additionally, we have imposed more structure on the model as prescribed by Arellano and Bond (1991), which yields similar results.

1. First we derive the intuitive result that as demand elasticities rise, the negotiated wages fall.

$$-\frac{\partial \omega^*}{\partial |\epsilon_n|} = Z(\omega^*)^{\psi-1}\left[\frac{\psi Eb\left(\hat{N}-1\right)}{|\epsilon_n|^2\hat{N}}\theta_m + Z(\omega^*)^{\psi}(1-\psi)\left(\frac{Eb\left(\hat{N}-1\right)(2|\epsilon_n|-1)}{\hat{N}|\epsilon_n|^2(|\epsilon_n|-1)^2}\right)\right] \geq 0$$

2. Next, we calculate the strategic effect of changes in offshoring on wage bargaining outcomes.

$$\frac{\partial \omega^*}{\partial i_n^*} = Z(\omega^*)^{\psi-1}\left(\frac{\psi Eb\left(\hat{N}-1\right)}{|\epsilon_n|\hat{N}}\frac{\partial \theta_m}{\partial i_m^*}\right) < 0$$

3. Calculating the cross-partial derivative yields

$$\begin{aligned}\frac{\partial^2 \omega^*}{\partial i_n^* \partial |\epsilon_n|} &= -Z(\omega^*)^{\psi-1}\left(\frac{\psi Eb\left(\hat{N}-1\right)}{|\epsilon_n|^2\hat{N}}\frac{\partial \theta_m}{\partial i_m^*}\right) \\ &\quad -Z(\omega^*)^{\psi-2}(1-\psi)\left(\frac{\psi Eb\left(\hat{N}-1\right)}{|\epsilon_n|\hat{N}}\frac{\partial \theta_m}{\partial i_m^*}\right)\frac{\partial Z(\omega^*)}{\partial |\epsilon_n|} \\ &= -Z(\omega^*)^{\psi-1}\left(\frac{\psi Eb\left(\hat{N}-1\right)}{|\epsilon_n|^2\hat{N}}\right)\left(\frac{\partial \theta_m}{\partial i_m^*}\right) \\ &\quad \left[1+(1-\psi)\left(\frac{(2|\epsilon_n|-1)}{|\epsilon_n|^2(|\epsilon_n|-1)^2}\right)\left[\sum_{n=1}^{N}\frac{1}{|\epsilon_n|(|\epsilon_n|-1)}\right]^{-1} - \frac{(1-\psi)\theta_m}{\sum_{n=1}^{N}\frac{\theta_m}{|\epsilon_n|}}\right] > 0\end{aligned}$$

4. The second-order effect of an increase in offshoring on the negotiated wage level is

$$\begin{aligned}\frac{\partial^2 \omega^*}{\partial i_n^{*2}} &= (1-\psi)Z(\omega^*)^{\psi-2}\psi\left[\frac{Eb\left(\hat{N}-1\right)}{\hat{N}|\epsilon_n|}\frac{\partial \theta_m}{\partial i_m^*}\right]^2 \\ &\quad -Z(\omega^*)^{\psi-1}\left[\frac{Eb\left(\hat{N}-1\right)}{\hat{N}|\epsilon_n|}\frac{\partial^2 \theta_m}{\partial i_m^{*2}}\right] > 0\end{aligned}$$

Finally, by substituting the signs of the components above into Eq. (B.1) we obtain

$$\frac{di_n^*}{d|\epsilon_n|} = -\frac{-(-)+(1-i_m^*)(+)}{-2(-)+(1-i_m^*)(+)} < 0.$$

As the price elasticity of demand rises, its price markup falls. Thus the inequality above states that multinationals choose to offshore high markup goods to foreign countries more intensively.

Q.E.D.

Appendix C. Foreign sourcing and changes in offshoring costs: Proof of Proposition 2

Proposition 2 compares differential responses across different products, within the same multinational firm, to simultaneous changes in offshoring costs. Specifically Proposition 2 states that $-\left.\frac{d^2 i_n^*}{d|\epsilon_n| d\alpha}\right|_{[\{p_n^*\},\omega^*,\{i_n^*\}]} \geq 0$, where $\{p_n^*\}$ is the vector of equilibrium price levels across all products, the equilibrium wage is ω^* paid to workers producing any product, and the vector of equilibrium offshoring decisions is $\{i_n^*\}$. Note that in equilibrium prices are a function of offshoring costs $p_n^*(\alpha)$, and equilibrium wages are a function of prices. The equilibrium vector of offshoring choices, $\{i_n^*(\alpha)\}$, depends also on offshoring costs; see Eq. (8). Let $\{\epsilon_n\}$ be the vector of demand elasticity parameters across all products. We can then rewrite the result in Proposition 1 as

$$\frac{di_n^*}{d|\epsilon_n|} \equiv h\left(\{\epsilon_n\}, \{i_n^*(\alpha)\}, \omega(\{p_n(\alpha)\})\right) < 0$$

Now differentiate the result from Proposition 1 with respect to α and we obtain

$$-\frac{d^2 i_n^*}{d|\epsilon_n| d\alpha} = -\sum_{n=1}^{N} h_{i_n^*}\frac{di_n^*}{d\alpha} - h_\omega\left[\sum_{n=1}^{N}\frac{d\omega}{dp(\alpha)}\frac{dp(\alpha)}{d\alpha} + \frac{d\omega}{di_n^*(\alpha)}\frac{di_n^*(\alpha)}{d\alpha}\right] \quad (C.1)$$

where the partial derivative taken with respect to i_m^* is

$$h_{i_m^*} = \frac{\frac{\partial^2 \omega^*}{\partial i_n^* \partial |\epsilon_n|} + \frac{\partial^2 \omega^*}{\partial i_n^{*2}}}{\left(-2\frac{\partial \omega^*}{\partial i_n^*} + (1-i_n^*)\frac{\partial^2 \omega^*}{\partial i_n^{*\,2}}\right)^2} > 0 \quad (C.2)$$

Next, it is straight forward to establish, by applying the implicit function theorem to the first-order condition for offshoring decisions, ϕ, that offshoring levels fall when offshoring costs rise; i.e., $\frac{di_n^*}{d\alpha} < 0$ for all n. Finally, note that the last term in Eq. (C.1) is zero if we evaluate the impact of changes in offshoring costs across products *within* firms that pay the same wage for each of its product lines. Thus, then conditional on firm-level negotiated wages, the effect of falling offshoring costs is

$$-\left.\frac{d^2 i_n^*}{d|\epsilon_n| d\alpha}\right|_{[\{p_n^*\},\{\omega_n^*\},\{i_n^*\}]} = -\sum_{n=1}^{N} h_{i_n^*}\frac{di_n^*}{d\alpha} > 0 \quad (C.3)$$

It is worth noting that the effect of a reduction in offshoring costs across firms that pay different wages and have different average price markups, cannot generally be signed. (Across firms that potentially pay different wages, the sign of $-\frac{d^2 i_n^*}{d|\epsilon_n| d\alpha}$ cannot be determined.) Previous studies and Table 6 show evidence consistent with this indeterminacy, in that aggregated levels of offshoring show no response to differences in wage pressure across countries.

Q.E.D.

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