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The Downstream Impact of Upstream Tariffs: Evidence from Investment Decisions in Supply Chains

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Abstract

We study how U.S. manufacturing firms' investment responds to tariff reductions in supplier industries. Our estimates, based on tariff reductions following multinational trade agreements, suggest that a hypothetical 10% reduction of all upstream tariffs would increase downstream investment by 4% to 6%. This estimate is not explained by decreasing uncertainty and stems from tariff reductions for homogeneous and low-R&D inputs, consistent with the investment response resulting from cost reductions rather than superior foreign technology embodied in imported inputs. Evidence from an instrumental variable estimation using the sudden increase in Chinese import penetration suggests that import competition also increases downstream investment.

I. Introduction

Protectionist trade policies in the form of higher import tariffs have recently gained in political popularity. While such policies help some domestic industries

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by sheltering them from foreign competition, they hurt others by increasing the price of imported inputs that are needed for production. For example, import tariffs on steel may help domestic steel producers but hurt downstream firms that use steel. Consequently, as their input costs increase, steel-using firms may reduce their investment in productive capacity (e.g., decide not to build a new factory). Given that trade in intermediate inputs accounts for as much as two-thirds of all international trade (Johnson and Noguera (2012)), understanding such consequences is important.

In this article, we study the impact of upstream tariffs on downstream investment in U.S. manufacturing firms. The reason for our focus on firms' investment is twofold: First, investment is a major driver of economic growth (De Long and Summers (1991), Mankiw, Romer, and Weil (1992)) and therefore provides a natural link between trade policies today and future economic prosperity. Understanding how tariffs affect investment is thus of high importance. Second, the prime benefit of lower tariffs in highly developed economies like the United States is presumably the lower cost of imported goods. Hence, as lower input costs increase the value of productive capacity, an intuitive prediction is that tariff reductions lead to an increase in downstream investment.

Theoretically, however, the relation between upstream tariffs and downstream investment can be ambiguous (e.g., Acemoglu, Autor, Dorn, Hanson, and Price (2016)): On the one hand, lower tariffs upstream may entail lower input costs downstream and lead to more investment. On the other hand, lower tariffs may increase the risk that domestic suppliers succumb to competition and go out of business, leading to supply chain disruptions, which may reduce firms' willingness to invest in productive capacity.

Overall, our empirical findings suggest that the former effect dominates. Specifically, we estimate that a hypothetical 10% decrease in all import tariffs in manufacturing industries (e.g., from 5% to 4.5%) would lead to an increase in downstream investment by 4%–6% (relative to the mean). Put differently, our findings suggest that a 10% decrease in import tariffs, which we estimate to reduce downstream input costs by about 1%, would enlarge the downstream firms' investment opportunity set and that the investment required to undertake the new projects would amount to 4%–6% of the firms' total investment. In terms of timing, we find that the increase in investment starts showing up in year two following the tariff reductions and lasts until the end of our sample period, 7 years later, thus suggesting a long-lived rather than transitory impact.

The increase in investment, however, need not be efficient but could reflect overinvestment. It is difficult to empirically distinguish optimal from overinvestment, but we provide some suggestive evidence that our findings are not due to overinvestment. First, we examine the relation between upstream tariff reductions and downstream profitability and productivity, which we would expect to decline following overinvestment. Our tests, however, do not support this prediction. Instead, we find evidence pointing in the other direction (i.e., that profitability and productivity increase). Second, we find that the overall increase in investment stems from firms with higher increases in profitability and productivity and firms with stronger corporate governance (as proxied by higher institutional ownership). Both findings seem less consistent with overinvestment.

In a number of further tests, we find that the average impact of upstream tariff reductions on downstream investment masks significant cross-sectional variation. In particular, the increase in investment is stronger for firms whose input costs account for a larger share of their overall production costs and for users of homogeneous, low-R&D inputs (e.g., cement). These results suggest that, for U.S. firms, input cost reductions are the primary reason for the increase in investment, rather than improved access to superior foreign technology embodied in imported goods. As such, the cross-sectional variation that we find provides an important distinction between our article, which studies firms in a highly industrialized economy (the United States), and prior work on trade liberalizations in developing countries (e.g., Brazil, Indonesia, Chile, India), where the effects have been attributed to better access to foreign goods of greater quality and variety. We also find that the response to upstream tariff reductions is stronger in concentrated than in dispersed industries (i.e., when firms are likely to have more bargaining power vis-à-vis suppliers and customers). Finally, we find an increase in investment only for firms that are not financially constrained, suggesting that financing frictions can reduce the extent to which tariff cuts translate into increased downstream investment.

A concern is that tariffs may be endogenous to investment opportunities as policymakers may set import tariffs to protect domestic industries that have few growth opportunities. To help alleviate this concern, we exploit tariff revisions following multinational trade agreements. Krugman, Obstfeld, and Melitz (2015) suggest that these agreements are less likely to be influenced by lobbying. Arguably, they are thus less likely to reflect individual industries' growth opportunities (Frésard and Valta (2016)). The idea is that the lobbying activities of exporters that stand to gain from freer trade may offset the lobbying activities of import-competing producers that stand to lose from a liberalization.

For our analysis, we thus rely on tariff revisions following the implementation of the Generalized System of Preferences (GSP) in 1976, tariff revisions agreed upon during the seventh General Agreement on Tariffs and Trade (GATT) round implemented from 1980 onward, and tariff revisions due to the North American Free Trade Agreement (NAFTA) and the eighth GATT round implemented from 1994 and 1995 onward. Specifically, we compare downstream firms' investment before and after these tariff revisions in a difference-in-differences (DiD) framework.

Reassuringly, we do not find any evidence that the tariff revisions are related to pretreatment firm- or industry-characteristics. In particular, we find no evidence of a relation between the tariff revisions and observable proxies for downstream growth opportunities (Tobin's Q and sales growth) in the pretreatment years. Controlling for these proxies does not affect our results either. Further, we find no evidence of differential pretreatment trends in investment (i.e., no evidence of a relation between tariff revisions and downstream investment before the revisions are implemented).

We also address the concern that the trade agreements may have led not only to lower tariffs but also to lower uncertainty (e.g., due to the resolution of trade policy uncertainty) and that reductions in downstream uncertainty may explain our findings. Specifically, we show that, while lower uncertainty does translate into higher investment, controlling for reductions in downstream uncertainty has virtually no effect on the estimated impact of the upstream tariff reductions. Finally, we find that the estimated effect of upstream tariffs (which we construct for each SIC4-industry and year) is robust to the inclusion of SIC3 × year fixed effects. Time-varying differences between firms in different SIC3-industries can thus not explain the results.

In a second test to address endogeneity concerns, we rely on a different identification assumption and use data from a different setting and period. Specifically, we exploit the sudden increase in Chinese import penetration in U.S. manufacturing industries between 1991 and 2011. Here, the identification strategy is based on the idea that the increase in imports from China is the result of economic reforms in the 1980s and 1990s in China and its accession to the World Trade Organization (WTO) in 2001. This suggests that Chinese import penetration in other developed countries (which is presumably driven by the same economic reforms in China and its WTO accession) can be used as an instrument for Chinese import penetration in the United States (Autor, Dorn, and Hanson (2013), Acemoglu et al. (2016), and Hombert and Matray (2018)). Using this approach, we find that higher Chinese import penetration in upstream industries leads to higher investment by downstream firms. This result is consistent with the following interpretation of our tariff-related findings: Lower import tariffs foster competition from foreign rivals, output prices fall, and downstream firms respond to the reduction in input costs by increasing investment. Further tests support this interpretation. We find that upstream tariff reductions are indeed followed by lower input material prices for downstream firms.

Our article is related to work on the impact of freer trade in the United States.[1] Autor et al. (2013) find that competition from China led to higher unemployment, reduced labor-force participation, and lower wages. Acemoglu et al. (2016) show that Chinese import competition was a key contributor to the decline in manufacturing employment in the 2000s. Pierce and Schott (2016) also focus on employment and link its decline to the granting of permanent normal trade relations to China.[2]

The aforementioned papers highlight that freer trade in the United States leads to substantial adjustment costs. We look at the other side of the cost–benefit equation. Unlike the short-run adjustment costs that are concentrated among the directly affected industries, workers, and communities, however, the long-run benefits are likely to be more dispersed. Hence, while potentially large in aggregate, the benefits of freer trade are likely to be small at the individual level and difficult to document. Our goal is to advance our understanding of these benefits by quantifying the impact of U.S. tariff reductions for intermediate goods on the investment decisions of downstream firms that use these goods as inputs. Relative to prior findings that firms reduce their investment after trade liberalizations in their *own*

[1]Also related are recent papers on the United States–China trade war of 2018 and 2019, including Amiti, Redding, and Weinstein (2019), (2020), Flaaen and Pierce (2019), Amiti, Kong, and Weinstein (2020), Fajgelbaum, Goldberg, Kennedy, and Khandelwal (2020), and Flaaen, Hortaçsu, and Tintelnot (2020).

[2]In a recent working paper, Bown, Conconi, Erbahar, and Trimarchi (2021) also focus on employment and find that antidumping duties against China reduced downstream employment. In one test using industry-level data, they also show a decline in investment, but they do not provide any firm-level evidence, nor do they examine any cross-sectional variation in the response.

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industries (Frésard and Valta (2016), Pierce and Schott (2018)), our contribution is thus to show how the response to tariff reductions propagates along the firms' supply chains.

Tariffs on intermediate goods have also been linked to total factor productivity (TFP). Specifically, the literature has found that, in developing countries, lower input tariffs are associated with higher TFP and attributes this relation to the superior foreign technology that is embodied in imported inputs and the greater variety of foreign inputs (Schor (2004), Amiti and Konings (2007), Kasahara and Rodrigue (2008), Goldberg, Khandelwal, Pavcnik, and Topalova (2010), Topalova and Khandelwal (2011), and Halpern, Koren, and Szeidl (2015)). Our work is different because an increase in TFP is not the same as an increase in investment, and neither one necessitates the other.

Further, none of the aforementioned papers examine the impact on firms' investment. An exception is Kandilov and Leblebicioğlu (2012), who use Mexican data from 1984 to 1990 to show that reductions in tariffs and import license coverage on intermediate inputs result in higher investment. Several important features distinguish our analysis from theirs: First, unlike Mexico in the 1980s, the United States is not a developing country and, as argued by Trefler (2004), it is not clear which results extend from developing/transitioning countries to highly industrialized economies like the United States. Second, Kandilov and Leblebicioğlu (2012) estimate panel regressions on 7 years of data around a single, unilateral trade liberalization. We, in contrast, exploit four multilateral trade agreements and estimate DiD models on 31 years of data (1971–2001). Third, because we use data on public firms that have observable share prices, we can control for proxies of growth opportunities and uncertainty (e.g., Tobin's Q, stock returns, and return volatility). Fourth, we not only examine how the downstream firms' response to upstream tariff reductions varies with the characteristics of the downstream firms themselves but also how the downstream response depends on the characteristics of the upstream suppliers.

We proceed as follows: In Section II, we describe the conceptual framework that guides our analysis and lay out the predictions. All formal derivations are provided in the Supplementary Material. In Section III, we describe the data. In Section IV, we present the results. In Section V, we conclude.

II. Conceptual Framework and Predictions

We have in mind firms that decide how much to invest in productive capacity by trading off the cost of investment with the expected payoff from producing more output. Upstream tariff reductions can affect this trade-off by increasing the expected profit per unit of output. This can occur through multiple, nonmutually exclusive channels: First, lower upstream tariffs can reduce the firms' cost of producing the output by reducing the price at which they can buy input from their suppliers (De Loecker, Goldberg, Khandelwal, and Pavcnik (2016), Blaum, Lelarge, and Peters (2018)). A lower tariff reduces, for example, the cost at which the input can be imported. It can also increase import competition, which can in turn lead to an increase in supplier productivity and thus a decrease in the marginal cost of producing the input (Melitz and Trefler (2012)) or a reduction in the markup that the suppliers charge. Second, lower upstream tariffs can increase the quality or variety of the available input (Goldberg et al. (2010)) and, through this channel, increase the price at which the downstream firms can sell their output. By increasing the expected profit per unit of output, upstream tariff reductions can thus increase the firms' incentives to invest in productive capacity. This motivates our main prediction:

Prediction 1. Upstream tariff reductions entail an increase in downstream investment.

The link between upstream tariffs and downstream investment in the above framework is the firms' supply chain: Lower upstream tariffs can increase the expected profit per unit of output by reducing the cost of input procured from upstream suppliers.[3] The cost of other resources not obtained from upstream suppliers (e.g., labor), however, should not be directly affected. Hence, upstream tariff reductions should have a larger effect on the expected profit per unit of output – and thus the incentives to expand productive capacity – if the input procured from upstream suppliers makes up a larger share of the overall production costs. This leads to the following prediction:

Prediction 2. All else equal, upstream tariff reductions entail a larger increase in downstream investment if the firms' input costs account for a larger share of their overall production costs.

Notwithstanding the above arguments, there are also reasons why upstream tariff reductions may not entail higher downstream investment: They could increase the risk of supply chain disruptions, which could in turn reduce firms' incentives to expand their productive capacity.

For concreteness, suppose that a downstream firm's supply chain is disrupted with some probability because its upstream supplier goes out of business. Suppose further that import tariff reductions increase this probability because they expose the supplier to more competition from abroad. If the supplier produced a homogeneous good (e.g., cement) and can be easily replaced with another (possibly foreign) supplier, then its demise is unlikely to have a significant impact on the downstream firm. If the supplier produced a differentiated good (e.g., industrial machinery) and cannot be easily replaced, however, then the supply chain disruption is likely to reduce the downstream firm's payoff. The reason is that the use of differentiated inputs is likely to require relationship-specific investments that lose some of their value if the supplier must be switched ex post. Any positive effect on the profit per unit of output conditional on the supplier's survival is thus mitigated by the increase in the risk that the supplier succumbs to foreign competition. Tariff reductions in upstream industries that produce differentiated goods are therefore likely to entail smaller increases in the downstream firms' incentives to expand their productive capacity. This motivates:

[3]Note that increases in the input's quality or variety can also be interpreted as decreases in its quality-adjusted cost.

Prediction 3. All else equal, upstream tariff reductions for homogeneous goods entail a larger increase in downstream investment than upstream tariff reductions for differentiated goods.

The idea that upstream tariff reductions increase the downstream firms' profit per unit of output – and, hence, their incentives to expand productive capacity – rests on an implicit assumption: The firms can negotiate lower prices from their suppliers but do not need to pass on all of the cost savings to their own customers. Or they can negotiate higher prices from the customers but do not need to pass on all of the gains to the suppliers. That is, the firms must have some bargaining power. Otherwise, without bargaining power, they would not be able to appropriate any of the cost savings from lower import tariffs or would be forced to pass on any of the gains to their own customers. In that case, upstream tariff reductions would not change the downstream firms' profit per unit of output and, hence, would not change their incentives to expand their productive capacity. This suggests that the investment response to upstream tariff reductions should be more pronounced if the downstream firms have more bargaining power vis-à-vis their suppliers and customers:

Prediction 4. All else equal, upstream tariff reductions entail a larger increase in downstream investment if the firms have more bargaining power vis-à-vis their suppliers and customers.

All predictions so far implicitly assume that the downstream firms can finance new investments. If they are financially constrained, however, then they may not be able to expand their productive capacity because they cannot come up with the required up-front financing. Imagine, for example, that the firms' internal cash flows from existing operations are insufficient and that moral hazard or adverse selection problems limit the pledgeability of any future cash flows from new investments. In that case, the downstream firms may respond less to upstream tariff reductions.

On the other hand, the tariff reductions could also relax the firms' financial constraints, leading to a larger response. Imagine, for example, that lower upstream tariffs not only increase the attractiveness of new investments but also the cash flows from existing operations (e.g., through lower input costs). A firm that was already unconstrained before would then expand from the old to the new optimum. A firm whose investment was below the old (unconstrained) optimum because of financial constraints, however, may expand even more if it now also "catches up" on investments that it could not undertake before but that it can finance now due to the higher internal cash flows.

A priori, whether financial constraints reduce or increase firms' response to upstream tariff reductions is thus an empirical question. Consequently, we formulate the prediction as follows:

Prediction 5. The increase in downstream investment in response to upstream tariff reductions differs, all else equal, between financially constrained and unconstrained downstream firms.

III. Data

We obtain data on imports in U.S. manufacturing industries (4-digit SIC codes 2000–3999) from the Center for International Data at UC Davis (http://cid.econ.ucdavis.edu/). The customs value of imports is available from 1972 and the value of import duties from 1974 onward. We begin by computing the effective import tariff rate for each combination of an industry, year, and country of origin as the value of import duties divided by the customs value of imports. Thereafter, for each industry and year, we compute the average import tariff rate across the different countries of origin, using the customs values of imports as weights. The resultant variable, $\text{IMPORT\_TARIFF}_{j,t}$, can thus be interpreted as the import-value-weighted average effective tariff rate in industry j and year t across the different countries of origin.

A potential concern is that changes in $\text{IMPORT\_TARIFF}_{j,t}$ may not actually reflect changes in tariff rates but instead changes in the amounts of imports from different countries. To avoid this problem, when computing the implied changes in $\text{IMPORT\_TARIFF}_{j,t}$ around the multinational trade agreements that we exploit in our subsequent tests, we hold the weight of each country of origin constant at the value of imports during the last year before the implementation of each trade agreement.

To construct upstream-downstream linkages (i.e., supplier-customer relations), we follow Acemoglu et al. (2016) and rely on the gross flows of goods between industries as reported in the U.S. Bureau of Economic Analysis (BEA) input–output tables. An advantage of this approach is that the flows of goods between industries are likely to be determined by the industries' innate production technologies rather than individual firms' decisions to buy from a particular supplier. For example, unlike the use of steel in the production of industrial machinery in general, any given firm's choice to buy steel from a particular supplier may be driven by unobservable firm characteristics. Relying on industry- rather than firm-level upstream-downstream linkages helps mitigate such concerns.

Using the above data on industry-level import tariffs and upstream-downstream linkages, we then compute in each year and for each industry the gross-flow-weighted average import tariff in its upstream (i.e., supplier) industries. Specifically, for each industry j and year t, we compute

$$(1)\qquad \text{UP\_TARIFF}_{j,t} = \sum_{s \in S_{-j}} \omega_{s,j} \times \text{IMPORT\_TARIFF}_{s,t}.$$

$\text{IMPORT\_TARIFF}_{s,t}$ is the tariff in industry s and year t, S_{-j} is the set of all industries other than j, and

$$(2)\qquad \omega_{s,j} = \frac{\text{Gross flow of goods from industry } s \text{ to industry } j}{\text{Total gross flow of goods from all industries to industry } j}.$$

Analogously, we compute the average tariff in the downstream (i.e., customer) industries as

$$\text{DOWN\_TARIFF}_{j,t} = \sum_{s \in S_{-j}} v_{j,s} \times \text{IMPORT\_TARIFF}_{s,t} \quad (3)$$

with

$$v_{j,s} = \frac{\text{Gross flow of goods from industry } j \text{ to industry } s}{\text{Total gross flow of goods from industry } j \text{ to all industries}}. \quad (4)$$

Similar to the above-discussed concern about changes in the amounts of imports from different countries when computing changes in IMPORT_ TARIFF$_{j,t}$, a concern regarding changes in UP_TARIFF$_{j,t}$ and DOWN_ TARIFF$_{j,t}$ is that these may reflect changes in the gross flows of goods between industries. To avoid this problem, when computing the changes in UP_TARIFF$_{j,t}$ and DOWN_TARIFF$_{j,t}$ that we use in our DiD analysis, we fix the industry weights $\omega_{s,j}$ in equation (2) and $v_{j,s}$ in equation (4) at the values implied by the last available BEA input–output table before each trade agreement.

As in Baker, Stein, and Wurgler (2003), we measure firms' investment in a given year as capital expenditures scaled by the book value of total assets at the end of the previous year. We also construct the following firm- and industry-level control variables: ln(ASSETS), TOBINS_Q, CASH/ASSETS, DEBT/ASSETS, EBITDA/ ASSETS, SALES_GROWTH, EXCESS_RETURN, EXCESS_VOLATILITY, IND_SALES_GROWTH, and IND_CONCENTRATION. Definitions of all variables are in the Appendix. All data come from Compustat and CRSP, and all variables are winsorized at the 1st and 99th percentiles as in Baker et al. (2003). Using nonwinsorized variables leads to similar results.

IV. Results

A. DiD Estimation Around Multinational Trade Agreements

A concern when attempting to estimate the impact of upstream tariffs on downstream investment is that tariffs are not randomly assigned but the outcome of policymaking. In particular, industry lobbyists may try to influence the tariff-setting process, and the extent of the lobbying may depend on firms' growth opportunities. Whether such lobbying would lead to an upward or downward bias, however, is difficult to say. On the one hand, the upstream suppliers to declining industries with few growth opportunities may lobby for higher tariffs to be protected from foreign competition. On the other hand, the downstream customers may lobby for lower tariffs to obtain cheaper inputs from abroad. We further note that any individual industry typically accounts for only a small fraction of any other industry's total sales or purchases. Indeed, Table A.1 in the Supplementary Material reveals that even the most important downstream (upstream) industry in terms of purchase (sales) volume accounts, on average, for only 7% (9%) of the upstream (downstream) industry's total sales (purchases). This evidence helps reduce the concern that the growth opportunities in any one industry are the key driver behind the lobbying efforts aimed at influencing upstream import tariffs.

Nonetheless, to alleviate the concern that lobbying efforts may confound our analysis, we use a DiD framework that exploits tariff revisions following multinational trade agreements.[4] The motivation for this strategy is based on Krugman et al. (2015), who suggest that such agreements are less likely to be influenced by industrial lobbying. Arguably, they are thus less likely to reflect individual industries' growth opportunities (Frésard and Valta (2016)). The key idea is that the lobbying activities of exporters that stand to gain from freer trade may offset the lobbying activities of import-competing producers that stand to lose from a trade liberalization.

For our analysis, we therefore rely on tariff revisions following large, multinational trade agreements: the implementation of the GSP (from 1976 onward), tariff revisions agreed upon during the 7th GATT round (from 1980 onward), and tariff revisions due to NAFTA and the 8th GATT round (from 1994 and 1995 onward). Specifically, around each trade agreement, we compute the reductions in import tariffs from 1 year before to 3 years after the agreement. We do so to capture the full extent of the tariff revisions, noting that some were not implemented immediately but phased in over several years. In Table A.3 in the Supplementary Material, we show that computing tariff reductions over alternative horizons does not change the results.

For each trade agreement k and industry j, we thus compute the reduction in upstream tariffs $\left(\Delta\text{UP\_TARIFF}_{k,j}\right)$, tariffs in industry j $\left(\Delta\text{OWN\_TARIFF}_{k,j}\right)$, and downstream tariffs $\left(\Delta\text{DOWN\_TARIFF}_{k,j}\right)$,

$$\Delta\text{UP\_TARIFF}_{k,j} = \text{UP\_TARIFF}_{k,j,t=-1} - \text{UP\_TARIFF}_{k,j,t=3}, \tag{5}$$

$$\Delta\text{OWN\_TARIFF}_{k,j} = \text{OWN\_TARIFF}_{k,j,t=-1} - \text{OWN\_TARIFF}_{k,j,t=3}, \tag{6}$$

$$\Delta\text{DOWN\_TARIFF}_{k,j} = \text{DOWN\_TARIFF}_{k,j,t=-1} - \text{DOWN\_TARIFF}_{k,j,t=3}. \tag{7}$$

$t = -1$ is the last year before the implementation of the trade agreement. That is, for the GSP, we compute tariff reductions from 1975 to 1979. For the 7th GATT round, we compute reductions from 1979 to 1983. For NAFTA and the 8th GATT round, given their close timing, we do not try to distinguish between the two and instead compute a single set of reductions from 1993 to 1997.

Importantly, as noted in Section III, we use the 1972 BEA input–output table when computing $\Delta\text{UP\_TARIFF}_{k,j}$ and $\Delta\text{DOWN\_TARIFF}_{k,j}$ between 1975 and 1979, the 1977 table when computing changes from 1979 to 1983, and the 1992 table when computing changes from 1993 to 1997. This approach helps ensure that our results are not confounded by changes in the gross flows of goods between industries after the trade agreements. Similarly, the value-weighted average tariff rates in each industry and year ($\text{IMPORT\_TARIFF}_{j,t}$), from which the variables $\text{UP\_TARIFF}_{j,t}$, $\text{OWN\_TARIFF}_{j,t}$, and $\text{DOWN\_TARIFF}_{j,t}$ are derived, are constructed using the import values from each country of origin as of year $t = -1$ as

[4]Table A.2 in the Supplementary Material shows that simple panel regressions confirm the findings from the DiD framework.

weights, which helps ensure that changes in the amounts of imports from the different countries following the trade agreements do not contaminate our findings.

Next, for each trade agreement (GSP, 7th GATT round, and NAFTA/8th GATT round), we distinguish between a 5-year preagreement period from $t = -5$ to $t = -1$, a 3-year implementation phase from $t = 0$ to $t = 2$, and a 5-year post-agreement period from $t = 3$ to $t = 7$. For each trade agreement, we thus create a firm-year panel from $t = -5$ to $t = 7$, where $t = -1$ denotes the last year before the implementation of the tariff revisions began. Considering a longer time period, until years $t = 10$, $t = 15$, or $t = 20$, leads to very similar results.

In the following step, we construct a regression sample by stacking all observations from the three panels. As in Gormley and Matsa (2011) and Deshpande and Li (2019), observations are thus included multiple times in the regression sample if they appear in more than one panel. Dropping observations from each panel that pertain to firms that already experienced large upstream tariff reductions in prior trade agreements does not change our findings (Table A.4 in the Supplementary Material).

Finally, we estimate a DiD model with continuous treatment intensity:

$$
\begin{aligned}
(8)\qquad \text{INVESTMENT}_{k,i,j,t} = {} & \left(\beta_1 \Delta\text{UP\_TARIFF}_{k,j} + \gamma_1 \Delta\text{OWN\_TARIFF}_{k,j}\right.\\
& \left. + \ \delta_1 \Delta\text{DOWN\_TARIFF}_{k,j}\right) \times \text{IMP}_{k,t}\\
& + \left(\beta_2 \Delta\text{UP\_TARIFF}_{k,j} + \gamma_2 \Delta\text{OWN\_TARIFF}_{k,j}\right.\\
& \left. + \ \delta_2 \Delta\text{DOWN\_TARIFF}_{k,j}\right) \times \text{POST}_{k,t}\\
& + \theta_1' \text{CONTROLS}_{k,i,j} \times \text{IMP}_{k,t}\\
& + \theta_2' \text{CONTROLS}_{k,i,j} \times \text{POST}_{k,t} + \alpha_{k,i} + \lambda_{k,t}\\
& + \rho_j \times t + \varepsilon_{k,i,j,t}.
\end{aligned}
$$

This model estimates the impact of upstream tariffs on downstream investment by asking how much the change in investment from before to after a trade agreement (the "effect" of POST) varies with the size of the tariff reduction (ΔUP_TARIFF). The parameter of interest is thus the coefficient β_2 on the interaction between the post-indicator and the size of the upstream tariff reduction.[5]

Trade agreements (GSP, 7th GATT, NAFTA/8th GATT) are indexed by k and years by t. The 2,351 firms and 128 (SIC4-)industries in the sample are indexed by i and j. $\text{INVESTMENT}_{k,i,j,t}$ is capital expenditures scaled by the beginning of year assets. Table A.6 in the Supplementary Material shows that our results are robust to using $\ln\left(\text{CAPEX}_{k,i,j,t}\right)$ instead. $\Delta\text{UP\_TARIFF}_{k,j}$, $\Delta\text{OWN\_TARIFF}_{k,j}$, and $\Delta\text{DOWN\_TARIFF}_{k,j}$ are the reductions in upstream, own industry, and downstream tariffs from $t = -1$ to $t = 3$. $\text{CONTROLS}_{k,i,j}$ are the pretreatment values (i.e., as of $t = -1$) of ln(ASSETS), TOBINS_Q, CASH/ASSETS, DEBT/ASSETS,

[5]As a robustness test, we have also used indicators for size-based categories of tariff reductions. Doing so suggests that the increase in downstream investment is strongest for the largest tariff reductions (Table A.5 in the Supplementary Material).

TABLE 1
Summary Statistics

Table 1 presents summary statistics for the pretreatment values of the variables used in the analysis. All variables are measured as of year $t=-1$, the last year before the implementation of the tariff revisions following the multinational trade agreements that we exploit in the difference-in-differences analysis: the implementation of the GSP (from 1976 onward), tariff revisions agreed upon during the 7th GATT round (from 1980 onward), and tariff revisions due to NAFTA and the 8th GATT round (from 1994 and 1995 onward). When computing the summary statistics, we use only one observation for each combination of a trade agreement and downstream firm.

	1	2	3	4	5	6
Variable	No. of Obs.	Mean	Std. Dev.	*p*1	*p*50	*p*99
UP_TARIFF (in percentage points)	3,660	1.264	0.968	0.120	1.074	6.518
ΔUP_TARIFF (in percentage points)	3,660	0.234	0.176	−0.021	0.203	0.761
OWN_TARIFF (in percentage points)	3,660	5.023	3.624	0.000	4.732	21.711
ΔOWN_TARIFF (in percentage points)	3,660	1.216	1.656	−1.960	0.979	5.700
DOWN_TARIFF (in percentage points)	3,660	1.177	1.731	0.012	0.527	10.686
ΔDOWN_TARIFF (in percentage points)	3,660	0.216	0.302	−0.491	0.114	1.136
CAPEX/ASSETS	3,660	0.074	0.068	0.002	0.055	0.390
ln(ASSETS) (in USD million)	3,660	4.354	1.914	0.859	4.127	9.465
TOBINS_Q	3,660	1.585	1.387	0.543	1.134	7.959
CASH/ASSETS	3,660	0.127	0.165	0.001	0.063	0.801
DEBT/ASSETS	3,660	0.220	0.170	0.000	0.205	0.735
EBITDA/ASSETS	3,660	0.111	0.179	−0.671	0.141	0.397
SALES_GROWTH	3,660	0.138	0.377	−0.633	0.095	2.019
EXCESS_RETURN	3,660	0.112	0.648	−0.824	−0.036	2.891
EXCESS_VOLATILITY	3,660	0.029	0.021	0.003	0.024	0.102
IND_SALES_GROWTH	3,660	0.104	0.162	−0.348	0.092	0.852
IND_CONCENTRATION	3,660	0.237	0.162	0.042	0.192	0.789

EBITDA/ASSETS, SALES_GROWTH, EXCESS_RETURN, EXCESS_VOLATILITY, IND_SALES_GROWTH, and IND_CONCENTRATION. We include these to account for firm size, growth opportunities, financial slack, leverage, profitability, uncertainty, and competition. We use pretreatment values because the tariff changes whose impact we want to estimate may affect not only firms' investment but also the firm- and industry-level variables we use as controls. In that case, the contemporaneous values of these variables (i.e., as of year t) would be endogenous, rendering them "bad controls" (Angrist and Pischke (2009)). Nonetheless, we have checked that using contemporaneous controls does not change our findings. $\text{IMP}_{k,t}$ is an indicator for the implementation phase and equal to 1 in years $t=0,1,2$. $\text{POST}_{k,t}$ is an indicator equal to 1 in years $t=3,4,\ldots,7$. $\alpha_{k,i}$ and $\lambda_{k,t}$ are trade agreement-specific firm and year fixed effects. $\rho_j \times t$ is an industry-specific time trend. We cluster the standard errors by industry (Bertrand, Duflo, and Mullainathan (2004), Petersen (2008)).

Table 1 provides summary statistics for the pretreatment values (i.e., as of year $t=-1$) of the different variables. The average values of UP_TARIFF, OWN_TARIFF, and DOWN_TARIFF are 1.3%, 5.0%, and 1.2%, respectively. ΔUP_TARIFF, ΔOWN_TARIFF, and ΔDOWN_TARIFF have average values of 0.2%, 1.2%, and 0.2%. The correlation of ΔUP_TARIFF with ΔOWN_TARIFF is 0.32 and 0.25 with ΔDOWN_TARIFF, and the correlation between ΔOWN_TARIFF and ΔDOWN_TARIFF is 0.11 (unreported). The mean value of INVESTMENT, defined as capital expenditures scaled by total assets, is 0.07. TOBINS_Q, CASH/ASSETS, DEBT/ASSETS, and EBITDA/ASSETS have mean values of 1.6, 0.13, 0.22, and 0.11. The average values of SALES_GROWTH, EXCESS_RETURN, EXCESS_VOLATILITY, IND_SALES_GROWTH, and IND_CONCENTRATION are 0.14, 0.11, 0.03, 0.10, and 0.24.

TABLE 2

Balance on Observables and Absence of Pretreatment Trends

Table 2 shows the coefficient estimates and corresponding t-statistics as well as the number of observations from regressions of the following form: $Y_{k,i,j} = \alpha_k + \beta \times \Delta\text{UP\_TARIFF}_{k,j} + \varepsilon_{k,i,j}$. Trade agreements (GSP, 7th GATT round, and NAFTA/8th GATT round) are indexed by k, firms by i, and industries by j. $Y_{k,i,j}$ is the dependent variable of interest for firm i in industry j and for trade agreement k, measured as of year $t=-1$ (the last year before the implementation of the tariff revisions). $\Delta Y_{t=-5,t=-1}$ is the change in $Y_{k,i,j}$ between $t=-5$ and $t=-1$. $\Delta\text{UP\_TARIFF}_{k,j}$ is the reduction in upstream import tariffs for industry j around trade agreement k.

	1	2	3
Dependent Variable:	Coefficient	t-Statistic	No. of Obs.
$\ln(\text{ASSETS})_{t=-1}$	−1.457	−1.61	3,660
$\text{TOBINS\_Q}_{t=-1}$	−0.133	−0.31	3,660
$\text{CASH/ASSETS}_{t=-1}$	0.022	0.33	3,660
$\text{DEBT/ASSETS}_{t=-1}$	−0.007	−0.17	3,660
$\text{EBITDA/ASSETS}_{t=-1}$	−0.045	−0.76	3,660
$\text{SALES\_GROWTH}_{t=-1}$	−0.002	−0.02	3,660
$\text{EXCESS\_RETURN}_{t=-1}$	0.096	0.77	3,660
$\text{EXCESS\_VOLATILITY}_{t=-1}$	0.009	1.63	3,660
$\text{IND\_SALES\_GROWTH}_{t=-1}$	0.018	0.35	3,660
$\text{IND\_CONCENTRATION}_{t=-1}$	0.002	0.03	3,660
$\Delta\ln(\text{ASSETS})_{t=-5,t=-1}$	−0.016	−0.12	2,836
$\Delta\text{TOBINS\_Q}_{t=-5,t=-1}$	−0.052	−0.27	2,778
$\Delta\text{CASH/ASSETS}_{t=-5,t=-1}$	0.011	0.75	2,835
$\Delta\text{DEBT/ASSETS}_{t=-5,t=-1}$	−0.009	−0.37	2,835
$\Delta\text{EBITDA/ASSETS}_{t=-5,t=-1}$	−0.007	−0.34	2,834
$\Delta\text{SALES\_GROWTH}_{t=-5,t=-1}$	−0.045	−0.68	2,716
$\Delta\text{EXCESS\_RETURN}_{t=-5,t=-1}$	0.003	0.02	2,669
$\Delta\text{EXCESS\_VOLATILITY}_{t=-5,t=-1}$	0.002	0.84	2,742
$\Delta\text{IND\_SALES\_GROWTH}_{t=-5,t=-1}$	0.058	0.79	2,838
$\Delta\text{IND\_CONCENTRATION}_{t=-5,t=-1}$	−0.007	−0.31	2,838

Before estimating the DiD model (equation (8)), we test whether the pretreatment values of the control variables (CONTROLS) or their pretreatment changes are correlated with our treatment variable of interest (ΔUP_TARIFF). To do so, we regress the pretreatment values and the pretreatment changes of the control variables on ΔUP_TARIFF and trade agreement fixed effects:

$$Y_{k,i,j} = \alpha_k + \beta \times \Delta\text{UP\_TARIFF}_{k,j} + \varepsilon_{k,i,j}. \quad (9)$$

$Y_{k,i,j}$ is the pretreatment value of the control variable or its pretreatment change $(\Delta Y_{t=-5,t=-1})$ from $t=-5$ to $t=-1$. The standard errors are clustered by (SIC4-) industry. Table 2 presents the results.[6] It is reassuring to see that we do not find evidence of a correlation between ΔUP_TARIFF and the pretreatment values or the pretreatment changes of the different control variables.

Table 3 presents the results of the DiD estimation (equation (8)). In column 1, we regress INVESTMENT on the interactions between ΔUP_TARIFF, IMP, and POST while controlling for trade agreement-specific firm and year fixed effects ($\alpha_{k,i}$ and $\lambda_{k,t}$). In column 2, we add the interactions between ΔOWN_TARIFF, IMP, and POST as well as between ΔDOWN_TARIFF, IMP, and POST. In column 3, we add the interactions between the pretreatment values of the control variables

[6]The reported number of observations refers to the observations that are effectively used in the estimation and varies between specifications as some variables are not available for all observations and cases with only a single observation for a given fixed effect ("singletons") are dropped in an iterative procedure. This note applies to all tables.

TABLE 3

Difference-in-Differences Estimation Around Multinational Trade Agreements

Table 3 presents estimates of the sensitivity of downstream firms' investment (CAPEX/ASSETS) to upstream tariff reductions (ΔUP_TARIFF) obtained from a difference-in-differences analysis around multinational trade agreements (GSP, 7th GATT round, and NAFTA/8th GATT round). POST is an indicator equal to 1 in years $t = 3, 4, \ldots, 7$, where $t = -1$ denotes the last year before the implementation of the tariff revisions. IMP is an indicator for the implementation phase and equal to 1 in years $t = 0, 1, 2$. All coefficient estimates are multiplied by 100 to improve readability. The standard errors are clustered by (SIC4-)industry. *t*-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4
	Dependent Variable: CAPEX/ASSETS			
(a) ΔUP_TARIFF × POST	2.606***	2.963***	2.307***	3.282***
	(3.69)	(3.72)	(2.88)	(2.79)
(b) ΔUP_TARIFF × IMP	0.594	0.738	0.398	0.909
	(0.61)	(0.74)	(0.56)	(0.99)
(c) ΔOWN_TARIFF × POST		−0.132	−0.122	−0.136
		(−1.55)	(−1.53)	(−1.44)
(d) ΔOWN_TARIFF × IMP		−0.208**	−0.175***	−0.183**
		(−2.47)	(−2.62)	(−2.50)
(e) ΔDOWN_TARIFF × POST		−0.869*	−0.922**	−0.030
		(−1.91)	(−2.21)	(−0.07)
(f) ΔDOWN_TARIFF × IMP		0.466	0.418	0.834**
		(0.92)	(1.19)	(2.35)
Trade agreement × Firm fixed effects	Yes	Yes	Yes	Yes
Trade agreement × Year fixed effects	Yes	Yes	Yes	Yes
Pretreatment controls (interacted)	No	No	Yes	Yes
SIC4-level time trends	No	No	No	Yes
Adj. R^2	0.393	0.394	0.406	0.409
No. of obs.	38,445	38,445	38,445	38,445
p-value of test of H_0: (a) = (b)	0.023	0.011	0.008	0.002
p-value of test of H_0: (c) = (d)	–	0.304	0.471	0.536
p-value of test of H_0: (e) = (f)	–	0.002	0.000	0.026
p-value of test of H_0: (a) + (b) = 0	0.030	0.021	0.045	0.036
p-value of test of H_0: (c) + (d) = 0	–	0.028	0.021	0.036
p-value of test of H_0: (e) + (f) = 0	–	0.641	0.459	0.254

and IMP and POST. This specification thus allows firms' investment in the pre, implementation-, and post-period to differ depending on the values of the control variables. In column 4, we add the industry-specific time trends ($\rho_j \times t$). Table A.7 in the Supplementary Material shows that replacing the time trends with SIC3 × year fixed effects does not change the results. Our preferred specification does not include SIC3 × year fixed effects, however, because these remove not only potential confounders at the SIC3 × year level but also a lot of the variation in the import tariffs.

The estimated coefficients on ΔUP_TARIFF × POST are positive and statistically significant at the 1% level in all four columns, ranging from 2.31 to 3.28 with *t*-statistics between 2.79 and 3.72. ΔUP_TARIFF measures the magnitude of the reductions in upstream tariffs around the trade agreements (from $t = -1$ to $t = 3$). The positive coefficient estimates thus provide evidence that tariff reductions in upstream industries entail an increase in downstream investment (Prediction 1). Unreported robustness tests show that this result is not driven by any particular industry: Removing any individual (SIC2-)industry from the sample does not affect our findings. In terms of economic magnitude, the estimates suggest that a hypothetical 10% decrease in all import tariffs in manufacturing industries (e.g., from 5%

to 4.5%) would translate into an increase in downstream investment by 4%–6% (relative to the mean level of investment).[7]

Table 3 also shows that controlling for tariff changes in firms' own industries (ΔOWN_TARIFF) has little effect on the estimated coefficients on changes in upstream tariffs (ΔUP_TARIFF). Consistent with this result, unreported analyses reveal no significant correlation between ΔUP_TARIFF and ΔOWN_TARIFF (ΔDOWN_TARIFF), conditional on trade agreement fixed effects. These findings are useful because they help to mitigate the concern that firms may respond not to changes in upstream import tariffs but instead to tariff changes in their own export markets.

The most direct way to address this concern would be to control for changes in outbound tariffs in each firm's own industry (e.g., changes in the weighted average import tariff imposed by the different destination countries). Unfortunately, we are not aware of any database that provides the necessary information on industry-level tariffs for the different export destinations during our sample period. However, controlling for changes in U.S. tariffs in each firm's own industry (ΔOWN_TARIFF), as we do, may help because changes in U.S. tariffs tend to be positively correlated with changes in foreign countries' tariffs in the same industry (e.g., Bernard, Jensen, and Schott (2006)), so that including ΔOWN_TARIFF can help to partially control also for changes in outbound tariffs.

As an (unreported) robustness test, we have also reestimated Table 3 for the subsample of observations with the smallest reductions in OWN_TARIFF (and/or DOWN_TARIFF). Doing so does not change the results: If anything, keeping only the bottom quartile of observations with the smallest reductions in OWN_TARIFF (and/or DOWN_TARIFF) increases the estimated impact of changes in upstream tariffs. In additional (unreported) tests, we further find that the investment response that we document is driven by domestic U.S. firms rather than multinational firms and that there is no increase in the relative importance of the firms' foreign sales. Both findings appear at odds with the concern that the observed increase in investment is due to an increase in firms' exports. Finally, we note that absorbing any changes in outbound tariffs at the SIC3-level by controlling for SIC3 × year fixed effects does not change our findings either (Table A.7 in the Supplementary Material).

The estimated impact of tariff reductions in firms' own industries is consistent with Frésard and Valta (2016). The coefficients on ΔOWN_TARIFF × IMP are negative and significant. The coefficients on ΔOWN_TARIFF × POST are not significant but similar in magnitude. Indeed, the differences between the estimated coefficients on ΔOWN_TARIFF × POST and ΔOWN_TARIFF × IMP are insignificant.

The findings are mixed regarding the impact of ΔDOWN_TARIFF: The coefficients are unstable in sign and significance. In particular, the positive and

[7]The pretreatment average of UP_TARIFF is 1.264%, so a 10% reduction of all upstream tariffs would correspond to ΔUP_TARIFF = 0.1264%. To improve readability, all estimates in Table 3 were multiplied by 100. An estimate of, for example, 2.606 thus suggests that a 10% tariff cut would entail an increase in downstream investment by $2.606 \times 0.1264 \times 0.01 = 0.0033$, corresponding to $0.0033/0.074 = 4.46\%$ of the pretreatment average of INVESTMENT.

significant coefficient on ΔDOWN_TARIFF × IMP appears to be an outlier and is not robust to alternative specifications. Further, the sum of the coefficients on ΔDOWN_TARIFF × IMP and ΔDOWN_TARIFF × POST is not statistically different from 0 in any specification. In contrast, the sum of the coefficients on ΔUP_TARIFF × IMP and ΔUP_TARIFF × POST and the sum of the coefficients on ΔOWN_TARIFF × IMP and ΔOWN_TARIFF × POST are significantly different from 0 in all specifications.

Taking all estimates at face value, our findings suggest that a hypothetical 10% decrease in all import tariffs in manufacturing industries would lead to a net increase in investment across all firms by 0.2%–1.6% during the implementation phase and 1.6%–4.6% during the post-period (relative to the mean level of investment in the year before the tariff revisions, i.e., year $t = -1$).

B. DiD Dynamics

To investigate the timing of downstream firms' investment response, we now estimate a model in which we interact the changes in upstream, own industry, and downstream tariffs with indicators for the different years before and after the trade agreements ($1\{t=\tau\}$). Specifically, we estimate

$$(10)\quad \text{INVESTMENT}_{k,i,j,t} = \sum_{\tau=-5}^{7} (\beta_\tau \Delta\text{UP\_TARIFF}_{k,j} + \gamma_\tau \Delta\text{OWN\_TARIFF}_{k,j} + \delta_\tau \Delta\text{DOWN\_TARIFF}_{k,j}) \times 1\{t=\tau\} + \sum_{\tau=-5}^{7} \theta'_\tau \text{CONTROLS}_{k,i,j} \times 1\{t=\tau\} + \alpha_{k,i} + \lambda_{k,t} + \rho_j \times t + \varepsilon_{k,i,j,t}.$$

We use year $t = -1$ as the reference year and thus omit $1\{t = -1\}$. This specification can also be interpreted as a falsification test. Tariff changes (i.e., treatment) should be unrelated to investment before the tariff changes actually occur (i.e., absent treatment). In other words, future tariff reductions should not predict investment increases in the years prior to the trade agreements.

Table 4 shows the results. The coefficient estimates on the interactions between ΔUP_TARIFF and the indicators for the years $t = -5$ to $t = -2$ are small in magnitude and not statistically significant in any column. Indeed, the null hypothesis that the coefficients are jointly equal to 0 cannot be rejected at conventional levels (p-values ranging from 0.63 to 0.89). This result is comforting: We do not find evidence of a treatment effect before the actual onset of treatment. Similarly, when we repeat our DiD estimation (equation (8)) using only observations from the years before each trade agreement (i.e., $t = -5$ to $t = -1$) and falsely assume that the tariff reductions already occurred in year $t = -3$, then the estimated "effects" of the upstream tariff reductions are small in magnitude and not statistically significant (Table A.8 in the Supplementary Material).

Table 4 further reveals that we also do not find any evidence of a relation between ΔUP_TARIFF and firms' investment during the first 2 years of the implementation phase (years $t = 0$ and $t = 1$). In contrast, the coefficient estimates on the interactions between ΔUP_TARIFF and the indicators for the years $t = 2$ to $t = 7$ are positive and statistically significant. This result suggests that downstream

TABLE 4

Difference-in-Differences Dynamics

Table 4 presents estimates of the sensitivity of downstream firms' investment (CAPEX/ASSETS) to upstream tariff reductions (ΔUP_TARIFF) obtained from a difference-in-differences analysis around multinational trade agreements (GSP, 7th GATT round, and NAFTA/8th GATT round) using the following regression: $\text{INVESTMENT}_{k,i,j,t} = \sum_{\tau=-5}^{7} (\beta_\tau \Delta\text{UP\_TARIFF}_{k,j} + \gamma_\tau \Delta\text{OWN\_TARIFF}_{k,j} + \delta_\tau \Delta\text{DOWN\_TARIFF}_{k,j} + \theta'_\tau \text{CONTROLS}_{k,i,j} 1\{t=\tau\} + \alpha_{k,i} + \lambda_{k,t} + \rho_j \times t + \varepsilon_{k,i,j,t}$. Trade agreements are indexed by k, and firms, (SIC4-)industries, and years by i, j, and t. We use the last year before the tariff revisions as the reference year and thus omit $1\{t=-1\}$. All coefficient estimates are multiplied by 100 to improve readability. The standard errors are clustered by (SIC4-)industry. t-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4
	Dependent Variable: CAPEX/ASSETS			
(a) ΔUP_TARIFF × $1\{t=-5\}$	−0.357	−0.021	0.300	−0.206
	(−0.37)	(−0.02)	(0.32)	(−0.19)
(b) ΔUP_TARIFF × $1\{t=-4\}$	0.449	0.694	0.848	0.469
	(0.46)	(0.71)	(0.85)	(0.43)
(c) ΔUP_TARIFF × $1\{t=-3\}$	0.042	0.019	0.225	−0.053
	(0.05)	(0.02)	(0.26)	(−0.06)
(d) ΔUP_TARIFF × $1\{t=-2\}$	−0.413	−0.414	0.083	−0.050
	(−0.66)	(−0.67)	(0.13)	(−0.08)
(e) ΔUP_TARIFF × $1\{t=0\}$	−0.296	−0.250	−0.151	0.047
	(−0.36)	(−0.35)	(−0.25)	(0.07)
(f) ΔUP_TARIFF × $1\{t=1\}$	−0.106	0.440	0.263	0.583
	(−0.08)	(0.38)	(0.24)	(0.47)
(g) ΔUP_TARIFF × $1\{t=2\}$	2.052**	2.630***	2.329***	2.782***
	(2.15)	(3.65)	(3.22)	(3.25)
(h) ΔUP_TARIFF × $1\{t=3\}$	2.704***	3.079***	2.779***	3.340***
	(3.12)	(3.77)	(3.08)	(3.21)
(i) ΔUP_TARIFF × $1\{t=4\}$	1.649*	1.822**	1.558*	2.267*
	(1.72)	(2.03)	(1.67)	(1.93)
(j) ΔUP_TARIFF × $1\{t=5\}$	2.620**	2.782***	2.412**	3.300**
	(2.48)	(3.16)	(2.55)	(2.60)
(k) ΔUP_TARIFF × $1\{t=6\}$	2.528**	2.910***	1.703*	2.677**
	(2.46)	(2.99)	(1.85)	(2.12)
(l) ΔUP_TARIFF × $1\{t=7\}$	3.469***	3.690***	3.084***	4.119***
	(3.53)	(3.50)	(2.88)	(3.16)
Trade agreement × firm fixed effects	Yes	Yes	Yes	Yes
Trade agreement × year fixed effects	Yes	Yes	Yes	Yes
ΔOWN_TARIFF (interacted)	No	Yes	Yes	Yes
ΔDOWN_TARIFF (interacted)	No	Yes	Yes	Yes
Pretreatment controls (interacted)	No	No	Yes	Yes
SIC4-level time trends	No	No	No	Yes
Adj. R^2	0.393	0.396	0.422	0.425
No. of obs.	38,445	38,445	38,445	38,445
p-value of test of H_0: (a) = (b) = (c) = (d) = 0	0.647	0.632	0.892	0.880

firms begin to respond to upstream tariff reductions after about 2 years and that the response continues (at least) until year 7. Our findings thus point toward a permanent rather than transitory impact of upstream tariff reductions on downstream investment.

Figures 1 and 2 present our findings graphically. Specifically, Figure 1 shows the decline in average upstream tariffs after the trade agreements. It depicts the β_τ coefficients and 95% confidence intervals obtained from model (10) when using UP_TARIFF instead of INVESTMENT as the dependent variable. Table A.9 in the Supplementary Material reports the corresponding coefficient estimates and t-statistics. Figure 2 shows the increase in firms' investment. It depicts the β_τ coefficients reported in column 4 of Table 4 and the corresponding 95% confidence intervals.

FIGURE 1

Import Tariffs in Upstream Industries Before and After Multinational Trade Agreements

Figure 1 shows the decline in average upstream import tariffs following multinational trade agreements (GSP, 7th GATT round, and NAFTA/8th GATT round). Specifically, the figure shows the estimated β_τ coefficients and 95% confidence intervals from the following regression: $\text{UP\_TARIFF}_{k,i,j,t} = \sum_{\tau=-5}^{7} (\beta_\tau \Delta\text{UP\_TARIFF}_{k,j} + \gamma_\tau \Delta\text{OWN\_TARIFF}_{k,j} + \delta_\tau \Delta\text{DOWN\_TARIFF}_{k,j} + \theta'_\tau \text{CONTROLS}_{k,i,j}) 1\{t=\tau\} + \alpha_{k,i} + \lambda_{k,t} + \rho_j \times t + \varepsilon_{k,i,j,t}$. Trade agreements are indexed by k, and firms, (SIC4-)industries, and years by i, j, and t. We use the last year before the tariff revisions as the reference year and thus omit $1\{t=-1\}$. The standard errors are clustered by (SIC4-)industry.

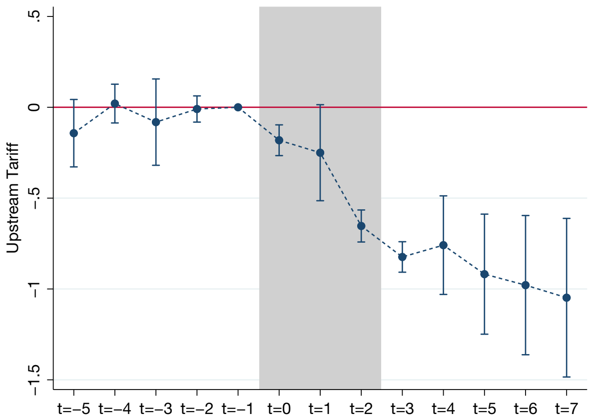
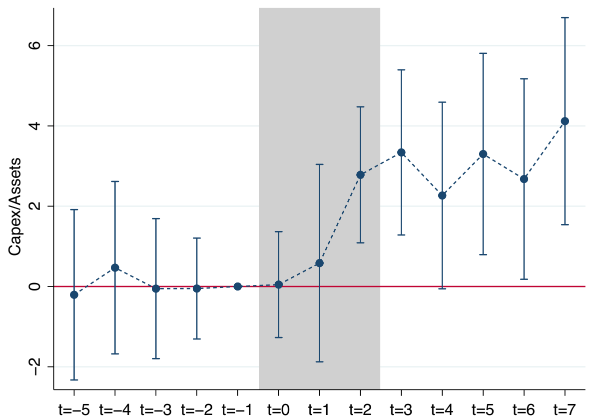


FIGURE 2

Investment in Downstream Industries Before and After Multinational Trade Agreements

Figure 2 shows estimates of the sensitivity of downstream firms' investment (CAPEX/ASSETS) to upstream tariff reductions (ΔUP_TARIFF) obtained from a DiD analysis around multinational trade agreements (GSP, 7th GATT round, and NAFTA/8th GATT round). Specifically, the figure shows the estimated β_τ coefficients and 95% confidence intervals from the following regression: $\text{INVESTMENT}_{k,i,j,t} = \sum_{\tau=-5}^{7} (\beta_\tau \Delta\text{UP\_TARIFF}_{k,j} + \gamma_\tau \Delta\text{OWN\_TARIFF}_{k,j} + \delta_\tau \Delta\text{DOWN\_TARIFF}_{k,j} + \theta'_\tau \text{CONTROLS}_{k,i,j}) 1\{t=\tau\} + \alpha_{k,i} + \lambda_{k,t} + \rho_j \times t + \varepsilon_{k,i,j,t}$. Trade agreements are indexed by k, and firms, (SIC4-)industries, and years by i, j, and t. We use the last year before the tariff revisions as the reference year and thus omit $1\{t=-1\}$. The standard errors are clustered by (SIC4-)industry.



C. Efficient Investment Versus Overinvestment

The estimates in Tables 3 and 4 suggest that downstream firms increase their investment following upstream tariff reductions. This increase, however, need not be efficient but could reflect overinvestment. Empirically distinguishing between these alternatives is challenging because we do not observe the optimal amount of investment and thus lack the reference point above which efficient investment turns into overinvestment. Nonetheless, we provide some suggestive evidence that the increase in investment is not primarily due to overinvestment.

We begin by examining the relation between upstream tariff reductions and downstream profitability and productivity. The idea is that inefficient overinvestment should entail a subsequent decline in profitability and productivity. To test this prediction, we replace investment as the outcome in our DiD analysis (equation (8)) with both firm- and industry-level measures of profitability and productivity: At the firm-level, we measure profitability as gross profit scaled by assets (Novy-Marx (2013)) and productivity as TFP estimated based on Giupponi and Landais (2023). At the industry level, we use TFP data from the NBER-CES Manufacturing Industry Database and gross profit scaled by output (because the NBER-CES data do not include the value of the assets). Definitions are in the Appendix.

Panel A of Table 5 shows the results.[8] At the firm level, the coefficient estimate on the interaction between ΔUP_TARIFF and POST is positive and significant at the 1% level when we look at GROSS_PROFIT/ASSETS. When looking at ln(TFP), the estimate is positive but insignificant. At the industry level, we find positive estimates that are significant at the 1% level when looking at GROSS_PROFIT/OUTPUT and 5% level when looking at ln(TFP).[9] In terms of economic magnitudes, the estimates suggest that a hypothetical 10% decrease in all import tariffs would translate into an increase in downstream GROSS_PROFIT/ASSETS at the firm level by about 2% and GROSS_PROFIT/OUTPUT and TFP at the industry level by about 5% and 1% (all relative to the respective variables' sample means).

Panel A of Table 5 thus presents evidence that downstream profitability and productivity increase after upstream tariff reductions. This finding appears less consistent with overinvestment, which we would expect to result in lower profitability and productivity. A caveat, however, is that the firms whose profitability and productivity increase might not be the ones that increase their investment. In columns 1–4 in Panel B, we thus repeat our investment analysis (equation (8)) on subsamples that are formed based on whether the firms' realized changes in profitability and productivity from $t = -1$ to $t = +7$ are above or below the sample

[8]As pre-treatment controls at the industry level, we use ln(TFP), SALES_GROWTH, and PROD_WORK/EMP (the ratio of production workers to employment). Not controlling for the pretreatment value of ln(TFP) when ln(TFP) is the outcome does not change the results.

[9]This result is consistent with the findings of Schor (2004), Amiti and Konings (2007), Kasahara and Rodrigue (2008), Goldberg et al. (2010), Topalova and Khandelwal (2011), and Halpern et al. (2015), who show that imported inputs led to increased TFP in Brazil, Indonesia, Chile, India, and Hungary, and with Bøler, Moxnes, and Ulltveit-Moe (2015), who propose complementarities between imported inputs and firms' own R&D efforts as a source of such productivity gains.

TABLE 5

Efficient Investment Versus Overinvestment

Table 5 presents estimates of the sensitivity of downstream profitability and productivity at the firm and industry levels to upstream tariff reductions in Panel A and estimates of the sensitivity of downstream firms' investment to upstream tariff reductions in various subsamples in Panel B. All specifications control for Trade agreement × Firm fixed effects (Trade agreement × Industry fixed effects in columns 3 and 4 of Panel A), Trade agreement × Year fixed effects, ΔOWN_TARIFF (interacted), ΔDOWN_TARIFF (interacted), Pretreatment controls (interacted), and SIC4-level time trends. All coefficient estimates are multiplied by 100 to improve readability. The standard errors are clustered by (SIC4-)industry. *t*-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Sensitivity of Downstream Profitability and Productivity at the Firm and Industry Levels to Upstream Tariff Reductions

	1	2	3	4
Dependent Variable:	Firm-Level GROSS_PROFIT/ASSETS	Firm-Level ln(TFP)	Industry-Level GROSS_PROFIT/OUTPUT	Industry-Level ln(TFP)
ΔUP_TARIFF × POST	6.877***	3.968	6.474***	4.264**
	(3.71)	(0.38)	(3.27)	(2.15)
ΔUP_TARIFF × IMP	3.840***	1.765	2.868***	4.297***
	(2.96)	(0.21)	(3.00)	(3.48)
Adj. R^2	0.781	0.706	0.919	0.831
No. of obs.	38,445	37,820	13,183	13,183

Panel B. Sensitivity of Downstream Investment to Upstream Tariff Reductions in Different Subsamples (Splits Based on Firm-Level Variables)

	1	2	3	4	5	6
Subsample:	High Increase in GROSS_PROFIT/ASSETS	Low Increase in GROSS_PROFIT/ASSETS	High Increase in ln(TFP)	Low Increase in ln(TFP)	High INST_OWN	Low INST_OWN
	Dependent Variable: CAPEX/ASSETS					
(a) ΔUP_TARIFF × POST	4.440***	0.816	4.170***	1.565	3.390**	1.943
	(3.24)	(0.45)	(3.76)	(0.80)	(2.48)	(1.19)
(b) ΔUP_TARIFF × POST	2.658***	−0.738	2.221***	−0.513	0.705	0.930
	(3.44)	(−0.36)	(3.05)	(−0.26)	(0.49)	(1.19)
Adj. R^2	0.396	0.426	0.428	0.398	0.491	0.326
No. of obs.	13,387	13,407	13,027	13,039	18,350	18,573
p-value of test of H_0: (a) in (1) = (a) in (2)	0.114					
p-value of test of H_0: (b) in (1) = (b) in (2)	0.143					
p-value of test of H_0: (a) in (3) = (a) in (4)			0.193			
p-value of test of H_0: (b) in (3) = (b) in (4)			0.180			
p-value of test of H_0: (a) in (5) = (a) in (6)					0.423	
p-value of test of H_0: (b) in (5) = (b) in (6)					0.888	

median ("high" and "low," respectively). We find positive and significant coefficient estimates on the interactions between ΔUP_TARIFF and POST only in the subsamples of firms with high increases in profitability and productivity. This result is consistent with the hypothesis that the overall increase in investment stems from firms whose profitability and productivity increase. The differences between the coefficient estimates in the different subsamples, however, are not statistically significant.

A further test is presented in columns 5 and 6. Here, the subsamples are formed based on whether the firms' institutional ownership is above or below the sample median.[10] The idea is that overinvestment is an agency problem and thus to test whether the increase in investment stems from firms with weak corporate governance (as proxied by low institutional ownership). In contrast, we find a positive and statistically significant coefficient estimate on the interaction between ΔUP_TARIFF and POST only in the subsample of firms with high institutional ownership. Similar to the results in columns 1–4, this finding seems less consistent with the increase in investment reflecting overinvestment, but a caveat is that the difference between the coefficient estimates in columns 5 and 6 is not statistically significant. In sum, however, while none of the above-discussed tests allow us to conclusively rule out that some of the firms' investments are inefficient, the combined evidence in Panels A and B of Table 5 do not seem to point toward overinvestment as the major driver of the increase in investment that we observe.

D. Controlling for Changes in Uncertainty

A possibility in the context of multinational trade agreements is that they may have led not only to lower tariffs but also lower uncertainty (e.g., due to the resolution of trade policy uncertainty; Handley and Limão (2015), (2017)). Given the known link between uncertainty and investment (McDonald and Siegel (1986), Dixit (1989), Leahy and Whited (1996), and Bloom, Bond, and van Reenen (2007)) one could thus be worried that reductions in uncertainty explain the increase in investment that we find.

Two features of our analysis help alleviate this concern. First, changes in aggregate uncertainty are absorbed by the year fixed effects in the regressions (and by the SIC3 × year fixed effects in Table A.7 in the Supplementary Material). Second, controlling for firm-level uncertainty in the form of EXCESS_VOLATILITY does not change our results (Table 3). Nonetheless, we now show that explicitly allowing for the impact of reductions in uncertainty has virtually no effect on the estimated relation between upstream tariff reductions and downstream investment. Specifically, we rely on the well-established insight that empirical measures of uncertainty can be constructed based on share price volatility (e.g., Leahy and Whited (1996), Bloom et al. (2007)) and use the reduction in EXCESS_VOLATILITY from $t = -1$ to $t = 3$ as a proxy for the reduction in uncertainty, that is,

[10]To form the subsamples around the GSP (1976) and 7th GATT round (1980), we use the firms' institutional ownership as of 1980, the first year for which the data are available. Our findings are similar when we drop observations around the GSP. For the subsample around the NAFTA/8th GATT round (1994/1995), we use the data as of 1993.

TABLE 6

Controlling for Changes in Uncertainty

Table 6 presents estimates of the sensitivity of downstream firms' investment (CAPEX/ASSETS) to upstream tariff reductions (ΔUP_TARIFF) when controlling for the impact of changes in uncertainty (ΔUNCERTAINTY). All estimates are obtained from a difference-in-differences analysis around multinational trade agreements (GSP, 7th GATT round, and NAFTA/8th GATT round). POST is an indicator equal to 1 in years $t = 3, 4, \ldots, 7$, where $t = -1$ denotes the last year before the implementation of the tariff revisions. IMP is an indicator for the implementation phase and equal to 1 in years $t = 0,1,2$. All coefficient estimates are multiplied by 100 to improve readability. The standard errors are clustered by (SIC4-)industry. t-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4
	Dependent Variable: CAPEX/ASSETS			
ΔUP_TARIFF × POST	2.485*** (3.53)	2.817*** (3.53)	2.305*** (2.86)	3.271*** (2.74)
ΔUP_TARIFF × IMP	0.462 (0.45)	0.667 (0.64)	0.410 (0.52)	0.909 (0.92)
ΔUNCERTAINTY × POST	0.498*** (7.36)	0.491*** (7.12)	0.414*** (6.14)	0.390*** (5.70)
ΔUNCERTAINTY × IMP	0.349*** (6.24)	0.350*** (6.23)	0.256*** (4.38)	0.241*** (4.11)
ΔOWN_TARIFF × POST		−0.130 (−1.55)	−0.122 (−1.54)	−0.150 (−1.54)
ΔOWN_TARIFF × IMP		−0.250*** (−3.00)	−0.220*** (−3.21)	−0.236*** (−3.21)
ΔDOWN_TARIFF × POST		−0.805* (−1.72)	−0.899** (−2.08)	0.055 (0.12)
ΔDOWN_TARIFF × IMP		0.413 (0.75)	0.343 (0.87)	0.809** (2.03)
Trade agreement × firm fixed effects	Yes	Yes	Yes	Yes
Trade agreement × year fixed effects	Yes	Yes	Yes	Yes
Pretreatment controls (interacted)	No	No	Yes	Yes
SIC4-level time trends	No	No	No	Yes
Adj. R^2	0.391	0.392	0.404	0.407
No. of obs.	34,205	34,205	34,205	34,205

$$\Delta\text{UNCERTAINTY}_{k,i} = \text{EXCESS\_VOLATILITY}_{k,i,t=-1} - \text{EXCESS\_VOLATILITY}_{k,i,t=3}. \tag{11}$$

We then add interactions between ΔUNCERTAINTY and IMP and POST to the regression specifications.

Table 6 shows the results. Consistent with prior work (e.g., Leahy and Whited 1996), we find that reductions in uncertainty entail higher investment: The coefficients on ΔUNCERTAINTY × POST and ΔUNCERTAINTY × IMP are positive and significant at the 1% level in all columns. Importantly, however, the coefficients on ΔUP_TARIFF × POST and ΔUP_TARIFF × IMP, as well as the corresponding t-statistics, are almost identical to the ones in Table 3. That is, while we find that changes in the uncertainty faced by the downstream firms are related to their investment decisions, this relation does not appear to explain the relation between upstream tariff reductions and downstream investment.

E. Cross-Sectional Variation

So far, we have documented an increase in downstream investment following upstream tariff reductions (consistent with Prediction 1). Now, we examine how

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the magnitude of the investment response varies with several firm- and industry-characteristics (Predictions 2–5). Studying such cross-sectional heterogeneity is important for at least three reasons. First, the variation can be informative about the relative importance of different channels through which the effect of upstream tariffs may operate. Second, understanding which firms are affected most and why is important for the design of transfer programs aimed at redistributing the gains from freer trade and thus critical for policy making. Third, to the extent that the cross-sectional variation corresponds to theoretical predictions, documenting such variation can help substantiate the inference that the increase in downstream investment is indeed due to the reduction in upstream tariffs.

1. Input Cost Importance

We begin by looking at the importance of input costs for the total cost of production (Prediction 2). Specifically, using information from the NBER-CES Manufacturing Industry Database, we compute for each downstream industry the ratio of material costs to the sum of material costs, energy costs, and wages.[11] We then classify industries with a ratio above (below) the median in year $t = -1$ as having high (low) material costs. Using the ratio of cost of goods sold (COGS) to the sum of COGS and selling, general, and administrative expenses or the ratio of COGS to sales at the firm level to gauge the importance of input costs does not change our findings.

Consistent with Prediction 2, Panel A of Table 7 shows that the estimated relation between upstream tariff reductions and downstream investment is positive and statistically significant (at the 1% level) only in the subsample of firms for which material costs are relatively more important. In contrast, the coefficient estimates are noticeably smaller and not statistically significant in the subsample of firms for which material costs are relatively less important. The differences between the estimated coefficients in the two subsamples are statistically significant at the 1% level.

2. Input Differentiation

Next, we examine Prediction 3 and discern between tariff reductions for homogeneous inputs (e.g., cement) and differentiated inputs (e.g., industrial machinery). For a first test, we distinguish between tariff reductions in upstream industries that produce homogeneous goods (ΔUP_TARIFF_FOR_HOMOGENEOUS_GOODS) versus differentiated goods (ΔUP_TARIFF_FOR_DIFFERENTIATED_GOODS) using the classification of Rauch (1999).[12] Column 1 in Panel B of Table 7 shows the results. We find a positive and statistically significant coefficient

[11] We measure all variables in real terms. Using nominal terms does not change the results.

[12] We obtain the required data from econweb.ucsd.edu/jrauch/rauch_classification.html. Rauch (1999) classifies goods as homogeneous if they are traded on organized exchanges and/or have reference prices (e.g., price quotations published in trade journals) and otherwise as differentiated. We follow Barrot and Sauvagnat (2016) and classify an industry as producing differentiated goods if the ratio of differentiated to homogeneous goods produced by the industry is greater than the median ratio of differentiated to homogeneous goods across all industries.

TABLE 7

Cross-Sectional Variation

Table 7 presents results from cross-sectional tests. Panel A shows estimates of the sensitivity of downstream firms' investment (CAPEX/ASSETS) to upstream tariff reductions (ΔUP_TARIFF) in the subsample of downstream firms with high material costs and in the subsample of downstream firms with low material costs. Panel B shows estimates of the sensitivity to upstream tariff reductions for homogeneous goods (ΔUP_TARIFF_FOR_HOMOGENEOUS_GOODS) and differentiated goods (ΔUP_TARIFF_FOR_DIFFERENTIATED_GOODS) as well as for goods with low R&D intensity (ΔUP_TARIFF_FOR_LOW_R&D_GOODS) and high R&D intensity (ΔUP_TARIFF_FOR_HIGH_R&D_GOODS). Panel C shows estimates of the sensitivity in the subsample of downstream firms in concentrated industries and in the subsample of downstream firms in dispersed industries. Panel D shows estimates of the sensitivity in the subsample of downstream firms that are more likely to be financially constrained and in the subsample of downstream firms that are less likely to be financially constrained. All specifications control for Trade agreement × Firm fixed effects, Trade agreement × Year fixed effects, ΔOWN_TARIFF (interacted), ΔDOWN_TARIFF (interacted), Pretreatment controls (interacted), and SIC4-level time trends. All coefficient estimates are multiplied by 100 to improve readability. The standard errors are clustered by (SIC4-)industry. *t*-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1		2
Subsample:	High Material Costs		Low Material Costs
	Dependent Variable: CAPEX/ASSETS		
Panel A. Downstream Firms with High Versus Low Material Costs			
(a) ΔUP_TARIFF × POST	6.029***		0.210
	(5.13)		(0.20)
(b) ΔUP_TARIFF × IMP	2.666***		−1.260
	(3.96)		(−1.03)
Adj. R^2	0.411		0.413
No. of obs.	18,302		20,143
p-value of test of H_0: (a) in (1) = (a) in (2)		0.000	
p-value of test of H_0: (b) in (1) = (b) in (2)		0.005	
Panel B. Tariff Reductions on Homogeneous (Low-R&D) Versus Differentiated (High-R&D) Goods			
(a) ΔUP_TARIFF_FOR_HOMOGENEOUS_GOODS × POST	5.380**		
	(2.29)		
(b) ΔUP_TARIFF_FOR_DIFFERENTIATED_GOODS × POST	−0.315		
	(−0.22)		
(c) ΔUP_TARIFF_FOR_HOMOGENEOUS_GOODS × IMP	1.411		
	(1.06)		
(d) ΔUP_TARIFF_FOR_DIFFERENTIATED_GOODS × IMP	−0.910		
	(−0.84)		
(a) ΔUP_TARIFF_FOR_LOW_R&D_GOODS × POST			6.586***
			(3.55)
(b) ΔUP_TARIFF_FOR_HIGH_R&D_GOODS × POST			−1.462
			(−0.77)
(c) ΔUP_TARIFF_FOR_LOW_R&D_GOODS × IMP			2.096*
			(1.74)
(d) ΔUP_TARIFF_FOR_HIGH_R&D_GOODS × IMP			−1.312
			(−1.07)
Adj. R^2	0.408		0.409
No. of obs.	38,445		38,445
p-value of test of $H_0: (a) = (b)$	0.031		0.003
p-value of test of $H_0: (c) = (d)$	0.100		0.016

Panel C. Concentrated Versus Dispersed Downstream Industries

	1		2		3		4
Subsample:	Concentrated (High HHI)		Dispersed (Low HHI)		Concentrated (High TOP4SHARE)		Dispersed (Low TOP4SHARE)
	Dependent Variable: CAPEX/ASSETS						
(a) ΔUP_TARIFF × POST	4.800***		0.582		4.680***		1.197
	(2.94)		(0.35)		(2.91)		(0.68)
(b) ΔUP_TARIFF × IMP	2.388***		−1.124		2.836***		−1.578
	(2.97)		(−0.97)		(3.57)		(−1.17)
Adj. R^2	0.416		0.404		0.425		0.396
No. of obs.	18,798		19,647		18,752		19,693
p-value of test of H_0: (a) in (1) = (a) in (2)		0.081					
p-value of test of H_0: (b) in (1) = (b) in (2)		0.009					
p-value of test of H_0: (a) in (3) = (a) in (4)						0.168	
p-value of test of H_0: (b) in (3) = (b) in (4)						0.007	

(continued on next page)

TABLE 7 (continued)

Cross-Sectional Variation

Panel D. Financially Unconstrained Versus Constrained Downstream Firms

	1	2	3	4	5	6
Subsample:	Unconstrained (High Assets)	Constrained (Low Assets)	Unconstrained (Dividend)	Constrained (No Dividend)	Unconstrained (Low WW_INDEX)	Constrained (High WW_INDEX)
	Dependent Variable: CAPEX/ASSETS					
(a) ΔUP_TARIFF × POST	4.703***	0.651	4.833***	−1.078	5.248***	−0.250
	(3.76)	(0.36)	(4.41)	(−0.66)	(4.54)	(−0.13)
(b) ΔUP_TARIFF × IMP	0.668	1.128	1.240*	0.104	1.158	0.553
	(0.52)	(1.36)	(1.74)	(0.06)	(1.04)	(0.48)
Adj. R^2	0.482	0.356	0.426	0.398	0.487	0.361
No. of obs.	19,121	19,324	22,724	15,566	19,013	19,160
p-value of test of H_0: (a) in (1) = (a) in (2)	0.032					
p-value of test of H_0: (b) in (1) = (b) in (2)	0.728					
p-value of test of H_0: (a) in (3) = (a) in (4)			0.002			
p-value of test of H_0: (b) in (3) = (b) in (4)			0.501			
p-value of test of H_0: (a) in (5) = (a) in (6)					0.009	
p-value of test of H_0: (b) in (5) = (b) in (6)					0.646	

estimate on the interaction between ΔUP_TARIFF_FOR_HOMOGENEOUS_GOODS and POST. In contrast, the coefficient estimate on the interaction between ΔUP_TARIFF_FOR_DIFFERENTIATED_GOODS and POST is small in magnitude and not significant. The difference between the two estimates is statistically significant at the 5% level.

Hombert and Matray (2018) show that higher R&D leads to more product differentiation. For a second test of Prediction 3, we thus distinguish between tariff reductions in high-R&D industries and tariff reductions in low-R&D industries. We use the industries' aggregate R&D expenditures scaled by aggregate sales to measure their R&D intensity and label those with above-median R&D-to-sales ratios as of year $t = -1$ as high-R&D industries. Measuring R&D intensity with the ratio of R&D expenses to total assets leads to similar results. Column 2 in Panel B of Table 7 displays the findings. Consistent with the results based on Rauch's (1999) classification in column 1, we find a positive and significant coefficient estimate on the interaction between ΔUP_TARIFF_FOR_LOW_R&D_GOODS and POST but not on the interaction between ΔUP_TARIFF_FOR_HIGH_R&D_GOODS and POST. The difference between the two estimates is significant at the 1% level.

The results in both columns 1 and 2 thus suggest that U.S. manufacturing firms that rely on homogeneous, low-R&D inputs benefit more from upstream tariff reductions than those relying on differentiated, high-R&D inputs. This is particularly relevant regarding the channel through which upstream tariffs affect downstream investment. In the context of developing countries, where prior work has linked freer trade in intermediate goods to higher TFP, the effect of upstream tariff reductions has been primarily attributed to superior foreign technology embodied in imported inputs and their greater variety. While highly plausible in the context of developing countries, this channel may seem less plausible in the context of a highly developed economy like the United States, where imports are arguably less likely to be a substantial source of superior technology or otherwise unavailable inputs. Indeed, our findings would seem to be most consistent with the idea that, for U.S. firms, the increase in downstream investment following upstream tariff cuts is primarily due to lower input costs (rather than superior foreign technology or greater input variety).

3. Bargaining Power

We now examine Prediction 4, that is, whether the increase in downstream investment is more pronounced for firms that have more bargaining power. However, because we cannot observe firms' bargaining power directly, we use a proxy: industry concentration. The idea is that firms in concentrated, rather than dispersed, downstream industries are likely to have more bargaining power in price negotiations with their suppliers and customers. Specifically, we split our sample based on the downstream industries' concentration, measured in two ways, with the Herfindahl–Hirschman Index (HHI) of sales in the industry and with the percentage of sales accounted for by the four companies with the largest sales volume (TOP4SHARE). Panel C of Table 7 shows the results.

Both in the implementation and in the post-reduction period, we find a positive and significant relation between upstream tariff reductions and downstream investment only in concentrated, but not in dispersed, downstream industries. The differences between the coefficient estimates in the high- versus low-concentration industries are statistically significant, except for the difference in the estimated coefficients on the interactions between ΔUP_TARIFF and POST in columns 3 and 4. Overall, the results of Panel C of Table 7 are thus consistent with the notion that higher industry concentration endows the downstream firms with more bargaining power vis-à-vis their suppliers and customers, which in turn results into a stronger response to upstream tariff reductions (Prediction 4).

4. Financial Constraints

The last cross-sectional dimension that we examine is financial constraints (Prediction 5). To do so, we use three proxies: size as measured by the book value of assets, an indicator for firms that pay dividends, and an index of financial constraints based on Whited and Wu (2006) (WW_INDEX). We then consider those downstream firms financially constrained that do not pay dividends or whose size is smaller or WW_INDEX larger than the median in year $t = -1$.

Panel D of Table 7 shows our findings. The estimated coefficients on the interactions between ΔUP_TARIFF and POST are positive and statistically significant at the 1% level for those downstream firms that are presumably unconstrained, irrespective of which proxy we use. In contrast, the estimates are much smaller and not statistically significant for the firms that are presumably financially constrained.[13] The difference between the estimated coefficients is statistically

[13]We also find no evidence that upstream tariff cuts relax the downstream firms' financial constraints (unreported).

significant (at the 5% level for firm size and the 1% level for the indicator for dividend-paying firms and the WW_INDEX). These findings suggest that financial frictions can reduce the extent to which upstream tariff reductions translate into increased downstream investment.

F. Outcomes at the Industry Level

So far, we relied on firm-level data from Compustat and CRSP with detailed information from financial statements and security prices. This allowed us to study the cross-sectional variation in firms' investment response as well as to check for balance on observables, verify the absence of pretreatment trends, and control for differences in observable, firm-level characteristics. In particular, the observable market valuations of public firms allowed us to construct proxies for important determinants of investment decisions such as growth expectations and uncertainty.

A disadvantage of data from Compustat and CRSP is the omission of private firms. This is relevant with regards to aggregate effects as it is conceivable that lower upstream tariffs entail higher downstream investment for public firms (as we find) but lower downstream investment for private firms (which are not in the sample). In that case, the aggregate effect of upstream tariffs could be different or even opposite in sign from the firm-level effect we estimate for public firms.

In this section, we thus complement our firm-level results with an industry-level analysis based on information from the NBER-CES Manufacturing Industry Database that covers both public and private U.S. manufacturing firms (SIC codes 2000–3999). Table 8 provides summary statistics.

TABLE 8

Summary Statistics at the Industry Level

Table 8 presents summary statistics for the pretreatment values of the variables used in the industry-level analysis. All variables are measured as of year $t = -1$, the last year before the implementation of the tariff revisions following the multinational trade agreements that we exploit in the difference-in-differences analysis: the implementation of the GSP (from 1976 onward), tariff revisions agreed upon during the 7th GATT round (from 1980 onward), and tariff revisions due to NAFTA and the 8th GATT round (from 1994 and 1995 onward).

	1	2	3	4	5	6
Variable:	No. of Obs.	Mean	Std. Dev.	*p*1	*p*50	*p*99
UP_TARIFF (in percentage points)	1,016	1.758	1.828	0.100	1.284	9.910
ΔUP_TARIFF (in percentage points)	1,016	0.259	0.243	−0.071	0.215	1.039
OWN_TARIFF (in percentage points)	1,016	6.792	5.775	0.000	5.333	28.273
ΔOWN_TARIFF (in percentage points)	1,016	1.168	1.806	−2.617	0.972	7.512
DOWN_TARIFF (in percentage points)	1,016	1.730	2.450	0.004	0.830	13.538
ΔDOWN_TARIFF (in percentage points)	1,016	0.279	0.385	−0.157	0.115	1.429
CAPEX/CAPITAL	1,016	0.075	0.052	0.019	0.068	0.182
INPUT_PRICE	1,016	2.760	0.975	1.293	2.560	5.340
ln(REAL_INPUT)	1,016	7.264	1.238	4.321	7.260	10.748
ln(REAL_OUTPUT)	1,016	7.966	1.195	5.328	7.950	11.110
ln(EMPLOYMENT)	1,016	3.265	1.075	0.693	3.201	5.935
ln(TFP)	1,016	−0.035	0.185	−0.486	−0.023	0.406
SALES_GROWTH	1,016	0.061	0.108	−0.237	0.060	0.335
PROD_WORK/EMP	1,016	0.732	0.116	0.380	0.755	0.909

Using the industry-level data, we estimate the following DiD model:

$$\text{(12)}\quad \text{INVESTMENT}_{k,j,t} = \big(\beta_1 \Delta\text{UP\_TARIFF}_{k,j} + \gamma_1 \Delta\text{OWN\_TARIFF}_{k,j} + \delta_1 \Delta\text{DOWN\_TARIFF}_{k,j}\big) \times \text{IMP}_{k,t} + \big(\beta_2 \Delta\text{UP\_TARIFF}_{k,j} + \gamma_2 \Delta\text{OWN\_TARIFF}_{k,j} + \delta_2 \Delta\text{DOWN\_TARIFF}_{k,j}\big) \times \text{POST}_{k,t} + \theta_1' \text{CONTROLS}_{k,j} \times \text{IMP}_{k,t} + \theta_2' \text{CONTROLS}_{k,j} \times \text{POST}_{k,t} + \alpha_{k,j} + \lambda_{k,t} + \rho_j \times t + \varepsilon_{k,j,t}.$$

We index trade agreements, (SIC4-) industries, and years by k, j, and t and use observations from $t = -5$ to $t = 7$ around each agreement, where $t = -1$ denotes the last year before the implementation of the tariff revisions. INVESTMENT is capital expenditures scaled by beginning of year capital.[14] CONTROLS are the $t = -1$-values of ln(TFP), SALES_GROWTH, and PROD_WORK/EMP, which we include to account for differences in productivity, growth opportunities, and skill intensity of the workforce. The Appendix provides definitions. All other variables are defined as before. We cluster the standard errors by industry (Bertrand et al. (2004), Petersen (2008)).

The estimated coefficient on the interaction between ΔUP_TARIFF and POST in the first column of Table 9 is positive and statistically significant at the

TABLE 9

Outcomes at the Industry Level

Table 9 presents estimates of the sensitivity of different (downstream-)industry-level variables to upstream tariff reductions (ΔUP_TARIFF) obtained from a difference-in-differences analysis around multinational trade agreements (GSP, 7th GATT round, and NAFTA/8th GATT round). POST is an indicator equal to 1 in years $t = 3, 4, \ldots, 7$, where $t = -1$ denotes the last year before the implementation of the tariff revisions. IMP is an indicator for the implementation phase and equal to 1 in years $t = 0, 1, 2$. All coefficient estimates are multiplied by 100 to improve readability. The standard errors are clustered by (SIC4-) industry. t-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4	5
Dependent Variable:	CAPEX/ CAPITAL	INPUT_ PRICE	ln(REAL_ INPUT)	ln(REAL_ OUTPUT)	ln(EMPLOYMENT)
ΔUP_TARIFF × POST	1.381**	−14.088***	19.102***	17.569***	18.984***
	(2.02)	(−2.75)	(2.93)	(2.86)	(3.70)
ΔUP_TARIFF × IMP	0.092	−16.934***	6.062*	7.775***	6.953***
	(0.18)	(−4.67)	(1.87)	(2.76)	(2.89)
Trade agreement × SIC4 fixed effects	Yes	Yes	Yes	Yes	Yes
Trade agreement × year fixed effects	Yes	Yes	Yes	Yes	Yes
ΔOWN_TARIFF (interacted)	Yes	Yes	Yes	Yes	Yes
ΔDOWN_TARIFF (interacted)	Yes	Yes	Yes	Yes	Yes
Pretreatment controls (interacted)	Yes	Yes	Yes	Yes	Yes
SIC4-level time trends	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.420	0.974	0.987	0.988	0.989
No. of obs.	13,188	13,183	13,183	13,183	13,183

[14]We scale by capital as the NBER-CES data do not include the book value of assets used in the firm-level analysis.

5% level, consistent with our firm-level results (Table 3) and recent evidence in Bown et al. (2021). The economic magnitude is also in line with the firm-level findings: A coefficient of 1.381 suggests that a hypothetical 10% decrease in all import tariffs would translate into an increase in downstream investment by about 3%. The finding that the estimated effect size at the industry level is slightly lower than the effect size suggested by the firm-level estimates (4%–6%) is consistent with the cross-sectional finding that financially constrained firms seem to respond less to upstream tariff reductions and the notion that private firms may be more likely to be financially constrained than public firms.

An additional benefit of using the NBER-CES data, apart from the inclusion of private firms, is the availability of high-quality information on industry-level prices, input and output quantities, and employment. Such information is useful because it allows us to conduct several ancillary tests. For example, we can now test directly if tariff reductions lead to lower input prices in downstream industries (as we have argued). Likewise, we can test if upstream tariff reductions entail an increase in downstream input and output quantities (as one would expect given the increase in investment). We can also study the extent to which upstream tariff reductions affect downstream employment. Hence, we now replace INVESTMENT in model (12) with the following variables: INPUT_PRICE, ln(REAL_INPUT), ln(REAL_OUTPUT), and ln(EMPLOYMENT). Definitions are in the Appendix.

Column 2 of Table 9 provides some evidence that input material prices indeed decline after upstream tariff reductions. The estimated coefficient of −14.088 suggests that a 10% reduction in upstream tariffs would lead to a decrease in downstream input prices by about 1%. Columns 3 and 4 suggest that downstream input and output quantities increase in real terms.[15] Column 5 suggests an increase in downstream employment, a result that is mirrored by the findings of Bown et al. (2021) and Barattieri and Cacciatore (2023) that temporary trade barriers and antidumping duties reduce employment in downstream industries. In terms of economic magnitudes, the coefficient estimates in columns 3–5 suggest that a hypothetical 10% decrease in all import tariffs would translate into an increase in downstream input, output, and employment by about 3%.

G. Instrumental Variable Estimation Using Chinese Import Penetration

Up to this point, we exploited tariff revisions following multinational trade agreements with the identifying assumption that changes in upstream tariffs (ΔUP_TARIFF) are uncorrelated with unobserved determinants of downstream firms' investment. Reassuringly, we indeed found no evidence that the tariff revisions are related to pretreatment firm- or industry-characteristics (Table 2). In particular, we found no evidence that the tariff revisions are correlated with observable proxies for downstream growth opportunities (e.g., Tobin's Q or sales growth) in the pretreatment years. Controlling for these proxies did not affect our results

[15]This result is consistent with Vandenbussche and Viegelahn's (2018) finding that Indian firms use fewer imported inputs after tariff hikes due to anti-dumping measures and that this accounts for a loss of up to 10% of output growth.

either (Table 3). Finally, there was no evidence of differential pretreatment trends in investment, that is, we found no relation between the tariff revisions and downstream investment before the revisions were implemented (Table 4).

To alleviate endogeneity concerns further and to verify the external validity of the DiD results around multinational trade agreements, in this section, we rely on a different identification assumption and use data from a different setting and period. In particular, we now extend our analysis beyond import tariffs and examine the relation between import competition and downstream investment. The conceptual link between this and our previous analysis is the following idea: Lower import tariffs can foster greater competition from foreign suppliers. Greater import competition can in turn create downward pressure on prices, to which downstream firms may respond by increasing investment. Hence, instead of looking at the relation between import tariffs and downstream investment, we now look at the impact of import competition directly. Specifically, we test how import competition in upstream industries affects downstream investment.

As in the analysis of the relation between import tariffs and investment, a concern is that the amount of import competition in an industry may be correlated with unobserved determinants of downstream investment (e.g., downstream growth opportunities that affect the expected demand for the upstream industries' output). To help mitigate this concern, we borrow a well-established identification strategy from the literature (e.g., Autor et al. (2013), Acemoglu et al. (2016), and Hombert and Matray (2018)) and exploit the sudden increase in Chinese import penetration in U.S. manufacturing industries between 1991 and 2011. The idea is that the increase in import penetration from China may not be due to U.S. demand shocks for Chinese goods but the result of economic reforms in the 1980s and 1990s in China as well as China's WTO accession in 2001. In that case, Chinese import penetration in other developed countries (which is presumably driven by the same economic reforms and WTO accession) can be used as an instrument for Chinese import penetration in the United States. The key identifying assumption here is that demand shocks for Chinese imports in the United States are uncorrelated with demand shocks for Chinese imports in these other developed countries and that Chinese manufacturing is not subject to strongly increasing returns to scale.

Building on Acemoglu et al. (2016), we thus proceed as follows:[16] First, for each U.S. manufacturing industry, we compute the amount of Chinese import penetration (CIP) as the amount of imports (M^{UC}) from China, scaled by the industry's initial absorption measured as output (Y) plus total imports (M) minus exports (E) in 1991 (the first year where the necessary data are available):

$$\text{CIP}_{j,t} = \frac{M_{j,t}^{\text{UC}}}{Y_{j,91} + M_{j,91} - E_{j,91}}. \tag{13}$$

We also compute the amount of Chinese import penetration in 8 other high-income countries (Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland):

[16] We obtain the data from https://economics.mit.edu/faculty/acemoglu/data/empsag/.

$$\text{CIPO}_{j,t} = \frac{M^{\text{OC}}_{j,t}}{Y_{j,91} + M_{j,91} - E_{j,91}}, \tag{14}$$

where M^{OC} is the total amount of imports from China in these countries.

Next, in analogy to UP_TARIFF, we compute the weighted average of CIP in upstream industries:

$$\text{UP\_CIP}_{j,t} = \sum_{s \in S_{-\text{j}}} \omega_{s,j} \times \text{CIP}_{s,t} \tag{15}$$

with

$$\omega_{s,j} = \frac{\text{Gross flow of goods from industry } s \text{ to industry } j}{\text{Total gross flow of goods from all industries to industry } j}. \tag{16}$$

Similarly, we compute UP_CIPO as the weighted average of CIPO in upstream industries and DOWN_CIP (DOWN_CIPO) as the weighted average of CIP (CIPO) in downstream industries.[17]

Finally, we estimate the effect of upstream import penetration from China on downstream investment in U.S. manufacturing firms by two-stage-least-squares (2SLS). Specifically, we estimate

$$\begin{aligned} \text{INVESTMENT}_{i,j,t} = {} & \alpha_i + \lambda_t + \beta \times \text{UP\_CIP}_{j,t} + \gamma \times \text{OWN\_CIP}_{j,t} \\ & + \delta \times \text{DOWN\_CIP}_{j,t} + \theta' \text{CONTROLS}_{i,j,t-1} + \varepsilon_{i,j,t}, \end{aligned} \tag{17}$$

using $\text{UP\_CIPO}_{j,t}$, $\text{OWN\_CIPO}_{j,t}$, and $\text{DOWN\_CIPO}_{j,t}$ to instrument $\text{UP\_CIP}_{j,t}$, $\text{OWN\_CIP}_{j,t}$, and $\text{DOWN\_CIP}_{j,t}$. $\text{INVESTMENT}_{i,j,t}$ is capital expenditures scaled by beginning of year total assets. α_i and λ_t are firm and year fixed effects. $\text{CONTROLS}_{i,j,t-1}$ are ln(ASSETS), TOBINS_Q, CASH/ASSETS, DEBT/ASSETS, EBITDA/ASSETS, SALES_GROWTH, EXCESS_RETURN, EXCESS_VOLATILITY, IND_SALES_GROWTH, and IND_CONCENTRATION. The sample period is from 1991 to 2011 as in Acemoglu et al. (2016).

Table 10 shows the results. In all odd-numbered columns, we only control for firm and year fixed effects. In all even-numbered columns, we also include the firm- and industry-level control variables. All standard errors are clustered by industry. Columns 1–6 show the coefficient estimates and *t*-statistics from the first stage and reveal a significant correlation between Chinese import penetration in the United States and other developed countries, consistent with prior literature.

Columns 7 and 8 in Table 10 show the results from the second stage. The estimated coefficient on UP_CIP in column 7 is 0.385 (*t*-stat. 2.62) and 0.276 (*t*-stat. 2.71) in column 8. That is, downstream firms' investment exceeds the sample average in years when upstream import penetration from China exceeds the average. Over the entire sample period, since Chinese import penetration has been steadily increasing, this translates into a larger total increase in investment for those

[17]When computing DOWN_CIP and DOWNSTREAM_CIPO, we use $v_{j,s} = \frac{\text{Gross flow of goods from industry } j \text{ to industry } s}{\text{Total gross flow of goods from industry } j \text{ to all industries}}$.

TABLE 10

2SLS IV Estimation Exploiting Variation in Import Competition from China

Table 10 presents estimates of the sensitivity of downstream firms' investment (CAPEX/ASSETS) to upstream import penetration from China (UP_CIP) obtained from 2SLS IV regressions using the import penetration in other developed countries as instruments for Chinese import penetration in the United States. The standard errors are clustered by (SIC4-) industry. *t*-statistics are reported in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

	1	2	3	4	5	6	7	8
	UP_CIP	UP_CIP	OWN_CIP	OWN_CIP	DOWN_CIP	DOWN_CIP	CAPEX/ ASSETS	CAPEX/ ASSETS
UP_CIPO	1.141***	1.137***	2.476***	2.433***	0.179***	0.176***		
	(22.11)	(23.30)	(3.10)	(3.24)	(3.34)	(3.36)		
OWN_CIPO	0.001	0.001	1.105***	1.106***	−0.014**	−0.014***		
	(0.11)	(0.16)	(7.41)	(7.49)	(−2.57)	(−2.62)		
DOWN_CIPO	−0.067***	−0.069***	−1.243***	−1.268***	1.313***	1.313***		
	(−3.14)	(−3.32)	(−2.75)	(−2.83)	(53.30)	(55.54)		
UP_CIP (instrumented)							0.385***	0.276***
							(2.62)	(2.71)
OWN_CIP (instrumented)							−0.032***	−0.023***
							(−2.99)	(−2.91)
DOWN_CIP (instrumented)							−0.210***	−0.213***
							(−2.69)	(−3.58)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	No	Yes	No	Yes	No	Yes	No	Yes
F-statistic on instruments	418	426	40	40	1,435	1,630	–	–
Adj. R^2	0.979	0.979	0.927	0.928	0.989	0.989	0.002	0.074
No. of obs.	29,328	29,328	29,328	29,328	29,328	29,328	29,328	29,328

firms whose upstream industries experienced larger increases in import competition from China. Specifically, in terms of economic magnitude, the estimates suggest that the increase in Chinese import penetration over the 20-year period from 1991 to 2011 entailed an increase in downstream investment by 12%–16%, relative to the 1991 level of investment, over the same period.[18] The results of this second analysis are thus broadly consistent with our tariff-related findings and the interpretation that lower import tariffs can foster competition from foreign rivals to which downstream firms may respond by increasing investment. The estimated magnitudes of the two effects, however, are not directly comparable because one is an estimate of the impact of tariff reductions around multinational trade agreements whereas the other is an estimate of the impact of import penetration from China. That is, while we would predict that both estimates have the same sign (as we find), we do not necessarily expect that they have the same magnitude.

V. Conclusion

Protectionist trade policies have recently gained in popularity. Such policies may help some domestic industries by sheltering them from foreign competition,

[18]From 1991 to 2011, the average import penetration from China in upstream manufacturing industries rose by ΔUP_CIP = 0.025. Column 7 suggests an associated increase in INVESTMENT by $0.025 \times 0.385 = 0.0096$, corresponding to 16% of the average 1991-level of INVESTMENT (0.059). Column 8 suggests an increase by 12%.

yet they can hurt others by increasing the price of imported inputs needed for production. Studying the impact of upstream tariff reductions on U.S. manufacturing firms' investments, we estimate that a hypothetical decrease in all tariffs by 10% would translate into an increase in downstream investment by 4%–6%. Cross-sectional tests suggest the importance of the share of input costs in total costs, input differentiation and R&D intensity, industry concentration, and financial constraints for the extent to which tariff cuts propagate downstream. Ancillary tests suggest that lower tariffs also entail higher downstream profitability, productivity, output, and employment. We leave it for future research to study the consequences of trade barriers other than tariffs, such as legal and regulatory requirements.

Our findings are important for several reasons. First, they contribute to a more comprehensive understanding of the effects that tariffs can have through firms' supply chains. Second, while theory generally predicts that freer trade is net-beneficial, empirical evidence of the possible benefits is harder to come by, in particular, for highly industrialized economies like the United States. Indeed, recent work on the impact of freer trade in the United States focuses on the negative consequences such as higher unemployment and lower wages. These papers highlight that trade liberalization entails substantial short-run adjustment costs. We, instead, provide evidence of potential benefits in the long run: higher investment in downstream industries, which goes hand in hand with higher profitability, productivity, employment, and output. The possibility that some of these new investments could reflect inefficient overinvestment cannot be ruled out entirely, yet our empirical evidence does not point in this direction. Third, our findings can help inform the ongoing debate about protectionist versus free trade policies and what type of transfer programs are needed to redistribute the gains from any given policy. In particular, our findings suggest that high import tariffs may be most detrimental if imposed in those industries that are "very upstream" in the overall production chain because, in that case, the tariffs may entail negative consequences for the entire sequence of downstream industries. Our results further indicate that the gains from freer upstream trade may not be realized uniformly but vary across firms and industries. Transfer programs to redistribute the surplus from trade liberalizations should thus take such possible heterogeneities into account.

Appendix. Variable Definitions

CAPEX/ASSETS (firm-level): Capital expenditures (CAPX) divided by the book value of total assets (AT) at the end of the previous year. Source: Compustat.

CAPEX/CAPITAL (industry-level): Total capital expenditures (in real terms) at the industry level divided by total capital (in real terms) at the end of the previous year. Source: NBER-CES Database.

CASH/ASSETS: Cash holdings (CHE) divided by book value of total assets (AT). Source: Compustat.

CIP: Amount of imports from China to the United States, scaled by the industry's initial absorption measured as output plus total imports minus exports in 1991. Source: UN Comtrade Database.

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CIPO: Amount of imports from China to other countries (Australia, Denmark, Finland, Germany, Japan, New Zealand, Spain, and Switzerland), scaled by the industry's initial absorption measured as output plus total imports minus exports in 1991. Source: UN Comtrade Database.

DEBT/ASSETS: Book value of total long-term and short-term debt (DLLT + DLC) divided by book value of total assets (AT). Source: Compustat.

DOWN_CIP: Weighted average CIP in all downstream industries. The weight of each downstream industry is the dollar value of the gross flow of goods from the upstream industry to the downstream industry divided by the dollar value of the total gross flow of goods from the upstream industry. Following Acemoglu et al. (2016), we use the 1992 BEA input–output table, and we aggregate industries to the level of 4-digit SIC codes. Source: BEA input–output tables, UN Comtrade Database.

DOWN_CIPO: Weighted average CIPO in all downstream industries. The weight of each downstream industry is the dollar value of the gross flow of goods from the upstream industry to the downstream industry divided by the dollar value of the total gross flow of goods from the upstream industry. Following Acemoglu et al. (2016), we use the 1992 BEA input–output table, and we aggregate industries to the level of 4-digit SIC codes. Source: BEA input–output tables, UN Comtrade Database.

DOWN_TARIFF: Weighted average import tariff rate in all downstream industries. The weight of each downstream industry is the dollar value of the gross flow of goods from the upstream industry to the downstream industry divided by the dollar value of the total gross flow of goods from the upstream industry. We aggregate industries to the level of 4-digit SIC codes. Source: Center for International Data at UC Davis, BEA input–output tables.

ΔDOWN_TARIFF: DOWN_TARIFF in year $t = -1$ minus DOWN_TARIFF in year $t = 3$. To ensure that ΔDOWN_TARIFF is not confounded by changes in the amounts of imports from different countries of origin, we use the import values as of year $t = -1$ to construct the weights used in computing DOWN_TARIFF. Similarly, to ensure that changes in the gross flows of goods between industries do not confound the results, we use the 1972 BEA input–output table when computing the tariff changes between 1975 and 1979, the 1977 BEA input–output table when computing the tariff changes from 1979 to 1983, and the 1992 BEA input–output table when computing the tariff changes from 1993 to 1997. Source: Center for International Data at UC Davis, BEA input–output tables.

EBITDA/ASSETS: EBITDA (EBITDA) divided by the book value of total assets (AT). Source: Compustat.

EXCESS_RETURN: Stock return ([PRCC_F$_t$/PRCC_F$_{t-1}$] − 1) minus market return ([USDVAL$_t$/USDVAL$_{t-1}$] − 1). Source: Compustat, CRSP.

EXCESS_VOLATILITY: Standard deviation of daily returns during the year minus standard deviation of daily market returns during the year. Source: CRSP.

GROSS_PROFIT/ASSETS (firm-level): Sales (SALE) minus cost of goods sold (COGS), divided by the book value of total assets (AT). Source: Compustat.

GROSS_PROFIT/OUTPUT (industry-level): Value of shipments (VSHIP) – material costs (MATCOST) – energy costs (ENERGY) – employee compensation (PAY), divided by the value of shipments (VSHIP). Source: NBER-CES Database.

IMP: Indicator equal to 1 in years $t = 0,1,2$, where $t = -1$ denotes the last year before the implementation of the tariff revisions.

IMPORT_TARIFF: Import tariff rate computed as the value of import duties divided by the customs value of imports. Source: Center for International Data at UC Davis.

IND_CONCENTRATION: Herfindahl–Hirschman Index (HHI) of sales in a given industry and year. Source: Compustat.

IND_SALES_GROWTH: Growth rate of aggregate sales in a given industry and year. Source: Compustat.

INPUT_PRICE: Material price index at the industry level. Source: NBER-CES Database.

INST_OWN: Number of shares held by institutional investors in the fourth quarter divided by the number of shares outstanding in December. Source: Thomson/Refinitiv, CRSP.

ln(ASSETS): Natural logarithm of the book value of total assets (AT). Source: Compustat.

ln(EMPLOYMENT): Natural logarithm of the number of employees (in 1,000s). Source: NBER-CES Database.

ln(REAL_INPUT): Natural logarithm of material costs divided by material price index. Source: NBER-CES Database.

ln(REAL_OUTPUT): Natural logarithm of sales divided by output price index. Source: NBER-CES Database.

ln(TFP) (firm-level): Natural logarithm of firm-level TFP, estimated based on Giupponi and Landais (2023): $\text{TFP}_{it} = [\text{SALE}_{it} - \text{COGS}_{it}] / \left[(\text{EMP}_{it})^{\alpha_{jt}} (\text{PPENT}_{it})^{1-\alpha_{jt}} \right]$, where i, j, and t index firms, (SIC4-)industries, and years. α_{jt} is the industry-level labor share, computed using the NBER-CES data as total employee compensation divided by value-added. Source: Compustat, NBER-CES Database.

ln(TFP) (industry-level): Natural logarithm of 5-factor TFP (index 1987 = 1) at the industry level. Source: NBER-CES Database.

OWN_CIP: CIP in the industry itself. Source: UN Comtrade Database.

OWN_CIPO: CIPO in the industry itself. Source: UN Comtrade Database.

OWN_TARIFF: Import tariff rate in the industry itself. Source: Center for International Data at UC Davis.

ΔOWN_TARIFF: OWN_TARIFF in year $t = -1$ minus OWN_TARIFF in year $t = 3$. To ensure that ΔOWN_TARIFF is not confounded by changes in the amounts of imports from different countries of origin, we use the import values as of year $t = -1$ to construct the weights used in computing OWN_TARIFF. Source: Center for International Data at UC Davis.

POST: Indicator equal to 1 in years $t = 3,4,\ldots,7$, where $t = -1$ is the last year before the implementation of the tariff revisions.

PROD_WORK/EMP: Ratio of the number of production workers to total employment at the industry level. Source: NBER-CES Database.

R&D/SALES: Research & development expenses (XRD) divided by sales (SALE). Zero if no R&D expenses are reported. Source: Compustat.

SALES_GROWTH (firm-level): Sales (SALE) divided by sales in the previous year − 1. Source: Compustat.

TOBINS_Q: [Book value of total assets (AT) − book value of equity (CEQ) + market value of equity (CSHO × PRCC_F)]/book value of total assets (AT). Source: Compustat.

TOP4SHARE: Percentage of aggregate industry sales accounted for by the four firms with the largest sales volume. Source: Compustat.

ΔUNCERTAINTY: EXCESS_VOLATILITY in year $t = -1$ minus EXCESS_VOLATILITY in year $t = 3$. Source: CRSP.

UP_CIP: Weighted average CIP in all upstream industries. The weight of each upstream industry is the dollar value of the gross flow of goods from the upstream to the downstream industry divided by the value of the total gross flow of goods to the downstream industry. Following Acemoglu et al. (2016), we use the 1992 BEA input–output table, and we aggregate industries to the level of 4-digit SIC codes. Source: BEA input–output tables, UN Comtrade Database.

UP_CIPO: Weighted average CIPO in all upstream industries. The weight of each upstream industry is the dollar value of the gross flow of goods from the upstream to the downstream industry divided by the value of the total gross flow of goods to the downstream industry. Following Acemoglu et al. (2016), we use the 1992 BEA input–output table, and we aggregate industries to the level of 4-digit SIC codes. Source: BEA input–output tables, UN Comtrade Database.

UP_TARIFF: Weighted average import tariff rate in all upstream industries. The weight of each upstream industry is the dollar value of the gross flow of goods from the upstream to the downstream industry divided by the value of the total gross flow of goods to the downstream industry. We aggregate industries to the level of 4-digit SIC codes. Source: Center for International Data at UC Davis, BEA input–output tables.

ΔUP_TARIFF: UP_TARIFF in year $t = -1$ minus UP_TARIFF in year $t = 3$. To ensure that ΔUP_TARIFF is not confounded by changes in the amounts of imports from different countries of origin, we use the import values as of year $t = -1$ to construct the weights used in computing UP_TARIFF. Similarly, to ensure that changes in the gross flows of goods between industries do not confound the results, we use the 1972 BEA input–output table when computing the tariff changes between 1975 and 1979, the 1977 BEA input–output table when computing the tariff changes from 1979 to 1983, and the 1992 BEA input–output table when computing the tariff changes from 1993 to 1997. Source: Center for International Data at UC Davis, BEA input–output tables.

WW_INDEX: $-0.091 \times [\text{IBC}/\text{AT}] - 0.044 \times \ln(\text{AT}) + 0.102 \times$ INDUSTRY_SALES_GROWTH $- 0.035 \times$ SALES_GROWTH $- 0.062 \times$ DIVIDENDPAYER $+ 0.021 \times [\text{DLTT}/\text{AT}]$. Formula based on Whited and Wu (2006). Source: Compustat.

Supplementary Material

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