The Effect of Hold-up Problems on Corporate Investment: Evidence from Import Tariff Reductions*

Thorsten Martin[‡] and Clemens A. Otto[§]

June 2017

Abstract

We provide empirical evidence of the importance of hold-up problems for investment decisions in a large number of U.S. manufacturing industries. We exploit variation in the severity of hold-up problems between upstream suppliers and downstream customers resulting from import tariff reductions in upstream industries. We find that downstream customers respond by increasing investment. As theory predicts, the effect is stronger if the customers are not vertically integrated with their suppliers, if they have little bargaining power, if their suppliers produce differentiated inputs, and if high uncertainty inhibits the use of long-term contracts.

JEL classification: D23, F14, G31, L14

Keywords: Hold-up Problems, Corporate Investment, Supply Chains, Import Tariffs

---

*We thank Jean-Edouard Colliard, François Derrien, Olivier Dessaint, Thierry Foucault, Denis Gromb, Yun Lou, Jean-Marie Meier, Tomasz Michalski, David Thesmar, Philip Valta, Guillaume Vuillemey, seminar participants at Chinese University of Hong Kong, Frankfurt School of Finance and Management, HEC Paris, Hong Kong University of Science and Technology, MIT Finance Lunch, Nanyang Technological University, National University of Singapore, Singapore Management University, Tilburg University, University of Hong Kong, and participants at the 4th Annual HEC Paris Workshop on Banking, Finance, Macroeconomics and the Real Economy and the European Summer Symposium in Financial Markets 2016 in Gerzensee for helpful comments and suggestions. Any remaining errors are the responsibility of the authors. Clemens A. Otto gratefully acknowledges the financial support of Investissements d'Avenir (ANR-11-IDEX-0003/Labex ECODEC No. ANR-11-LABX-0047).

[‡]HEC Paris, 1 rue de la Libération, 78350 Jouy en Josas, France, *E-mail:* thorsten.martin@hec.edu

[§]HEC Paris, 1 rue de la Libération, 78350 Jouy en Josas, France, *E-mail:* otto@hec.fr

1 Introduction

Hold-up problems can distort investment decisions. This insight is a key building block of the transaction cost theory of Williamson (1975) and Klein, Crawford, and Alchian (1978) and the property rights theory of Grossman and Hart (1986) and Hart and Moore (1990).[1] The Sveriges Riksbank Prizes in Economic Sciences in Memory of Alfred Nobel in 2009 and 2016 are evidence of the continuing importance of both theories in economics and finance. However, despite the prominent role of hold-up problems in theory, the empirical evidence of their effect on firms' investment decisions is limited to anecdotes, case-studies, and niche settings. Systematic, direct evidence of the empirical importance of hold-up problems for firms' investment decisions is missing from the literature. This paper aims to provide such evidence for a large panel of U.S. manufacturing industries (SIC codes 2000 to 3999) from 1974 to 2012.

Our analysis exploits the fact that most firms are part of vertical production chains: They buy input from upstream suppliers and sell output to downstream customers. Hold-up problems can arise in this setup if the downstream firms ("customers") must bargain over the input prices with the upstream firms ("suppliers") after investing in productive capacity (e.g., building a factory). In that case, the suppliers may be able to extract rents by threatening not to sell to the customers (i.e., to "hold them up"). Anticipating this problem can reduce the customers' incentives to invest.[2]

To study this effect, we rely on large reductions in import tariffs as a source of variation in the severity of the hold-up problem. When import tariffs in upstream industries are lowered, downstream customers' bargaining position vis-à-vis their domestic suppliers improves as the cost of procuring inputs from alternative foreign sources decreases. This, in turn, reduces the suppliers' ability to hold-up their customers and increases the customers' incentives to invest.

[1] See Whinston (2003) and Gibbons (2005) for discussions of the differences and commonalities of the two theories.

[2] See Grout (1984) for an early formalization of the idea that ex post bargaining can distort ex ante investments.

A benefit of of our empirical approach is that the import tariff rates in upstream industries are not choice variables of the downstream firms. Changes in these tariff rates are thus less likely to be correlated with unobserved determinants of the firms' investment decisions than other sources of variation in the severity of hold-up problems (e.g., variation stemming from the firms' attempts to maximize expected profits, such as differences in the level of vertical integration or the extent to which investments are relationship-specific).

Theory predicts that a lower threat of ex post hold-up should induce customers to increase investment in productive capacity. We find strong support for this prediction: Downstream customers increase their investments in response to import tariff reductions in upstream industries. This result holds both at the level of individual firms as well as at the industry level. Specifically, our estimates imply that firms increase their capital expenditures by 5% to 6% if the fraction of their upstream suppliers that have experienced large tariff reductions increases by one standard deviation (7%). At the aggregate level, this implies an increase of total investment in the U.S. manufacturing sector by USD 5 to 6 billion per year.[3] To the best of our knowledge, we are the first to document this effect.

Our findings are important for several reasons. First, we provide systematic, direct evidence of the widespread importance of hold-up problems for firms' investment decisions – a key building block of both transaction cost economics and the property rights theory of the firm. An implication is that the equilibrium level of vertical integration that we observe empirically does not eliminate all hold-up problems. Hence, our results point towards significant barriers to firms' ability to overcome hold-up problems through, for example, contractual arrangements (e.g., Iyer and Saunter (2016)) or vertical integration (see Lafontaine and Slade (2007) for a review). Second, our paper contributes

[3]During our sample period, the average aggregate investment per year of all public and private firms in the NBER-CES Manufacturing Industry Database is about USD 100 billion.

to the finance literature on corporate investment by documenting that hold-up problems in supply chains have a significant effect on firms' investment decisions. Third, our analysis adds to our understanding of the propagation of economic shocks through production networks (e.g., Barrot and Sauvagnat (2015)) by showing how tariff reductions in upstream industries affect the capital expenditures of downstream firms.

Key assumptions of the underlying theory that we test are that suppliers and customers are not vertically integrated, that investments are relationship-specific, and that contracts are incomplete. Consistent with these premises, we find that the effect of tariff reductions on corporate investment is significant only for non-integrated customers and suppliers producing differentiated goods (as proxied by high R&D expenditures). For suppliers that produce generic goods, the estimated effect is close to zero and not statistically significant. Similarly, for customers that are vertically integrated, the estimate is not statistically different from zero. Finally, the effect is stronger if a high level of uncertainty about future contingencies (as proxied by customers' sales volatility) makes the use of comprehensive, long-term contracts more difficult.

Theory also predicts that the effect of tariff reductions on investment is weaker for customers with high bargaining power vis-à-vis their suppliers. Using industry concentration and firm size as proxies for bargaining power, we find strong support for this prediction. Lastly, tariff reductions should have a weaker effect if shipping costs are high. The reason is that high shipping costs provide a barrier to international trade (e.g., Krugman, Obstfeld, and Melitz (2015)) and thus mitigate the effect of tariff reductions on prices. Consistent with this argument, we find that the effect of upstream tariff reductions on downstream investment is significant only for supplier industries with low shipping costs.

A potential concern regarding our analysis is that import tariff reductions in supplier industries may affect customers' investment decisions for reasons other than hold-up problems. Even without a

hold-up problem, increased import competition upstream may lead to lower input prices that make new investments more attractive for downstream firms. This alternative explanation, however, is difficult to reconcile with our empirical findings – in particular, with our cross-sectional results.

First, if suppliers and customers can bargain over and commit to the price and quantity of the input before the customers have to make their investments – so that there is no hold-up problem – then more competition among the suppliers leads to lower input prices but *not* to more investment. The reason is that if bargaining and commitment occur before the investment decision, then the suppliers and customers maximize their joint surplus by choosing the first-best investment. The input price is used only to redistribute this surplus. In that case, an increase in competition among the suppliers leads to lower input prices but does not affect the customers' investment (which remains at the first-best level).

Second, standard models of trade in which increased import competition leads to lower prices (e.g., Melitz and Ottaviano (2008)) do not predict that the effect of upstream tariff reductions on downstream investment is weaker for customers with higher bargaining power. The reason is that there is no bilateral bargaining in these models, and suppliers simply post prices at which they are willing to sell to any customer. As a consequence, differences in individual customers' bargaining power do not matter. Further, even if differences in bargaining power were to play a role, one would expect that customers with higher bargaining power should be able to obtain larger price concessions and thus increase their investment more in response to upstream tariff reductions than customers with lower bargaining power. The data reject this prediction: We find that customers with higher bargaining power respond less to upstream tariff reductions. This is consistent with the importance of hold-up problems but not with the alternative explanation that customers simply respond to lower input prices resulting from increased import competition.

Third, the alternative explanation suggests that the effect of upstream tariff reductions on

downstream investment should be weaker if the suppliers produce differentiated rather than generic inputs. The reason is that product differentiation should shield domestic suppliers from foreign competition (Hombert and Matray (2016)). We, however, find that the effect is significant only for supplier industries that produce differentiated inputs. For supplier industries producing generic inputs, the estimated effect is close to zero and not statistically significant.

Fourth, a simple decrease in prices due to increased competition neither explains why we find an effect only for customers that are not vertically integrated with their suppliers, nor why the effect is stronger if uncertainty about future contingencies is high. The importance of hold-up problems for corporate investment decisions, in contrast, predicts both findings.

Overall, a parsimonious model in which a hold-up problem distorts firms' investment decisions predicts all our empirical results. In contrast, the alternative explanation that downstream firms simply respond to lower input prices resulting from increased import competition in upstream industries is difficult to reconcile with our findings. In particular, this alternative explanation does generally not predict the cross-sectional variation that we document or even predicts effects with the opposite sign.

Regarding the existing literature, our work is most closely related to a small number of papers that provide evidence of an effect of hold-up on investment in very particular settings. Ciliberto (2006) examines whether hospitals that have vertically integrated or formed joint ventures with their physicians add more healthcare services over time than hospitals that negotiate managed care contracts independently. Vukina and Leegomonchai (2006) provide some evidence that hold-up problems affect investment decisions in the U.S. broiler industry. Cookson (2014) studies the consequences of expropriation risk due to incomplete contracting and finds that better understood courts in American Indian reservations lead to greater employment and more establishments in high-sunk-cost industries such as golf courses. Geng, Hau, and Lai (2016) investigate whether joint

equity ownership of firms that control complementary patents can mitigate hold-up problems and find that such "shareholder overlap" is associated with higher R&D expenditures and more patent filings.

In a broader sense, our research is also related to a growing number of papers in economics and finance that examine the consequences of tariff reductions and import competition on corporate actions and outcomes (e.g., Guadalupe (2007), Guadalupe and Cuñat (2009), Fresard (2010), Guadalupe and Wulf (2010), Valta (2012), Xu (2012), Fresard and Valta (2016)). An important difference between these papers and our work is that we are not interested in the effect of tariff reductions *per se* and that we do not study how firms are affected by or respond to tariff changes in their *own* industry. Finally, our paper is related to the empirical literature on transaction cost and property rights based explanations for vertical integration [4] and to the literature in trade and international economics that studies the consequences of trade liberalizations in general and tariff reductions in particular.[5]

2 Conceptual Framework and Predictions

To provide a framework for our analysis and formally derive the empirical predictions, we now present a simple model in the spirit of Hart (1995). There are two firms, C (for customer) and S (for supplier), and two dates, $t = 0$ and $t = 1$. At $t = 0$, C invests in its productive capacity. If C invests $i \in \mathbb{R}_+$, it can produce $f(i)$ units of output at $t = 1$, where f is a continuous, increasing, and concave function. For example, $f(i)$ could be the capacity of a factory built at cost i. Each

[4] See Lafontaine and Slade (2007), Joskow (2008), and Klein (2008) for reviews.

[5] E.g., Tybout, de Melo, and Corbo (1991), Tybout and Westbrook (1995), Pavcnik (2002), Melitz (2003), Amiti and Konings (2007), Melitz and Ottaviano (2008), Topalova and Khandelwal (2011), and Halpern, Koren, and Szeidl (2015).

unit of output is produced using one unit of input and thereafter sold at a price of one. C can buy the required input either from S or on a spot market populated by a large number of domestic and foreign suppliers. The (quality adjusted) price per unit of input is $p < 1$ on the spot market and x when bought from S, where x is determined through Nash bargaining between C and S at $t = 1$, after C's investment has been sunk. S's opportunity cost of supplying the input is $k < p$ per unit, and C's bargaining power is $\beta \in (0, 1)$. For simplicity, there is no discounting. Risk-aversion does not play a role because there is no uncertainty.

C's optimal investment at $t = 0$ is

$$i^* \in \arg\max_{i \in \mathbb{R}_+} f(i) \left[1 - p + \beta (p - k)\right] - i. \tag{1}$$

The intuition is that C expects to obtain its outside option $1 - p$ plus a fraction β of the gains from trade $p - k$ per unit of output $f(i)$. Given f's concavity in i, the unique solution is given by the first order condition[6]

$$f'(i^*) = \frac{1}{1 - p + \beta (p - k)}. \tag{2}$$

The price per unit of input that results from bargaining between C and S at $t = 1$ is[7]

$$x^* = \beta k + (1 - \beta) p, \tag{3}$$

and the quantity of input to be supplied is

$$q^* = f(i^*). \tag{4}$$

Note that i^* is smaller than the first-best investment i^{FB} given by $f'(i^{FB}) = 1/(1 - k)$. The reason is a hold-up problem: C's incentives to invest in its productive capacity at $t = 0$ are reduced because S can extract some of the surplus in the bargaining process at $t = 1$.

[6] We assume $f'(0) > 1/\left[1 - p + \beta (p - k)\right] > f'(\infty)$ to guarantee that an interior optimum exists.

[7] This follows from $f(i^*)\left[1 - x^*\right] - i^* = f(i^*)\left[1 - p + \beta (p - k)\right] - i^*$.

Four assumptions are important for this result. First, C and S cannot write a complete, long-term contract at $t = 0$. The reason could be, for example, that it is prohibitively costly to unambiguously describe all possibly relevant dimensions of the required input under all future contingencies ex ante.[8] Second, C's investment must be sunk at $t = 0$. That is, the investment cannot be delayed and is irreversible. Third, S's opportunity cost of supplying the input is lower than the cost of C's best alternative. The marginal return from C's investment is therefore larger if trade with S occurs than if it does not. This condition is what makes the investment "relationship-specific" in the sense of Hart (1995). Fourth, C does not have all the bargaining power. As a consequence, C must share the gains from trade with S.

We now introduce one additional assumption: The spot market price p of the input is an increasing function of the import tariff rate τ in the suppliers' industry, i.e.,[9]

$$p = p(\tau) \text{ with } p'(\tau) > 0. \tag{5}$$

An immediate implication is that the price (x^*) at which S sells input to C is also increasing in the tariff rate (τ), i.e.,

$$\frac{\partial x^*}{\partial \tau} = (1 - \beta)\, p'(\tau) > 0. \tag{6}$$

This yields a very basic prediction:

> ***Prediction 1:*** *Suppliers charge their customers lower prices in response to import tariff reductions in the suppliers' industries.*

[8] Under some conditions, certain mechanisms can solve the hold-up problem even when contracts are incomplete. For brevity, we simply assume that these conditions are not met. See Hart (1995) for a discussion of the different mechanisms that have been proposed in the literature and their validity.

[9] That import tariffs increase prices is a standard result in the literature in trade and international economics (e.g., Krugman, Obstfeld, and Melitz (2015)), so we do not microfound this assumption.

Applying the implicit function theorem to Equation (2) and using $p'(\tau) > 0$, we further obtain

$$\frac{di^*}{d\tau} = (1-\beta)\, p'(\tau) \frac{f'(i^*)^2}{f''(i^*)} < 0, \tag{7}$$

implying that a decrease in the tariff rate (τ) leads to an increase in C's investment (i^*). This result motivates our second prediction:

> ***Prediction 2:*** *Customers increase their investments in response to import tariff reductions in their suppliers' industries.*

The intuition is as follows. A reduction of the import tariff (τ) lowers the spot market price (p) of the input. This improves C's outside option, and S's (implicit) threat of not selling to C looses some of its potency. As a consequence, the price (x^*) at which S agrees to sell the input to C declines, and the profit that C obtains from investing in productive capacity increases. Anticipating this increase in profits improves C's incentives to invest.

How strongly the incentives to invest are affected by a change in the import tariff rate depends on C's bargaining power. Taking the partial derivative of Equation (7) with respect to β yields

$$\frac{\partial \frac{di^*}{d\tau}}{\partial \beta} = -p'(\tau) \frac{f'(i^*)^2}{f''(i^*)} > 0, \tag{8}$$

implying that, all else equal, a change in the tariff rate (τ) has a weaker effect on C's investment (i^*) if C's bargaining power (β) is high. This motivates our third prediction:

> ***Prediction 3:*** *The response of customers' investments to tariff reductions in their suppliers' industries is weaker for customers with high bargaining power.*

The intuition is as follows. C's incentives to invest depend on the price (x^*) per unit of input that results from bargaining with S. Equation (3) shows that this price is a weighted average of S's opportunity cost (k) and the spot market price (p), where the weight of the spot market price

is $1-\beta$. Changes in the spot market price (p) due to changes in the tariff rate (τ) thus have a smaller effect when C's bargaining power (β) is large.

Further predictions can be derived by relaxing different assumptions of the model.[10] First, there is no hold-up problem if C and S are vertically integrated. Second, there is no hold-up problem if the required input is generic and can be supplied by many alternative, domestic suppliers (at opportunity cost k). Third, there is no hold-up problem if C and S can write a complete, long-term contract. We thus obtain three additional predictions:

> ***Prediction 4.a:*** *The increase in customers' investments in response to import tariff reductions in their suppliers' industries is stronger for customers that are not vertically integrated into their suppliers' industries.*

> ***Prediction 4.b:*** *The increase in customers' investments in response to import tariff reductions in their suppliers' industries is stronger for tariff reductions in industries that produce differentiated rather than generic goods.*

> ***Prediction 4.c:*** *The increase in customers' investments in response to import tariff reductions in their suppliers' industries is stronger if complete, long-term contracts are more difficult to write.*

Finally, as transportation costs can act as a barrier to international trade (e.g., Krugman, Obstfeld, and Melitz (2015)), tariff reductions are likely to have a smaller effect on prices in industries with high shipping costs. This implies that the effect of upstream tariff reductions on downstream investment should be stronger if the shipping costs in the upstream industry are low:[11]

[10] We provide a formal analysis in the Appendix.

[11] This prediction can be derived formally with the assumption $\frac{\partial^2 p(\tau,s)}{\partial \tau \partial s} < 0$, where s stands for shipping costs.

Prediction 4.d: *The increase in customers' investments in response to import tariff reductions in their suppliers' industries is stronger if the shipping costs in the suppliers' industries are low.*

3 Data

3.1 Investment and Control Variables

We measure investment by capital expenditures in year t scaled by the book value of total assets at the end of year $t-1$ (e.g., Baker, Stein, and Wurgler (2003)).[12] We also compute *Ln(Assets)*, *Tobin's Q*, *Cash/Assets*, *Debt/Assets*, *EBITDA/Assets*, *Cash Flow/Assets*, *Sales Growth*, *Excess Return*, and *Excess Volatitlity* for each firm-year combination and *Industry Sales Growth* and *Industry Concentration* for each industry-year combination in our sample. All data are obtained from Compustat and CRSP, and all variables are winsorized at the 1st and 99th percentile as in Baker, Stein, and Wurgler (2003).[13] Detailed definitions are provided in the Appendix.

3.2 Customer-Supplier Relations

As in Acemoglu, Autor, Dorn, Hanson, and Price (2016), we identify customer-supplier relations at the industry level based on the gross flows of goods between industries reported in the 1992 U.S. Bureau of Economic Analysis (BEA) input-output table. An advantage of this approach – compared to identifying customer-supplier relations at the firm level – is that relations at the industry level are more likely to be determined by the industries' innate production technologies than an individual firm's choice to buy from a particular supplier. As a consequence, customer-supplier relations at the industry level are more likely to be exogenous to unobserved firm level

[12] We show in the Appendix that our results are robust to using $Ln(Capex)$ as an alternative measure (Table A.1).

[13] We show in the Appendix that using non-winsorized variables leads to very similar results (Table A.2).

characteristics than relations at the firm level.

3.3 Import Tariffs

We obtain data on U.S. imports in manufacturing industries (SIC codes 2000 to 3999) between 1974 and 2012 from Peter Schott's website and the Center for International Data at UC Davis.[14] Throughout the paper, we define industries at the four-digit SIC code level and compute the import tariff rate for each industry-year combination as the total value of duties collected divided by the total value of imports. Figure 1 shows the (equally weighted) average import tariff rate across all industries in our data for each year between 1974 and 2012. As is well known, the average import tariff has steadily declined over the past 40 years, from 8.23% in 1974 to 1.86% in 2012.

3.4 Large Tariff Reductions

We follow the literature and focus on so-called "large tariff reductions" (e.g., Fresard (2010), Valta (2012), Fresard and Valta (2016)). Specifically, we classify a tariff reduction in year t as large if it is more than three times as large as the average absolute year-on-year tariff change in the industry.[15] Note, however, that our findings do not depend on this definition and are robust to using alternative measures of tariff reductions (see Table A.3 in the Appendix).

Focusing on large (rather than any) tariff reductions has two main benefits. First, it facilitates comparing our findings with the existing literature. Second, investments in productive capacity (e.g., building a factory) are likely to be discrete and to have a fixed cost component.[16] Hence,

[14] `http://faculty.som.yale.edu/peterschott/` and `http://cid.econ.ucdavis.edu/`, respectively.

[15] Because we are not interested in transitory changes we also require that the implied tariff reductions from years $t-1$ to $t+1$, $t-2$ to $t+2$, and $t-3$ to $t+3$ are larger than three times the average absolute tariff change. Further, because tariff reductions are unlikely to have an economically significant effect if the tariff rate is very small to begin with, we do not classify a tariff reduction as large if the tariff rate before the reduction is already smaller than 1%.

[16] Note that adding fixed costs or discrete investment levels to our model complicates the analysis but does not

firms may not adjust their investment in response to marginal tariff changes and are likely to react only to tariff reductions that are sufficiently large.

Figure 2 shows the number of large tariff reductions across industries from 1974 to 2012 and reveals two distinct features. First, large tariff reductions occur in almost all years.[17] Second, there are three noticeable spikes in the number of large tariff reductions, corresponding to major events in international trade policy: the implementation of the Generalized System of Preferences (GSP) in 1976, which eliminated import tariffs on several thousand types of products when imported from a number of designated beneficiary countries, the completion of the seventh and eighth General Agreement on Tariffs and Trade (GATT) rounds in 1979 and 1994 – the so called "Tokyo round" and the "Uruguay round," which led to the creation of the World Trade Organization (WTO) – and the start of the North American Free Trade Agreement (NAFTA) in 1994.[18]

Figure 3 shows how the average tariff rate evolves during the five years before and after large reductions. On average, such reductions imply a decrease in the tariff rate by 1.74 percentage points, corresponding to a 27% decrease relative to the average rate of 6.43% before the reduction. Tariff reductions of this magnitude are generally considered important events in the literature and have been shown to have significant economic effects (e.g., Trefler (2004); Fresard and Valta (2016)).

change the predictions qualitatively.

[17]Large tariff *increases*, instead, are much less frequent: In total, we observe 493 large tariff reductions but only 55 large increases. Including these increases in our analysis does not change our findings (see column (4) of Table 3).

[18]While the general pattern is the same, the precise number of large tariff reductions in each year does not exactly match that in Fresard and Valta (2016), primarily because we are using a longer sample period – 1974 to 2012 vs. 1974 to 2005 – so that the cutoff defining "large" tariff changes (three times the average tariff change in an industry during the sample period) is not exactly the same in the two samples.

3.5 Fraction of Supplier Industries that Experienced Large Tariff Reductions

Based on the customer-supplier relations derived from the 1992 BEA input-output table, we compute for each industry-year combination the (gross-flow-weighted) fraction of supplier industries that have experienced large tariff reductions in the past. The resulting variable, denoted *Supplier Tariff Reduction*, is the main regressor of interest in our analysis. *Supplier Tariff Reduction* ranges from zero to one. It is equal to zero if none of the upstream industries have experienced a large tariff reduction. It is equal to one if large tariff reductions have occurred in all supplier industries.

Formally, for customer industry j and year t, we have

$$\textit{Supplier Tariff Reduction}_{j,t} = \sum_{s \in S_{\text{-}j}} \frac{\omega_{j,s} \times \textit{Post Tariff Reduction}_{s,t}}{\omega_{j,s}}, \tag{9}$$

where $S_{\text{-}j}$ is the set of all industries other than j, $\omega_{s,j}$ is the gross flow of goods that industry j receives from industry s, and $\textit{Post Tariff Reduction}_{s,t}$ is an indicator equal to one if industry s has experienced a large tariff reduction prior to year t.[19]

To give an example, consider an industry j that obtains 50% of its inputs from industry $s = 1$ and 30% from industry $s = 2$. The remaining 20% of inputs are produced by j itself. Suppose now that prior to year t there has been a large tariff reduction in industry $s = 1$ but not in $s = 2$. $\textit{Supplier Tariff Reduction}_{j,t}$ would then be equal to 0.5 because industry j obtains 50% of its inputs from supplier industries that have experienced a large tariff reduction prior to year t.

[19] If an industry experiences a large tariff increase after having previously experienced a large tariff reduction, for the years following the large tariff increase, we treat the industry as if it had not previously experienced a large tariff reduction. That is, we assume that large tariff increases "cancel out" large tariff reductions.

3.6 Summary Statistics

Table 1 presents summary statistics. Our sample comprises 44,590 firm-year observations from 1974 to 2012.[20] The mean value of *Supplier Tariff Reduction* indicates that, on average, firms obtain about 11% of their inputs from upstream industries that have previously experienced large tariff reductions.

The summary statistics for the different firm- and industry-level variables are similar to the corresponding statistics for the universe of all firms in Compustat during the sample period (unreported). The average book value of assets is USD 1 billion. Our sample, however, ranges from firms with assets of USD 2 million to firms with assets of more than USD 25 billion. The average value of our measure of investment, *Capex/Assets*, is 0.06. As for the value of total assets, the variation across observations is large, and *Capex/Assets* ranges from a minimum value of 0.001 to a maximum of 0.347.

4 Results

4.1 Effect of Tariff Reductions on Prices

We begin by testing a basic prediction of our model: Tariff reductions lead to lower prices (Prediction 1). Using industry-specific price indices for U.S. manufacturing industries (SIC codes 2000-3999) from the NBER-CES Manufacturing Industry Database,[21] we estimate the following OLS regression:

$$Price\ Index_{s,t} = \beta \times Post\ Tariff\ Reduction_{s,t} + \delta_s + \eta_t + \varepsilon_{s,t} \tag{10}$$

[20] The number of observations in some of our subsequent analyses can be smaller than 44,590 because the information required for some regression specifications is not always available for all observations in the sample.

[21] The data are provided jointly by the National Bureau of Economic Research (NBER) and U.S. Census Bureau's Center for Economic Studies (CES) and available at `http://www.nber.org/nberces/`.

where *Price Index*$_{s,t}$ is the price index for industry s in year t, *Post Tariff Reduction*$_{s,t}$ is an indicator equal to one if industry s has experienced a large tariff reduction prior to year t, δ_s are industry fixed effects, and η_t are year fixed effects.[22] Standard errors are clustered by year.

Table 2 presents the results. The sample period is 1974 to 2011 (the last year in the NBER-CES data). We find a negative and statistically significant coefficient estimate on *Post Tariff Reduction*. This result corroborates the basic prediction that tariff reductions lead to lower prices.

4.2 Effect of Supplier Tariff Reductions on Customers' Investment

To assess the empirical importance of hold-up problems for customers' investment decisions, we now examine how customers' capital expenditures are affected by large tariff reductions in upstream industries (Prediction 2). Specifically, we estimate OLS regressions of the following form:

$$\frac{\textit{Customer Capex}_{i,j,t}}{\textit{Customer Assets}_{i,j,t-1}} = \beta \times \textit{Supplier Tariff Reduction}_{j,t} + \gamma' X_{i,j,t-1} + \delta_i + \eta_t + \varepsilon_{i,j,t} \qquad (11)$$

where i indexes firms, j industries (defined at the four-digit SIC code level), and t years.

For each (downstream) customer industry j in year t, *Supplier Tariff Reduction*$_{j,t}$ is the (gross-flow-weighted) fraction of (upstream) supplier industries (excluding industry j itself) that have experienced large tariff reductions in the past. $X_{i,j,t-1}$ is a vector of lagged firm- and industry-level controls: *Ln(Assets)*, *Tobin's Q*, *Cash/Assets*, *Debt/Assets*, *EBITDA/Assets*, *Cash Flow/Assets*, *Sales Growth*, *Excess Return*, *Excess Volatility*, *Industry Sales Growth*, and *Industry Concentration*. We further control for firm fixed effects (δ_i) and year fixed effects (η_t). All standard errors are adjusted for heteroskedasticity and clustered in two ways, by industry×year and by firm.[23]

Table 3 presents the results. In column (1), we only control for firm and year fixed effects (δ_i and η_t). In column (2), we add the different firm- and industry-level control variables ($X_{i,j,t-1}$).

[22] Using *Ln(Price Index)* as the dependent variable yields very similar results (untabulated).

[23] We show in the Appendix that our results are robust to alternative clustering choices (Table A.4).

As predicted by theory, the coefficient estimate on *Supplier Tariff Reduction* is positive and statistically significant in both specifications (at the 1% level in column (1) and at the 5% level in column (2)). The point estimates imply an increase in customer investment by 5% to 6% for a one-standard-deviation increase in *Supplier Tariff Reduction* (relative to the average level of *Capex/Assets* of 0.06). This finding is evidence of an economically significant effect of hold-up problems on customers' investment decisions and consistent with Prediction 2.

A concern is that tariff changes are not randomly assigned and may coincide with unobserved changes in investment opportunities. In particular, tariff changes (or a lack thereof) may be the result of industrial lobbying. Firms in industries with lucrative growth opportunities may lobby for a reduction in import tariffs in their suppliers' industries. Similarly, suppliers to industries with declining growth opportunities may lobby for an increase in import tariffs to be protected from foreign competitors in times of declining demand.

Krugman, Obstfeld, and Melitz (2015) argue that multilateral trade negotiations are less likely to be captured by lobbying groups than the decision making process behind unilateral policy changes.[24] Tariff changes due to multilateral trade agreements are thus more likely exogenous to changes in customers' investment opportunities. In column (3), we thus only rely on large tariff reductions occurring in 1976, 1980, and 1995, following the implementation of the Generalized System of Preferences (GSP), the completion of the seventh and eighth General Agreement on Tariffs and Trade (GATT) rounds, and the start of the North American Free Trade Agreement (NAFTA) (see also Fresard and Valta (2016)). As in columns (1) and (2), we find a positive coefficient

[24]The key argument is as follows. Unilateral trade liberalizations may face opposition from import-competing domestic producers, who stand to lose from a tariff reduction and are typically better informed and organized than the domestic consumers that stand to gain. In multilateral trade negotiations, domestic exporters provide a counterweight: They stand to gain from a liberalization of trade between the involved countries and are arguably as well informed and organized as the import-competing producers.

estimate on *Supplier Tariff Reduction* that is statistically significant at the 5% level.

The magnitude of the coefficient estimate in column (3), 0.054, is very similar to the magnitude of the estimates in columns (1) and (2), 0.055 and 0.042, respectively. This finding suggests that a potential correlation between tariff reductions in upstream industries and unobserved growth opportunities of downstream customers resulting from industrial lobbying is unlikely to generate a quantitatively important bias in our estimations. At the same time, relying only on large tariff reductions in 1976, 1980, and 1995, as we do in column (3), ignores variation in hold-up problems between suppliers and customers stemming from large tariff reductions in other years. For this reason, throughout the paper, we exploit all large tariff reductions during the entire sample period.[25]

In column (4), we add *Supplier Tariff Increase* as an explanatory variable, the (gross-flow weighted) fraction of supplier industries that have experienced large tariff *increases* in the past.[26] Consistent with the predictions of our model, the point estimate of the effect of *Supplier Tariff Increase* is negative. However, the estimate is noisy and not statistically significant. The coefficient on *Supplier Tariff Reduction* remains positive and statistically significant (at the 5% level). In column (5), we include two additional control variables: an indicator for large tariff reductions in a firm's own industry (*Own Industry Tariff Reduction*) and the gross-flow weighted fraction of downstream industries that have experienced large tariff reductions (*Downstream Tariff Reduction*). The coefficient estimate on *Supplier Tariff Reduction* is not affected by these additional controls.

4.3 Effect on Investment at the Aggregate Level

In Table 4, we examine the effect of upstream tariff reductions on the aggregate amount of investment in the downstream industries. For this purpose, we rely on information obtained from the

[25] Unreported analyses confirm that our findings are generally robust to using only large tariff reductions following multilateral trade agreements (as we do in column (3) of Table 3) in all our analyses.

[26] *Supplier Tariff Increase* is constructed analogously to *Supplier Tariff Reduction*.

NBER-CES Manufacturing Industry Database on the total amount of capital stock and investment of all private and public U.S. firms in manufacturing industries (SIC codes 2000 to 3999) between 1974 and 2011 (the last year in the database).

We define two measures of aggregate investment at the industry level: *Growth of Capital Stock*, which is the year-on-year growth rate (in percent) of the total capital stock, and *Capex/Capital Stock*, which is the total amount of capital expenditures in year t scaled by the total amount of capital stock at the end of year $t-1$. We find positive and statistically significant coefficient estimates on *Supplier Tariff Reduction* in all specifications. This result shows that upstream tariff reductions lead to an increase in downstream investment also at the aggregate (industry) level.

4.4 Cross-sectional Variation due to Differences in Bargaining Power

We now examine how the increase in investment in response to tariff reductions in upstream industries depends on the customers' bargaining power vis-à-vis their suppliers (Prediction 3). Our first approach is to distinguish between large tariff reductions in supplier industries that are concentrated and in supplier industries that are dispersed. The idea is that suppliers in more concentrated industries have more bargaining power. At one end of the spectrum would be maximum concentration: an industry with a single, monopolistic supplier that has all the bargaining power vis-à-vis its customers. The polar opposite would be maximum dispersion: an industry with atomistic suppliers in perfect competition and with zero bargaining power. Based on this intuition, we assess the suppliers' bargaining power by computing the Herfindahl-Hirschman Index (HHI) of sales for each industry-year combination in the Compustat database between 1974 and 2012. We then classify an industry-year combination as "concentrated" if its HHI is larger than the median HHI. Otherwise, the industry is classified as "dispersed."

Our second approach is to test whether the estimated effect of tariff reductions varies with the

customers' bargaining power. To do so, we measure the level of concentration in each customer's industry (using the HHI of sales) as well as the size of each customer (using the natural logarithm of total assets). We then add interaction terms between *Supplier Tariff Reduction* and *Customer Industry Concentration* and *Customer Size* to the regressions, expecting that both industry concentration and size increase a customer's bargaining power.

Table 5 presents the results. All regressions include the full set of firm- and industry-level controls ($X_{i,j,t-1}$) specified in Equation (11).[27] To conserve space, we do not report the associated coefficient estimates and t-statistics.

Column (1) shows the estimation results obtained from the regression in which we distinguish between large tariff reductions in concentrated and in dispersed supplier industries. In this specification, we also control for the average level of concentration across all of a customer's supplier industries (*Supplier Industry Concentration*). The regression reveals a positive effect on customers' capital expenditures for large tariff reductions in concentrated supplier industries (statistically significant at the 1% level). In contrast, the estimated effect of large tariff reductions in dispersed supplier industries is close to zero and not statistically significant. The null-hypothesis that the effect of large tariff reductions in dispersed supplier industries is the same as in concentrated supplier industries is rejected at the 1% level by a Wald test (unreported).

In columns (2) and (3), we interact *Supplier Tariff Reduction* with *Customer Industry Concentration* and *Customer Size*. In line with our earlier results (Table 3), we find positive coefficient estimates on *Supplier Tariff Reduction* that are statistically significant at the 1% level in both columns. Further, we find negative coefficient estimates on the interactions with *Customer Industry Concentration* and *Customer Size* (both statistically significant at the 5% level). This result is consistent with the first column: The effect is stronger if *suppliers* have more bargaining power

[27] Note that $X_{i,j,t-1}$ includes both proxies of customers' bargaining power, *Industry Concentration* and *Ln(Assets)*.

(column (1)) and thus weaker if *customers* have more bargaining power (columns (2) and (3)).

Overall, our findings support Prediction 3: Customers with higher bargaining power vis-à-vis their suppliers increase their investments less in response to large tariff reductions in upstream industries than customers with lower bargaining power.

4.5 Cross-sectional Variation due to Differences in Vertical Integration, Product Differentiation, Uncertainty, and Shipping Costs

We now test Predictions 4.a-d. To do so, we distinguish between customers that are vertically integrated into their suppliers' industries and those that are not (Prediction 4.a). We also distinguish between suppliers that produce differentiated inputs and those that produce generic inputs (Prediction 4.b). Further, we examine whether customers' response to large tariff reductions in their suppliers' industries is stronger if a higher level of uncertainty about future contingencies makes the use of comprehensive, long-term contracts more difficult (Prediction 4.c). Finally, we distinguish between tariff reductions in industries with high versus low shipping costs (Prediction 4.d). Table 6 presents the results.

In panel A, for each customer, we distinguish between large tariff reductions in supplier industries into which the customer is vertically integrated and large tariff reductions in supplier industries into which the customer is not vertically integrated. Our model predicts that customers increase their investments in response to tariff reductions if they are *not* vertically integrated with their suppliers. The reason is that, in this case, tariff reductions reduce hold-up problems. In contrast, our model predicts no reaction to tariff reductions if suppliers and customers *are* vertically integrated because, in that case, there is no hold-up problem to begin with.

In line with this argument, we find a significant effect of upstream tariff reductions only for customers that are *not* vertically integrated into their suppliers' industries. The difference between

the estimated effects for customers that are not integrated and customers that are integrated is statistically significant at the 5% level (unreported). The empirical evidence thus supports Prediction 4.a.

In panel B, we distinguish between supplier industries that produce differentiated inputs and those that produce generic inputs. We do so, because our model predicts an increase in customers' investments in response to tariff reductions if the suppliers produce differentiated inputs – but not if the inputs are generic. The intuition is as follows: Ex post bargaining about the price of differentiated inputs creates a hold-up problem that can be mitigated by import tariff reductions. If, instead, the inputs are perfectly generic and can be bought from a large number of suppliers at the same (quality adjusted) price, then there is no hold-up problem in the first place.

Following Barrot and Sauvagnat (2015), in each year, we classify a supplier industry as producing differentiated inputs if the ratio of aggregate R&D expenditures to aggregate sales in the industry is higher than the median R&D-to-sales ratio in Compustat from 1974 to 2012. Otherwise, the industry is classified as producing generic inputs. Based on this classification, we find a significant effect of large tariff reductions only if the suppliers produce differentiated inputs. In contrast, the estimated effect for suppliers producing generic inputs is close to zero and not statistically significant.[28] These results are consistent with Prediction 4.b.

In panel C, we examine how the effect of large tariff reductions in upstream industries varies with the volatility of the customers' sales. The idea behind this analysis is as follows. There is no hold-up problem if the customer and the supplier can write a complete, long-term contract. However, such a contract is arguably more difficult to write if the level of uncertainty about relevant future

[28]The effect for suppliers producing generic inputs is estimated with low precision. As a consequence, despite a point estimate close to zero, the hypothesis that the effect for suppliers producing generic inputs does not differ from that for suppliers producing differentiated inputs cannot be rejected at conventional levels (unreported).

contingencies is high. Hence, a high level of uncertainty is likely to inhibit the use of comprehensive, long-term contracts as a means to overcome the hold-up problem.

We thus predict that the effect of tariff reductions in upstream industries has a stronger effect on customers' investment decisions if the level of uncertainty about future contingencies is high (Prediction 4.c). Using *Customer Sales Volatility* as a proxy for such uncertainty, we find strong support for this prediction. The coefficient estimate on the interaction term between *Supplier Tariff Reduction* and *Customer Sales Volatility* is positive and statistically significant at the 1% level.[29]

Finally, in panel D, we distinguish between supplier industries with high shipping costs and those with low shipping costs. Specifically, we classify an industry-year combination as having high shipping costs if the shipping costs are larger than the median (and otherwise as having low shipping costs). The idea behind this analysis is that high shipping costs inhibit international trade (e.g., Krugman, Obstfeld, and Melitz (2015)) and thus mitigate the effect of tariff reductions on prices. As a consequence, tariff reductions in upstream industries with high shipping costs should have a weaker effect on downstream customers' investment than tariff reductions in industries with low shipping costs. We indeed find a significant effect of upstream tariff reductions only for supplier industries with low shipping costs. This result supports Prediction 4.d.

5 Discussion of Alternative Explanations

5.1 Lower Input Prices Resulting from Increased Import Competition

A potential concern regarding the interpretation of our findings is that firms may invest more simply because of lower input prices. Further, trade liberalizations that lead to more import competition can lead to a decline in prices (e.g., Melitz and Ottaviano (2008)). Hence, if firms

[29]Note that *Customer Sales Volatility* is estimated using the time-series of a customer's annual sales during the sample period. Hence, it is a constant for a given customer, and its main effect is absorbed by the firm fixed effects.

increase investment in response to lower input prices, then import tariff reductions in upstream industries could lead to more downstream investment even if there is no hold-up problem. This alternative explanation, however, is difficult to reconcile with our empirical findings – in particular, with our cross-sectional results.

First, if suppliers and customers can bargain over and commit to the price and quantity of the input before the customers have to make their investments – so that there is no hold-up problem – then more competition among the suppliers leads to lower input prices but *not* to more investment. The reason is that if bargaining and commitment occur before the investment decision, then the suppliers and customers maximize their joint surplus by choosing the first-best investment. The input price is used only to redistribute this surplus. In that case, an increase in competition among the suppliers leads to lower input prices but does not affect the customers' investment (which remains at the first-best level).

Second, we find that the effect of upstream tariff reductions on downstream investment is weaker for customers with higher bargaining power (Table 5). This result is predicted by our model (Prediction 3). It is not predicted by a model in which prices are determined by monopolistic competition among firms as in, e.g., Melitz and Ottaviano (2008). In that case, suppliers simply post prices at which they are willing to sell to any customer. As a consequence, the effect of tariff reductions does not depend on the customers' bargaining power. Further, even if bargaining power were to play a role, one would expect that customers with higher bargaining power should be able to obtain a larger price concession when competition among the suppliers increases. This should result in a larger increase in the customers' investment – the opposite of what we find.

Third, we find that the increase in customers' investment is significant only for tariff reductions in supplier industries that produce differentiated goods but not if the suppliers produce generic goods (Table 6, Panel B). This result is predicted by our model (Prediction 4.b) but not by the

alternative explanation. In particular, Hombert and Matray (2016) show that product differentiation shields domestic firms from import competition. Thus, the alternative explanation would predict that the increase in customers' investment should be driven by tariff reductions in supplier industries that produce generic goods – the opposite of what we find.

Fourth, we find an effect of upstream tariff reductions only for customers that are not vertically integrated with their suppliers (Table 6, Panel A). Fifth, we find that the effect is stronger if the use of comprehensive, long-term contracts is made more difficult by a higher level of uncertainty about future contingencies (Table 6, Panel C). Both results are predicted by our model (Predictions 4.a and 4.c, respectively). The alternative explanation, however, does not predict such cross-sectional variation.

Overall, our empirical findings – in particular, our cross-sectional results – match the predictions of the model presented in Section 2 and speak to the importance of hold-up problems for corporate investment decisions. These findings are difficult to reconcile with the alternative explanation that there are no hold-up problems and that downstream firms simply respond to lower input prices resulting from increased import competition in upstream industries. This alternative explanation does generally not predict the cross-sectional variation that we document or even predicts effects with the opposite sign.

5.2 Relaxation of Financial Constraints Due to Tariff Reductions

Another concern is that our findings may be explained by an effect of tariff changes in upstream industries on downstream customers' financial constraints. For example, upstream tariff reductions that lead to lower input prices may make downstream customers more profitable and through this channel affect the customers' ability to finance additional investments.

To mitigate this concern, we examine sub-samples of customers that are unlikely to be financially

constrained. Specifically, we restrict attention to (1) firms that pay dividends, (2) firms with a KZ-index (Kaplan and Zingales (1997)) that is smaller than the sample median, and (3) firms with a WW-index (Whited and Wu (2006)) that is smaller than the sample median. Under the alternative explanation that large tariff reductions in their suppliers' industries affect customers' investment decisions through their effect on the customers' financial constraints, we should not find any effect when focusing on sub-samples of presumably unconstrained firms.

Table 7 shows that we find positive coefficient estimates on *Supplier Tariff Reduction* in all three sub-samples of financially unconstrained customers (statistically significant at the 1% level in column (1) and at the 5% level in columns (2) and (3)). The magnitude of the estimated coefficients is similar to the magnitude of the coefficients reported in Table 3. These findings are inconsistent with the alternative explanation that our results are driven by changes in customers' financial constraints.

6 Conclusion

Hold-up problems between customers and suppliers have long been recognized in the theoretical literature as an important impediment to corporate investment (Williamson (1975); Klein, Crawford, and Alchian (1978); Grossman and Hart (1986); Hart and Moore (1990)). Direct empirical evidence of an effect of such hold-up problems on firms' investment decisions, however, is very scarce. To provide such evidence, we examine how the capital expenditures of downstream customers respond to large import tariff reductions in upstream industries. The intuition behind this approach is that tariff reductions in upstream industries improve customers' bargaining position vis-à-vis their suppliers and thus mitigate hold-up problems.

A simple model in the spirit of Hart (1995), which we use as a framework for our analysis, predicts that customers increase their investments after tariff reductions in their suppliers' indus-

tries. Further predictions are that the increase in investment is weaker for customers with higher bargaining power, that the increase is stronger if the suppliers produce differentiated rather than generic inputs, and that the increase is driven by customers that are not vertically integrated into their suppliers' industries. Theory also predicts that the increase in investment is stronger if a high level of uncertainty about future contingencies limits the use of comprehensive, long-term contracts. Finally, theory predicts that upstream tariff reductions should have a weaker effect on downstream investment if the shipping costs in the upstream industry are high.

Our analysis of the investment decisions of U.S. manufacturing firms (SIC codes 2000 to 3999) in response to large import tariff reductions in upstream industries between 1974 and 2012 provides strong support for these predictions. Specifically, our estimates imply that firms increase their capital expenditures by 5% to 6% if the fraction of their upstream suppliers that have experienced large tariff reductions increases by one standard deviation (7%). At the aggregate level, this implies an increase of total investment in the U.S. manufacturing sector by USD 5 to 6 billion per year. To the best of our knowledge, we are the first to document this evidence.

References

[1] Acemoglu, D., Autor, D., Dorn, D., Hanson, G., Price, B., 2016. Import competition and the great US employment sag of the 2000s. Journal of Labor Economics 34, 141–198.

[2] Amiti, M., Konings, J., 2007. Trade liberalization, intermediate inputs, and productiviy: Evidence from Indonesia. American Economic Review 97, 1611–1638.

[3] Baker, M., Stein, J., Wurgler, J., 2003. When does the market matter? Stock prices and the investment of equity-dependent firms. Quaterly Journal of Economics 118, 969–1005.

[4] Barrot, J., Sauvagnat, J., 2015. Input specificity and the propagation of idiosyncratic shocks in production networks. Quarterly Journal of Economics, forthcoming.

[5] Ciliberto, F., 2006. Does organizational form affect investment decisions? Journal of Industrial Economics 54, 63–93.

[6] Cookson, J., 2014. Economic consequences of judicial institutions: Evidence from a natural experiment. Unpublised Working Paper. University of Colorado.

[7] Fresard, L., 2010. Financial strength and product market behavior: The real effects of corporate cash holdings. Journal of Finance 65, 1097–1122.

[8] Fresard, L., Valta, P., 2016. How does corporate investment respond to increased entry threat? Review of Corporate Finance Studies 5, 1–35.

[9] Geng, H., Hau, H., Lai, S., 2016. Technological progress and ownership structure. Unpublised Working Paper. University of Hong Kong, University of Geneva, and Swiss Finance Institute.

[10] Gibbons, R., 2005. Four formal(izable) theories of the firm? Journal of Economic Behavior and Organization 58, 200–245.

[11] Grossman, S., Hart, O., 1986. The costs and benefits of ownership: A theory of vertical and lateral integration. Journal of Political Economy 94, 691–719.

[12] Grout, P., 1984. Investment and wages in the absence of binding contracts: A Nash bargaining approach. Econometrica 52, 449–460.

[13] Guadalupe, M., 2007. Product market competition, returns to skill, and wage inequality. Journal of Labor Economics 25, 439–474.

[14] Guadalupe, M., Cuñat, V., 2009. Globalization and the provision of incentives inside the firm. Journal of Labor Economics 27, 179–212.

[15] Guadalupe, M., Wulf, J., 2010. The flattening firm and product market competition: The effect of trade liberalization on corporate hierarchies. American Economic Journal - Applied Economics 4, 105–127.

[16] Halpern, L., Koren, M., Szeidl, A., 2015. Imported inputs and productivity. American Economic Review 105, 3660–3703.

[17] Hart, O., 1995. Firms, contracts, and financial structure. Oxford University Press. New York, NY.

[18] Hart, O., Moore, J., 1990. Property rights and the nature of the firm. Journal of Political Economy 98, 1119–1158.

[19] Hombert, J., Matray, A., 2016. Can innovation help U.S. manufacturing firms escape import competition from China? Unpublished Working Paper. HEC Paris and Princeton University.

[20] Iyer, R., Sautner, Z., 2016. Contracting between firms: Empirical evidence. Review of Economics and Statistics, forthcoming.

[21] Joskow, P., 2008. Vertical integration. Handbook of New Institutional Economics. Springer. Berlin.

[22] Kaplan, S., Zingales, L., 1997. Do investment-cash flow sensitivities provide useful measures of financing constraints? Quarterly Journal of Economics 112, 169–215.

[23] Klein, P., 2008. The make-or-buy decision: Lessons from empirical studies. Handbook of New Institutional Economics. Springer. Berlin.

[24] Klein, B., Crawford, R., Alchian, A., 1978. Vertical integration, appropriable rents, and the competitive contracting process. Journal of Law and Economics 21, 297–326.

[25] Krugman, P., Obstfeld, M., Melitz, M., 2015. International economics: Theory and policy, 10th (Global) Edition. Pearson Press. Essex, England.

[26] Lafontaine, F., Slade, M., 2007. Vertical integration and firm boundaries: The evidence. Journal of Economic Literature 45, 629–685.

[27] Lamont, O., Polk, C., Saá-Requejo, J., 2001. Financial constraints and stock returns. Review of Financial Studies 14, 529–554.

[28] Melitz, M., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71, 1695–1725.

[29] Melitz, M., Ottaviano, G., 2008. Market size, trade, and productivity. Review of Economic Studies 75, 295–316.

[30] Pavcnik, N., 2002. Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants. Review of Economic Studies 69, 245–276.

[31] Topalova, P., Khandelal, A., 2011. Trade liberalization and firm productivity: The case of India. Review of Economics and Statistics 93, 995–1009.

[32] Trefler, D., 2004. The long and the short of the Canada-U.S. free trade agreement. American Economic Review 94, 870–895.

[33] Tybout, J., de Melo, J., Corbo, V., 1991. The effects of trade reforms on scale and technical efficiency. New evidence from Chile. Journal of International Economics 31, 231–250.

[34] Tybout, J., Westbrook, M., 1995. Trade liberalization and the dimensions of efficiency change in Mexican manufacturing industries. Journal of International Economics 39, 53–78.

[35] Valta, P., 2012. Competition and the cost of debt. Journal of Financial Economics 105, 661–682.

[36] Vukina, T., Leegomonchai, P., 2006. Oligopsony power, asset specificity, and hold-up: Evidence from the broiler industry. American Journal of Agricultural Economics 88, 589–605.

[37] Whited, T., Wu, G., 2006. Financial Constraints Risk. Review of Financial Studies 19, 531–559.

[38] Whinston, M., 2003. On the transaction cost determinants of vertical integration. Journal of Law, Economics, and Organization 19, 1–23.

[39] Williamson, O., 1975. Markets and hierachies: Analysis and antitrust implications. Free Press. New York, NY.

[40] Xu, J., 2012. Profitability and capital structure: Evidence from import penetration. Journal of Financial Economics 106, 427–446.

Figure 1: Average Import Tariff Rate in U.S. Manufacturing Industries (SIC codes 2000 to 3999) from 1974 to 2012

This figure shows the (equally weighted) average import tariff rate (in percent) across all U.S. manufacturing industries in our data (SIC codes 2000 to 3999) in each year from 1974 to 2012. Import tariff rates for each industry-year combination are computed as the total value of duties collected divided by the total value of imports. Data on the value of imports and duties are from Peter Schott's website (`http://faculty.som.yale.edu/peterschott/`) and the Center for International Data at UC Davis (`http://cid.econ.ucdavis.edu/`).

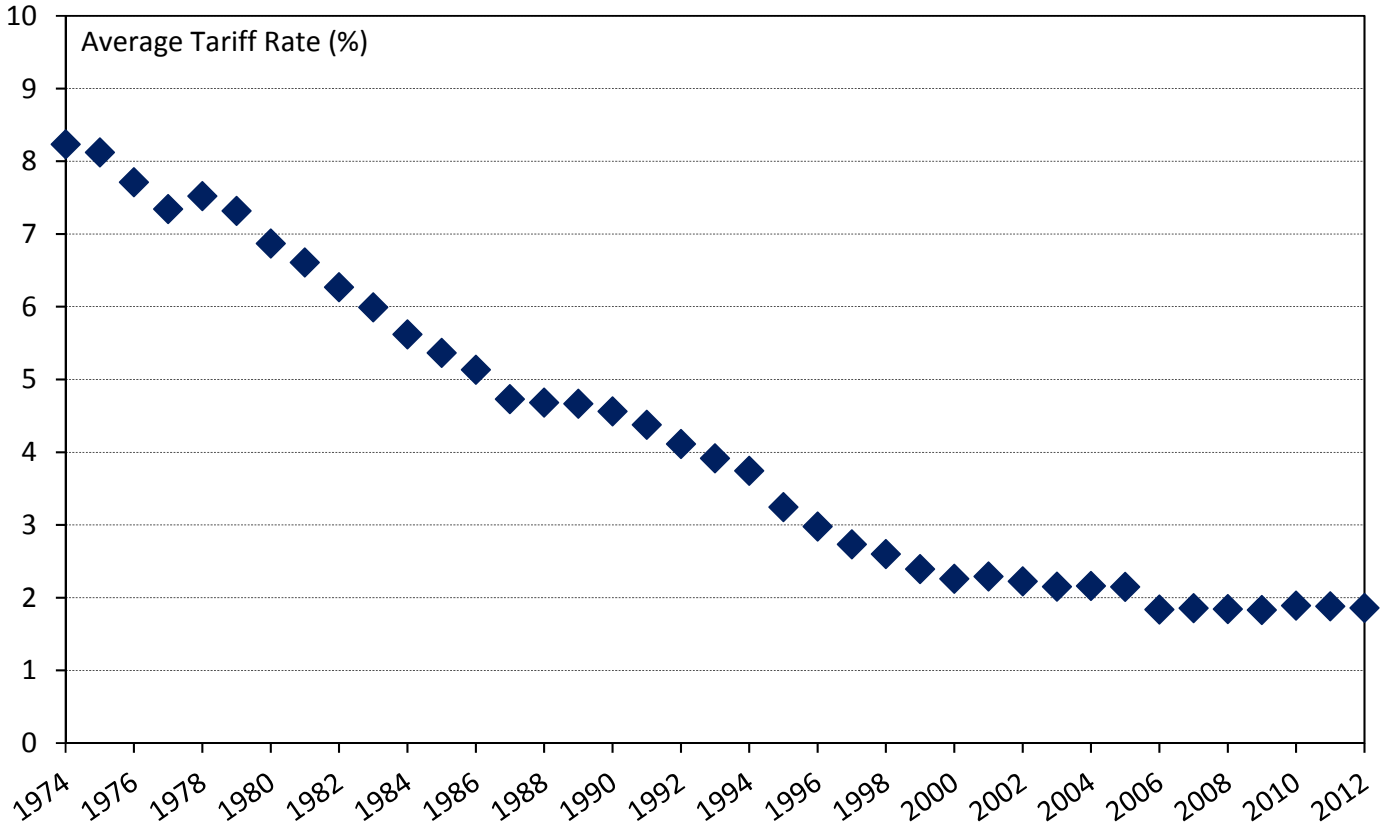

Figure 2: Number of Large Tariff Reductions in U.S. Manufacturing Industries (SIC codes 2000 to 3999) from 1974 to 2012

This figure shows the number of large import tariff reductions in manufacturing industries in the U.S. (SIC codes 2000 to 3999) for each year during the sample period from 1974 to 2012. Tariff rates for each industry-year combination are computed as the total value of duties collected divided by the total value of imports. Year-on-year tariff reductions are classified as "large" if they are more than three times as large as the average absolute year-on-year tariff change in the industry. Data on the value of imports and duties are from Peter Schott's website (`http://faculty.som.yale.edu/peterschott/`) and the Center for International Data at UC Davis (`http://cid.econ.ucdavis.edu/`).

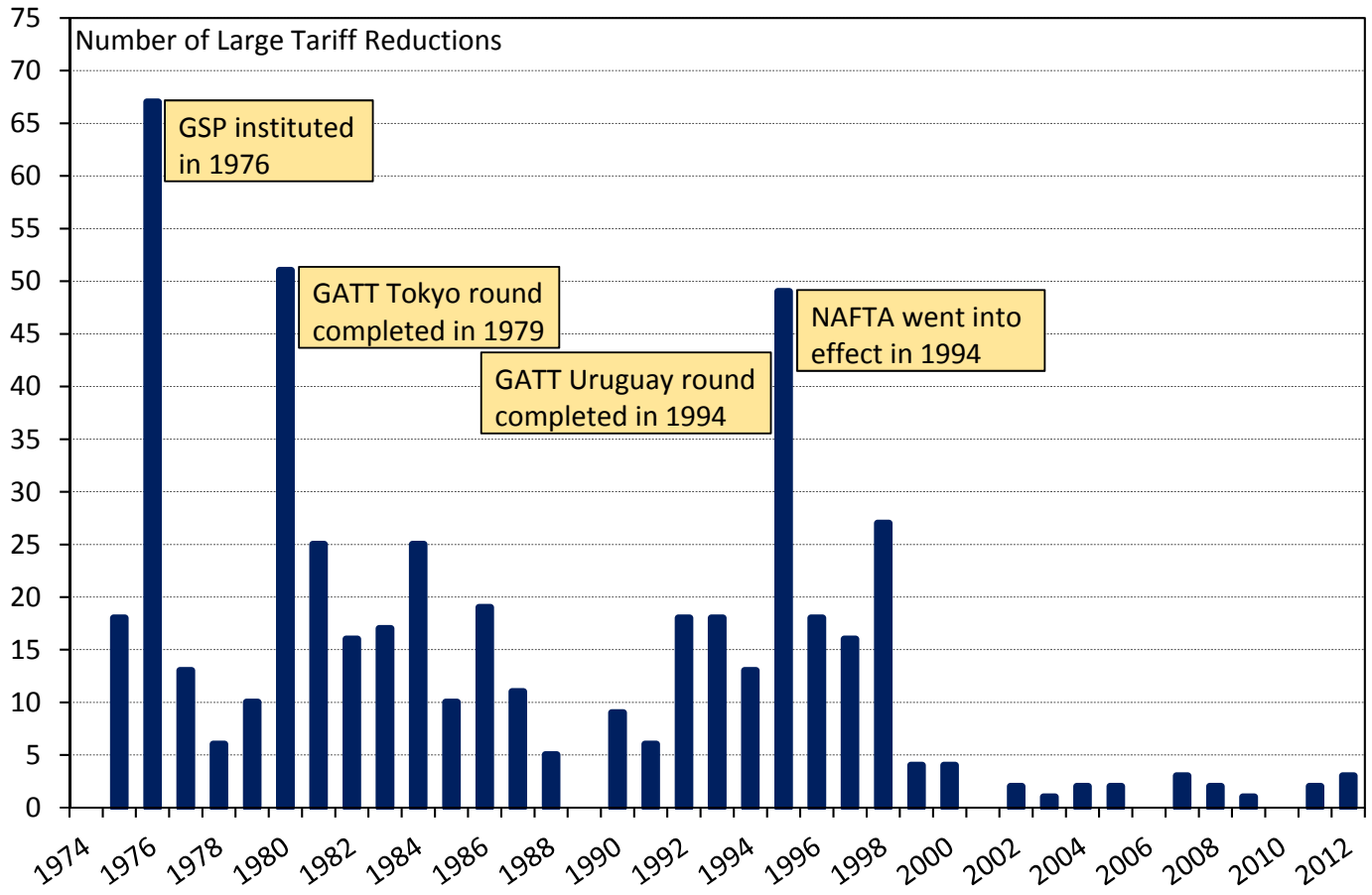

Figure 3: Average Tariff around Large Tariff Reductions in U.S. Manufacturing Industries (SIC codes 2000 to 3999) from 1974 to 2012

This figure shows the (equally weighted) average import tariff rate (in percent) around large tariff reductions in U.S. manufacturing industries (SIC codes 2000 to 3999) during the sample period from 1974 to 2012. Tariff rates for each industry-year combination are computed as the total value of duties collected divided by the total value of imports. Year-on-year tariff reductions are classified as "large" if they are more than three times as large as the average absolute year-on-year tariff change in the industry. Data on the value of imports and duties are from Peter Schott's website (`http://faculty.som.yale.edu/peterschott/`) and the Center for International Data at UC Davis (`http://cid.econ.ucdavis.edu/`).

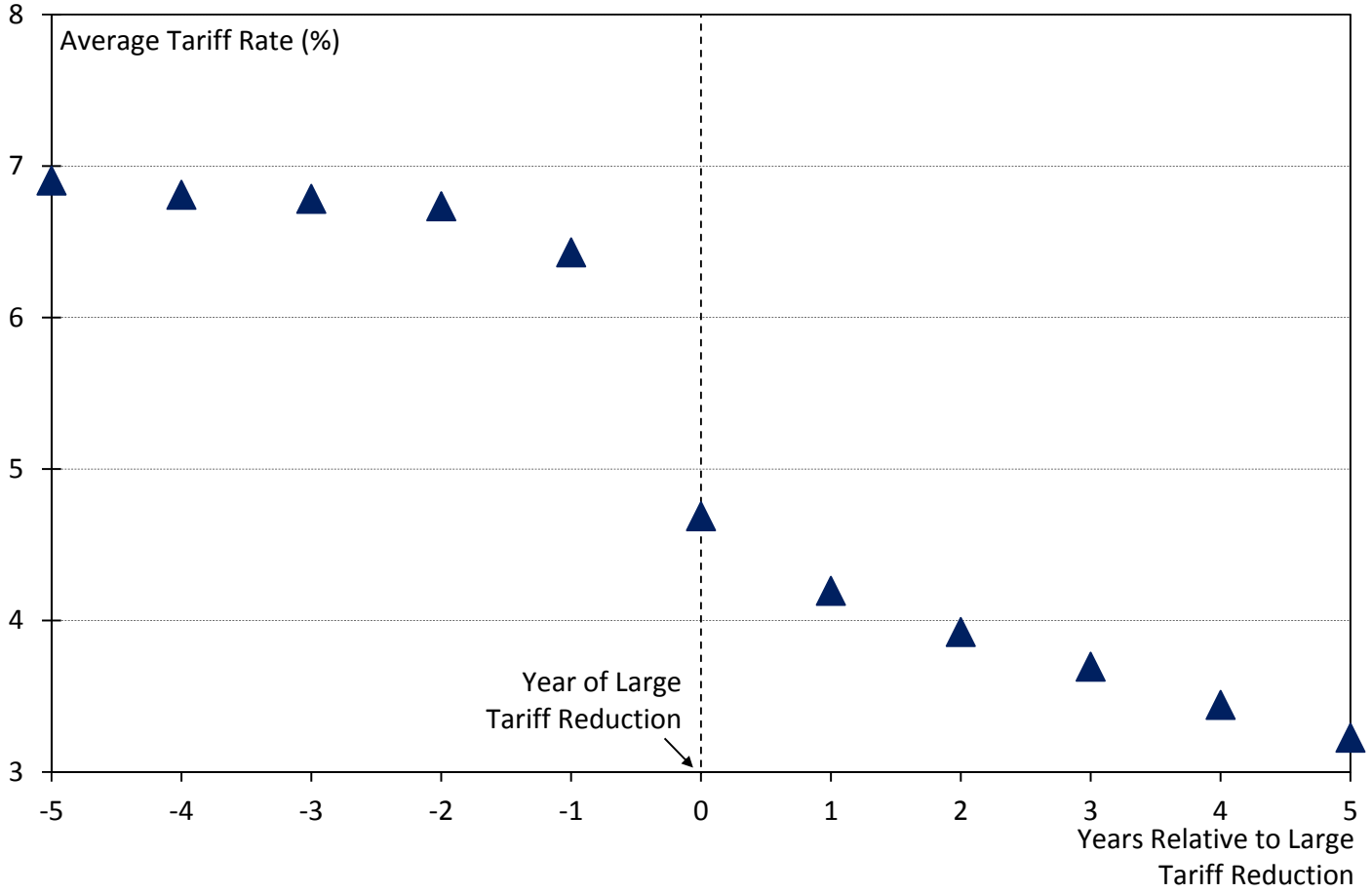

Table 1: Summary Statistics

This table presents summary statistics for our sample of 44,590 firm-year observations over the period from 1974 to 2012. For a given firm-year combination, *Supplier Tariff Reduction* is the fraction of supplier industries that have experienced large tariff reductions in the past. Detailed definitions of all variables are provided in the Appendix.

Variable	Observations	Mean	Std. Dev.	Min.	25%	Median	75%	Max.
Supplier Tariff Reduction	44,590	0.113	0.072	0.000	0.056	0.109	0.153	0.503
Capex/Assets	44,590	0.061	0.061	0.001	0.022	0.043	0.079	0.347
Assets (in USD million)	44,590	1,031	3,445	2	24	87	397	25,636
Ln(Assets)	44,590	4.676	2.061	0.688	3.179	4.466	5.984	10.152
Tobin's Q	44,590	1.985	1.732	0.560	1.015	1.391	2.191	11.010
Cash/Assets	44,590	0.190	0.221	0.001	0.030	0.097	0.270	0.911
Debt/Assets	44,590	0.201	0.180	0.000	0.039	0.172	0.312	0.783
EBITDA/Assets	44,590	0.060	0.226	-1.022	0.031	0.117	0.180	0.380
Cash Flow/Assets	44,590	-0.030	0.234	-1.226	-0.034	0.040	0.082	0.235
Sales Growth	44,590	0.195	0.564	-0.731	-0.023	0.101	0.254	3.939
Excess Return	44,590	0.037	0.713	-0.939	-0.376	-0.101	0.224	3.782
Excess Volatility	44,590	0.028	0.020	0.001	0.013	0.023	0.037	0.103
Industry Sales Growth	44,590	0.095	0.174	-0.399	0.012	0.090	0.164	0.815
Industry Concentration	44,590	0.274	0.193	0.055	0.135	0.217	0.362	0.922

Table 2: Effect of Large Import Tariff Reductions on Prices

This table presents coefficient estimates for the effect of large import tariff reductions on prices at the industry level. The data are obtained from the NBER-CES Manufacturing Industry Database (`http://www.nber.org/nberces/`) and cover U.S. manufacturing industries (SIC codes 2000-3999). The sample period is 1974 to 2011 (the last year in the NBER-CES data). Individual industries are identified by their four-digit SIC codes. *Post Tariff Reduction* is an indicator equal to one if the industry has experienced a large tariff reduction in the past. *Price Index* is the price index for each industry. Standard errors are clustered by year, and t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)
Dependent Variable:	Price Index
Post Tariff Reduction	-0.030**
	(-2.04)
Industry & Year Fixed Effects	Yes
R^2	0.480
Observations	4,706

Table 3: Effect of Large Import Tariff Reductions in Supplier Industries on Customers' Investment

This table presents coefficient estimates for the effect of large import tariff reductions in supplier industries on customers' capital expenditures. The sample period is 1974 to 2012. *Supplier Tariff Reduction (Increase)* is the fraction of supplier industries that have experienced large tariff reductions (increases) in the past. *Own Industry Tariff Reduction* is an indicator equal to one if there has been a large tariff reduction in a customer's own industry. *Downstream Tariff Reduction* is the fraction of downstream industries that have experienced large tariff reductions. *Capex/At* is a customer's capital expenditures in year t scaled by the book value of total assets at the end of year t-1. Detailed variable definitions are provided in the Appendix. Column (3) uses only large tariff reductions in 1976, 1980, and 1995, following the GSP implementation, completion of the seventh and eighth GATT rounds, and start of NAFTA. *t*-statistics are reported in parentheses. Standard errors are clustered in two ways, by (SIC4-)industry×year and by firm. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable:	Capex/At	Capex/At	Capex/At	Capex/At	Capex/At
Supplier Tariff Reduction	0.055***	0.042**	0.054**	0.040**	0.041**
	(2.87)	(2.27)	(2.34)	(2.14)	(2.19)
Supplier Tariff Increase				-0.115	
				(-1.45)	
Own Industry Tariff Reduction					0.002
					(1.01)
Downstream Tariff Reduction					0.014
					(1.27)
Ln(Assets)		-0.011***	-0.011***	-0.011***	-0.011***
		(-13.02)	(-13.13)	(-13.07)	(-13.02)
Tobin's Q		0.007***	0.007***	0.007***	0.007***
		(15.33)	(15.36)	(15.32)	(15.34)
Cash/Assets		-0.006*	-0.006*	-0.006*	-0.006*
		(-1.86)	(-1.82)	(-1.85)	(-1.87)
Debt/Assets		-0.038***	-0.038***	-0.038***	-0.038***
		(-11.57)	(-11.59)	(-11.56)	(-11.58)
EBITDA/Assets		0.044***	0.044***	0.044***	0.044***
		(9.64)	(9.60)	(9.64)	(9.64)
Cash Flow/Assets		-0.004	-0.004	-0.004	-0.004
		(-1.34)	(-1.29)	(-1.34)	(-1.33)
Sales Growth		0.004***	0.004***	0.004***	0.004***
		(5.53)	(5.54)	(5.53)	(5.51)
Excess Return		0.004***	0.004***	0.004***	0.004***
		(8.91)	(8.90)	(8.92)	(8.91)
Excess Volatility		-0.258***	-0.256***	-0.258***	-0.259***
		(-10.32)	(-10.26)	(-10.34)	(-10.37)
Industry Sales Growth		0.010***	0.010***	0.010***	0.010***
		(5.16)	(5.21)	(5.12)	(5.14)
Industry Concentration		0.002	0.004	0.003	0.003
		(0.55)	(0.96)	(0.59)	(0.58)
Firm & Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2	0.417	0.475	0.475	0.475	0.475
Observations	44,590	44,590	44,590	44,590	44,590

Table 4: Effect on Aggregate Investment at the Industry Level

This table presents coefficient estimates for the effect of large import tariff reductions in supplier industries on customers' aggregate investment at the industry level. The data are obtained from the NBER-CES Manufacturing Industry Database (`http://www.nber.org/nberces/`) and cover U.S. manufacturing industries (SIC codes 2000-3999). The sample period is 1974 to 2011 (the last year in the NBER-CES data). Individual industries are identified by their four-digit SIC codes. The dependent variable in columns (1) and (2) is *Growth of Capital Stock*, the year-on-year growth rate of the aggregate capital stock in the customers' industry. The dependent variable in columns (3) and (4) is *Capex/Capital Stock*, the aggregate amount of capital expenditures in year t scaled by the aggregate amount of capital stock at the end of year t-1. *Supplier Tariff Reduction* is the fraction of supplier industries that have experienced large tariff reductions in the past. All control variables are equally weighted averages across all firms in a given year and industry in the CRSP/Compustat merged database. Detailed variable definitions are provided in the Appendix. Standard errors are clustered by year, and t-statistics are reported in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)
Dependent Variable:	Growth of Capital Stock		Capex/Capital Stock	
Supplier Tariff Reduction	0.037**	0.046***	0.034*	0.043**
	(2.59)	(3.14)	(2.03)	(2.46)
Ln(Assets)		0.001		-0.000
		(1.14)		(-0.10)
Tobin's Q		0.009***		0.010***
		(6.45)		(6.75)
Cash/Assets		-0.041***		-0.055***
		(-3.36)		(-4.69)
Debt/Assets		-0.022***		-0.008
		(-3.05)		(-1.28)
EBITDA/Assets		-0.013		-0.023
		(-1.00)		(-1.60)
Cash Flow/Assets		0.030**		0.051***
		(2.07)		(3.55)
Sales Growth		0.003***		0.004***
		(3.00)		(3.00)
Excess Return		-0.005**		-0.000
		(-2.41)		(-0.13)
Excess Volatility		0.054		-0.032
		(0.51)		(-0.25)
Industry Concentration		-0.009**		-0.014***
		(-2.66)		(-4.43)
Industry & Year Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.473	0.488	0.446	0.470
Observations	4,296	4,296	4,296	4,296

Table 5: Cross-Sectional Variation Depending on Customers' and Suppliers' Bargaining Power

This table presents coefficient estimates for the effect of large import tariff reductions in supplier industries on customers' capital expenditures. The sample period is 1974 to 2012. In column (1), we distinguish between tariff reductions in concentrated and in dispersed supplier industries. In each year, a supplier industry is classified as concentrated if the Herfindahl-Hirschman Index (HHI) of sales in the industry is larger than the median and as dispersed otherwise. *Supplier Industry Concentration* is the weighted average industry concentration across a customer's supplier industries. *Customer Industry Concentration* is the Herfindahl-Hirschman Index (HHI) of sales in the customer's industry. *Customer Size* is the natural logarithm of the book value of the customer's total assets. *Control Variables* is a vector of all firm- and industry-level control variables as specified in Equation (11) and includes *Customer Industry Concentration* and *Customer Size*. All other variables are defined as in Table 3. Detailed variable definitions are provided in the Appendix. t-statistics are reported in parentheses. Standard errors are clustered in two ways, by (SIC4-)industry×year and by firm. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)
Dependent Variable:	Capex/At	Capex/At	Capex/At
Supplier Tariff Reduction	0.073***		
(Concentrated Supplier Industry)	(3.41)		
Supplier Tariff Reduction	-0.003		
(Dispersed Supplier Industry)	(-0.13)		
Supplier Industry Concentration	0.077		
	(1.03)		
Supplier Tariff Reduction		0.082***	0.113***
		(3.24)	(3.23)
Supplier Tariff Reduction		-0.119**	
× Customer Industry Concentration (HHI)		(-2.53)	
Supplier Tariff Reduction			-0.011**
× Customer Size (Ln(Assets))			(-2.11)
Control Variables	Yes	Yes	Yes
Firm & Year Fixed Effects	Yes	Yes	Yes
R^2	0.476	0.475	0.475
Observations	43,779	44,590	44,590

Table 6: Cross-Sectional Variation Depending on Vertical Integration, Input Differentiation, Contingency Uncertainty, and Shipping Costs

This table presents coefficient estimates for the effect of large import tariff reductions in supplier industries on customers' capital expenditures. The sample period is 1974 to 2012. In panel A, we distinguish between tariff reductions in supplier industries into which the customer is vertically integrated and in supplier industries into which the customer is not vertically integrated. *Customer Integration* is the fraction of supplier industries into which the customer is vertically integrated. In panel B, we distinguish between tariff reductions in supplier industries producing differentiated inputs and in supplier industries producing generic inputs. In each year, a supplier industry is classified as producing differentiated inputs if the ratio of aggregate R&D expenditures divided by aggregate sales in the industry is larger than the median and as producing generic inputs otherwise. *Supplier Differentiation* is the fraction of a customer's supplier industries that are classified as producing differentiated inputs. In panel C, we interact *Supplier Tariff Reduction* with *Customer Sales Volatility*, the demeaned standard deviation of the customer's annual sales over the sample period scaled by the customer's average sales. In panel D, we distinguish between tariff reductions in supplier industries with high shipping costs and in supplier industries with low shipping costs. In each year, a supplier industry is classified as having high shipping costs if its shipping costs (as a percentage of the customs value of the imports) are larger than the median and as having low shipping costs otherwise. *Shipping Costs* is the average value of the shipping costs (as a percentage of the customs value of the imports) across the customer's different supplier industries. *Control Variables* is a vector of all firm- and industry-level control variables as specified in Equation (11). All other variables are defined as in Table 3. Detailed variable definitions are provided in the Appendix. t-statistics are reported in parentheses. Standard errors are clustered in two ways, by (SIC4-)industry×year and by firm. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Panel A: Vertical Integration		Panel B: Input Differentiation	
Dependent Variable:	Capex/At	Dependent Variable:	Capex/At
Supplier Tariff Reduction	0.052**	Supplier Tariff Reduction	0.043**
(Customer Not Integrated)	(2.44)	(Differentiated Input)	(2.22)
Supplier Tariff Reduction	-0.070	Supplier Tariff Reduction	-0.009
(Customer Integrated)	(-1.20)	(Generic Input)	(-0.16)
Customer Integration	0.164***	Supplier Differentiation	-0.065
	(3.22)		(-1.50)
Control Variables	Yes	Control Variables	Yes
Firm & Year Fixed Effects	Yes	Firm & Year Fixed Effects	Yes
R^2	0.479	R^2	0.476
Observations	41,145	Observations	43,779

Panel C: Contingency Uncertainty		Panel D: Shipping Costs	
Dependent Variable:	Capex/At	Dependent Variable:	Capex/At
Supplier Tariff Reduction	0.048**	Supplier Tariff Reduction	0.043**
	(2.49)	(Low Shipping Costs)	(2.00)
Supplier Tariff Reduction	0.186***	Supplier Tariff Reduction	0.034
× Customer Sales Volatility	(4.39)	(High Shipping Costs)	(1.57)
		Shipping Costs	-0.001
			(-1.22)
Control Variables	Yes	Control Variables	Yes
Firm & Year Fixed Effects	Yes	Firm & Year Fixed Effects	Yes
R^2	0.476	R^2	0.476
Observations	44,590	Observations	43,779

Table 7: Effect of Large Import Tariff Reductions on Financially Unconstrained Customers

This table presents coefficient estimates for the effect of large import tariff reductions in their suppliers' industries on customers' capital expenditures for three samples of customers that are unlikely to be financially constrained. In column (1), we focus on customers that pay out dividends. In column (2), we focus on customers whose Kaplan and Zingales (1997) index is smaller than the sample median. In column (3), we focus on customers whose Whited and Wu (2006) index is smaller than the sample median. The sample period is 1974 to 2012. *Control Variables* is a vector of all firm- and industry-level control variables as specified in Equation (11). All other variables are defined as in Table 3. Detailed variable definitions are provided in the Appendix. t-statistics are reported in parentheses. Standard errors are clustered in two ways, by (SIC4-)industry×year and by firm. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)
Sample:	Dividend Payers	KZ-Index < Median	WW-Index < Median
Dependent Variable:	Capex/At	Capex/At	Capex/At
Supplier Tariff Reduction	0.056***	0.049**	0.046**
	(2.58)	(2.18)	(2.12)
Control Variables	Yes	Yes	Yes
Firm & Year Fixed Effects	Yes	Yes	Yes
R^2	0.511	0.532	0.560
Observations	17,904	21,067	21,837

Appendix to "The Effect of Hold-up Problems on Corporate Investment: Evidence from Import Tariff Reductions"

Variable Definitions

Variable	Definition
Assets	Total assets (at). Source: Compustat.
Average Supplier Tariff Rate	(Gross-flow weighted) average import tariff rate in all supplier industries. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
Capex/Assets	Capital expenditures (capx) in year t / total assets (at) at the end of year $t-1$. Source: Compustat.
Capex/Capital Stock	Aggregate capital expenditures in year t / aggregate capital stock at the end of year $t-1$. Source: NBER-CES database.
Cash/Assets	Total cash holdings (che) / total assets (at). Source: Compustat.
Cash Flow/Assets	Income before extraordinary items (ibc) / total assets (at). Source: Compustat.
Customer Integration	(Gross-flow weighted) fraction of supplier industries into which a customer is vertically integrated. Source: Compustat, 1992 BEA input-output table.
Customer Sales Volatility	Standard deviation of a customer's annual sales scaled by the customer's average sales. Demeaned. Source: Compustat.
Debt/Assets	Total long-term and short-term debt (dllt + dlc) / total assets (at). Source: Compustat.
Dividend Payer	Indicator equal to one if a firm pays dividends. Source: Compustat.
Downstream Tariff Reduction	(Gross-flow weighted) fraction of downstream industries that have experienced large tariff reductions in the past. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
EBITDA/Assets	EBITDA (ebitda) / total assets (at). Source: Compustat.
Excess Return	Stock Return ([prcc_f / prcc_f$_{t-1}$] - 1) - Market Return ([usdval / usdval$_{t-1}$] - 1). Source: Compustat, CRSP.
Excess Volatility	Yearly standard deviation of daily returns - yearly standard deviation of daily market returns. Source: CRSP.
Growth of Capital Stock	(Aggregate capital stock at the end of year t / aggregate capital stock at the end of year $t-1$) - 1. Source: NBER-CES database.
Industry Concentration	Herfindahl-Hirschman Index (HHI) of sales in a given industry and year. Source: Compustat.
Industry Sales Growth	Growthrate of aggregate sales in a given industry and year. Source: Compustat.
Kaplan-Zingales (KZ) Index	$-1.001909*[(ib+dp)/ppent_{t-1}]+0.2826389*[(at+csho*prcc_f-ceq-txdb)/at]+3.139193*[(dltt+dlc)/(dltt+dlc+seq)]-39.3678*[(dvc+dvp/ppent_{t-1})]-1.314759*[che/ppent_{t-1}]$. (Formula based on Lamont, Polk, and Saá-Requejo (2001)). Source: Compustat.
Ln(Assets)	Natural logarithm of total assets (at). Source: Compustat.

Variable	Definition
Own Industry Tariff Reduction	Indicator equal to one if the industry has experienced a large tariff reduction in the past. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
Post Tariff Reduction	Indicator equal to one if the industry has experienced a large tariff reduction in the past. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
Sales Growth	[Sales (sale) in year t / Sales in year t-1] - 1. Source: Compustat.
Shipping Costs	Shipping costs in percent of customs value. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
Supplier Differentiation	(Gross-flow weighted) fraction of supplier industries whose R&D expenditures scaled by sales are larger than the Compustat median. Source: 1992 BEA input-output table, Compustat.
Supplier Industry Concentration	(Gross-flow weighted) average of the Herfindahl-Hirschman Index (HHI) of sales in upstream industries. Source: Compustat, 1992 BEA input-output table.
Supplier Tariff Increase	(Gross-flow weighted) fraction of supplier industries that have experienced large tariff increases in the past. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
Supplier Tariff Reduction	(Gross-flow weighted) fraction of supplier industries that have experienced large tariff reductions in the past. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
Supplier Tariff Reduction ($3 \times$ Median Tariff Change)	"Supplier Tariff Reduction" using three times the median (instead of the mean) avg. tariff change as the cutoff defining "large" reductions. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
$\mathbb{1}$ {Supplier Tariff Reduction} (Important Suppliers Only)	Indicator equal to one if at least one upstream industry supplying at least 10% of the customer industry's inputs has experienced a large tariff reduction in the past. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table.
Supplier Tariff Reduction (Concentrated Supplier Industry)	"Supplier Tariff Reduction" based only supplier industries whose Herfindahl-Hirschman index of sales is larger than the Compustat median. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table, Compustat.
Supplier Tariff Reduction (Customer Integrated)	"Supplier Tariff Reduction" based only on supplier industries into which a customer is integrated. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table, Compustat.
Supplier Tariff Reduction (Customer Not Integrated)	"Supplier Tariff Reduction" based only on supplier industries into which a customer is not integrated. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table, Compustat.

Variable	**Definition**
Supplier Tariff Reduction (Differentiated Input)	"Supplier Tariff Reduction" based only on supplier industries whose R&D expenditures scaled by sales are larger than the Compustat median. Source: Peter Schott's website, Center for International Data at UC Davis,1992 BEA input-output table, Compustat.
Supplier Tariff Reduction (Dispersed Supplier Industry)	"Supplier Tariff Reduction" based only supplier industries whose Herfindahl-Hirschman index of sales is smaller than or equal to the Compustat median. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table, Compustat.
Supplier Tariff Reduction (Generic Input)	"Supplier Tariff Reduction" based only on supplier industries whose R&D expenditures scaled by sales are smaller than or equal to the Compustat median. Source: Peter Schott's website, Center for International Data at UC Davis, 1992 BEA input-output table, Compustat.
Tobin's Q	[Total assets (at) - book value of equity (ceq) + market value of equity (chso*prcc_f)] / total assets (at). Source: Compustat.
Whited-Wu (WW) Index	$-0.091 * [ibc/at] - 0.044 * ln(at) + 0.102 * industrysalesgrowth - 0.035 * salesgrowth - 0.062 * dividendpayer + 0.021 * [dltt/at]$. (Formula based on Whited and Wu (2006)) Source: Compustat.

Relaxing Assumptions of the Model to Derive Predictions 4.a-c

Vertical Integration. Suppose C and S are vertically integrated and operate as a single entity V that maximizes the joint surplus of C and S. In that case, the optimal investment at $t = 0$ is

$$i^V \in \arg\max_{i \in \mathbb{R}_+} f(i)\,(1-k) - i \tag{A1}$$

and equal to the first-best investment i^{FB} given by $f'(i^{FB}) = 1/(1-k)$, which does not depend on the tariff rate τ. Hence, tariff changes do not lead to changes in the level of investment. This result motivates Prediction 4.a.

Generic Input. Suppose the marginal return from C's investment does not depend on whether trade with S occurs because the required input is generic and can be bought from many alternative (domestic) suppliers whose opportunity cost per unit of input is k. C will then push down S to its reservation utility during the bargaining process, and the input price per unit will be $x = k$. C's optimal investment at $t = 0$ is then the first-best investment i^{FB} given by $f'(i^{FB}) = 1/(1-k)$ and does not depend on the tariff rate. Hence, tariff changes do not lead to changes in the level of investment. This result motivates Prediction 4.b.

Complete Contract. Suppose C and S can write a complete contract at $t = 0$. The optimal contract specifies the first-best investment level i^{FB} given by $f'(i^{FB}) = 1/(1-k)$ and an input price x given by

$$f(i^{FB})(1-x) - i^{FB} = f(\hat{i})\,[1-p(\tau)] - \hat{i} + \beta\left\{f(i^{FB})(1-k) - i^{FB} - f(\hat{i})\,[1-p(\tau)] + \hat{i}\right\}, \tag{A2}$$

where $\hat{i}$ is given by $f'(\hat{i}) = 1/[1-p(\tau)]$. The quantity to be supplied is $q^{FB} = f(i^{FB})$.

The intuition is that C and S maximize the total surplus by specifying the first-best level of investment and set the price per unit of input so that C obtains its outside option plus a fraction β of the gains from trade. With a complete contract, the investment is efficient, and bargaining between C and S just re-distributes the surplus. A crucial difference compared to the model with a hold-up problem is that C's investment does not depend on the tariff rate in this case. Hence, tariff changes do not lead to changes in the level of investment. This motivates Prediction 4.c.

Table A.1: Regression Results Using *Ln(Capex)* as the Dependent Variable

This table presents the results for the regressions reported in Table 3 when using *Ln(Capex)* instead of *Capex/At* as the dependent variable. All regressions (variables) are otherwise specified (defined) as in Table 3. t-statistics are reported in parentheses. Standard errors are clustered in two ways, by (SIC4-)industry×year and by firm. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable:	Ln(Capex)	Ln(Capex)	Ln(Capex)	Ln(Capex)	Ln(Capex)
Supplier Tariff Reduction	0.223	0.884***	0.760**	0.823***	0.852***
	(0.46)	(3.25)	(2.34)	(3.01)	(3.17)
Supplier Tariff Increase				-3.463**	
				(-2.26)	
Own Industry Tariff Reduction					0.020
					(0.76)
Downstream Tariff Reduction					0.296*
					(1.79)
Ln(Assets)		0.890***	0.889***	0.889***	0.890***
		(64.86)	(64.86)	(64.92)	(64.78)
Tobin's Q		0.128***	0.128***	0.128***	0.128***
		(19.75)	(19.80)	(19.71)	(19.74)
Cash/Assets		-0.280***	-0.278***	-0.279***	-0.281***
		(-4.32)	(-4.27)	(-4.30)	(-4.33)
Debt/Assets		-0.721***	-0.719***	-0.720***	-0.721***
		(-11.95)	(-11.90)	(-11.94)	(-11.95)
EBITDA/Assets		0.805***	0.802***	0.804***	0.805***
		(9.04)	(9.01)	(9.04)	(9.05)
Cash Flow/Assets		0.040	0.043	0.040	0.040
		(0.63)	(0.67)	(0.64)	(0.64)
Sales Growth		0.079***	0.080***	0.079***	0.079***
		(6.60)	(6.61)	(6.60)	(6.59)
Excess Return		0.076***	0.076***	0.076***	0.076***
		(10.11)	(10.09)	(10.12)	(10.10)
Excess Volatility		-5.519***	-5.489***	-5.533***	-5.540***
		(-11.23)	(-11.16)	(-11.28)	(-11.29)
Industry Sales Growth		0.141***	0.143***	0.139***	0.140***
		(4.73)	(4.80)	(4.66)	(4.69)
Industry Concentration		0.063	0.093	0.069	0.064
		(0.85)	(1.25)	(0.93)	(0.86)
Firm & Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2	0.869	0.919	0.919	0.919	0.919
Observations	44,590	44590	44,590	44,590	44,590

Table A.2: Regression Results Using Non-Winsorized Variables

This table presents the results for the regressions reported in Table 3 when using non-winsorized variables. t-statistics are reported in parentheses. Standard errors are clustered in two ways, by (SIC4-)industry×year and by firm. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable:	Capex/At	Capex/At	Capex/At	Capex/At	Capex/At
Supplier Tariff Reduction	0.053***	0.042**	0.065**	0.039*	0.040**
	(2.62)	(2.07)	(2.51)	(1.90)	(1.97)
Supplier Tariff Increase				-0.174*	
				(-1.93)	
Own Industry Tariff Reduction					0.002
					(1.07)
Downstream Tariff Reduction					0.017
					(1.41)
Ln(Assets)		-0.013***	-0.013***	-0.013***	-0.013***
		(-11.58)	(-11.65)	(-11.61)	(-11.58)
Tobin's Q		0.006***	0.006***	0.006***	0.006***
		(10.73)	(10.75)	(10.72)	(10.73)
Cash/Assets		-0.004	-0.003	-0.004	-0.004
		(-0.81)	(-0.78)	(-0.80)	(-0.83)
Debt/Assets		-0.040***	-0.040***	-0.039***	-0.040***
		(-8.10)	(-8.10)	(-8.09)	(-8.10)
EBITDA/Assets		0.026***	0.026***	0.026***	0.026***
		(3.43)	(3.42)	(3.43)	(3.43)
Cash Flow/Assets		-0.001	-0.001	-0.001	-0.001
		(-0.31)	(-0.28)	(-0.30)	(-0.30)
Sales Growth		-0.000**	-0.000**	-0.000**	-0.000**
		(-2.36)	(-2.39)	(-2.37)	(-2.34)
Excess Return		0.001	0.001	0.001	0.001
		(1.56)	(1.56)	(1.56)	(1.56)
Excess Volatility		-0.204***	-0.203***	-0.205***	-0.205***
		(-5.33)	(-5.31)	(-5.34)	(-5.35)
Industry Sales Growth		0.001	0.001	0.001	0.001
		(1.57)	(1.56)	(1.56)	(1.58)
Industry Concentration		0.001	0.003	0.001	0.001
		(0.13)	(0.50)	(0.18)	(0.16)
Firm & Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2	0.349	0.388	0.388	0.388	0.388
Observations	44,590	44,590	44,590	44,590	44,590

Table A.3: Regression Results Using Alternative Measures of Tariff Reductions

This table presents coefficient estimates using alternative tariff reduction measures. The sample period is 1974 to 2012. *Supplier Tariff Reduction (3 × Median Tariff Change)* is based on the median (instead of the mean) year-on-year tariff change in an industry. $\mathbb{1}\{$*Supplier Tariff Reduction*$\}$*(Important Suppliers Only)* is an indicator equal to one if at least one upstream industry supplying at least 10% of a customer industry's total inputs has experienced a large tariff reduction in the the past. *Average Supplier Tariff Rate* is the weighted average import tariff rate across supplier industries. t-statistics are reported in parentheses. Standard errors are clustered in two ways, by (SIC4-)industry×year and by firm. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)
Dependent Variable:	Capex/At	Capex/At	Capex/At
Supplier Tariff Reduction	0.047***		
(3 × Median Tariff Change)	(2.75)		
$\mathbb{1}\{$Supplier Tariff Reduction$\}$		0.011**	
(Important Suppliers Only)		(2.24)	
Average Supplier Tariff Rate			-0.006*
			(-1.92)
Ln(Assets)	-0.011***	-0.012***	-0.011***
	(-13.01)	(-4.48)	(-13.04)
Tobin's Q	0.007***	0.007***	0.007***
	(15.37)	(2.85)	(15.38)
Cash/Assets	-0.006*	-0.005	-0.006*
	(-1.88)	(-0.39)	(-1.83)
Debt/Assets	-0.038***	-0.029***	-0.038***
	(-11.52)	(-2.70)	(-11.54)
EBITDA/Assets	0.044***	0.103***	0.044***
	(9.62)	(4.98)	(9.63)
Cash Flow/Assets	-0.004	-0.017	-0.004
	(-1.30)	(-1.36)	(-1.31)
Sales Growth	0.004***	0.006***	0.004***
	(5.52)	(2.80)	(5.54)
Excess Return	0.004***	0.007***	0.004***
	(8.90)	(4.44)	(8.90)
Excess Volatility	-0.260***	-0.390***	-0.258***
	(-10.39)	(-4.47)	(-10.33)
Industry Sales Growth	0.010***	0.006	0.010***
	(5.17)	(1.30)	(5.20)
Industry Concentration	0.002	-0.024**	0.002
	(0.57)	(-2.46)	(0.54)
Firm & Year Fixed Effects	Yes	Yes	Yes
R^2	0.475	0.464	0.475
Observations	44,590	5,661	44,590

Table A.4: Regression Results Using Alternative Clustering Levels

This table presents the key coefficient estimates reported in Table 3 and the associated t-statistics for alternative clustering levels (in parentheses). The first t-statistic reported under each coefficient estimate is based on standard errors that are clustered by (SIC4-)industry×year. The second t-statistic is based on standard errors that are clustered by firm. The third is based on standard errors that are clustered in two ways, by firm and by year. The fourth is based on standard errors that are clustered by (SIC4-)industry. The fifth is based on standard errors that are clustered in two ways, by (SIC4-)industry and by year. All regressions are specified as in Table 3. We only report the key coefficients and the associated t-statistics to conserve space. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)
Dependent Variable:	Capex/At	Capex/At	Capex/At	Capex/At	Capex/At
Supplier Tariff Reduction	0.055	0.042	0.054	0.04	0.041
(Cluster: Industry×Year)	(4.31)***	(3.64)***	(3.71)***	(3.43)***	(3.52)***
(Cluster: Firm)	(3.12)***	(2.42)**	(2.42)**	(2.28)**	(2.32)**
(Cluster: Firm & Year)	(2.97)***	(2.41)**	(2.43)**	(2.29)**	(2.30)**
(Cluster: Industry)	(2.42)**	(1.90)*	(2.47)**	(1.79)*	(1.78)*
(Cluster: Industry & Year)	(2.47)**	(1.99)*	(2.59)**	(1.87)*	(1.84)*
Supplier Tariff Increase				-0.115	
(Cluster: Industry×Year)				(-2.35)**	
(Cluster: Firm)				(-1.50)	
(Cluster: Firm & Year)				(-1.39)	
(Cluster: Industry)				(-1.44)	
(Cluster: Industry & Year)				(-1.39)	
Own Industry Tariff Reduction					0.002
(Cluster: Industry×Year)					(1.36)
(Cluster: Firm)					(1.08)
(Cluster: Firm & Year)					(0.96)
(Cluster: Industry)					(0.99)
(Cluster: Industry & Year)					(0.94)
Downstream Tariff Reduction					0.014
(Cluster: Industry×Year)					(2.02)**
(Cluster: Firm)					(1.35)
(Cluster: Firm & Year)					(1.15)
(Cluster: Industry)					(0.77)
(Cluster: Industry & Year)					(0.74)
Control Variables	No	Yes	Yes	Yes	Yes
Firm & Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2	0.417	0.475	0.475	0.475	0.475
Observations	44,590	44,590	44,590	44,590	44,590