How Does Corporate Investment Respond to Increased Entry Threat?

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We study how product-market interactions affect investment. We use reductions of import tariffs to examine how incumbents modify investment when the threat of rivals' entry intensifies. Incumbents reduce investment by 7.2% in response to higher entry threat. Consistent with a strategic behavior, the investment reduction varies across market structures: it concentrates in markets in which competitive actions are strategic substitutes, where deterring entry is costly and investment makes incumbents look soft. Our results provide novel evidence on how and why firms' interactions influence corporate investment. (*JEL* F13, G31, L1)

Received August 10, 2015; accepted December 1, 2015 by Editor Efraim Benmelech.

Firms do not operate in isolation, but they interact with rivals in the product market. They invest resources to develop and promote new products, increase differentiation, and satisfy existing customers to enhance their competitive position and ultimately maximize their value. The importance of firms' product-market interactions for corporate investment is the subject of a large theoretical literature in finance and economics (Spence 1977; Dixit 1980; Fudenberg and Tirole 1984). Yet, despite a recent surge of interest for the implications of firms' interactions and

We thank Effi Benmelech (the editor), an anonymous referee, Julien Cujean, Francois Derrien, Michel Dubois, Rudiger Fahlenbrach, Xavier Giroud, Radhakrishnan Gopalan, Dirk Hackbarth, Uli Hege, Jerry Hoberg, Evgeny Lyandres, Adrien Matray, Sebastien Michenaud, Boris Nikolov, Gordon Phillips, Urs Peyer, Peter Pontuch, Carolina Salva, Albert Sheen, Philipp Schnabl, Denis Sosyura, David Thesmar, and seminar participants at the Boston College, Boston University, Columbia University, George Washington University, HEC Montreal, the University of British Columbia, the University of Geneva, the University of Maryland, the University of St. Gallen, the Adam Smith Conference, the French Finance Association Meetings, the European Winter Finance Conference, the SFS Cavalcade, the Paris Spring Corporate Finance Conference, the Rothschild Caesarea Conference, the 4nations cup, and the City University of Hong Kong International Conference for valuable comments and suggestions. This paper builds on parts of a previous version titled "Competitive Pressure and Corporate Policies: Evidence from Trade Liberalization." Valta acknowledges financial support from the Investissements d'Avenir (ANR-11-IDEX-0003/Labex Ecodec/ANR-11-LABX-0047). Supplementary data can be found on *The Review of Corporate Finance Studies* web site. Send correspondence to Laurent Frésard, University of Maryland, 4414 Van Munching Hall, College Park, MD 20742; telephone: (301) 405-9639. E-mail: lfresard@rhsmith.umd.edu.

doi:10.1093/rcfs/cfv015 Advance Access publication December 28, 2015

peer effects among finance researchers, there is surprisingly little empirical evidence on how interactions with product market rivals influence firms' investment choices.

The lack of evidence has two main origins. First, firms can use investment strategically to influence rivals' decisions.[1] The existence of such strategic behavior renders product-market structures endogenous to firms' investment, making it difficult to identify a causal link between product market interactions and investment. Second, the theoretical predictions on how and why product-market interactions matter for investment depend on elements of market structures that are typically difficult to measure in the data.

The goal of this paper is to address these empirical challenges. We examine how firms respond to situations in which the threat of entry by new competitors suddenly increases. We measure increases in entry threat using large reductions of import tariffs. We argue that, by lowering the cost of entry for foreign rivals, these events generate plausibly exogenous variation in the likelihood of entry faced by domestic firms. This variation enables us to estimate the causal effect of increased entry threat on corporate investment.

We identify 91 significant reductions of import tariffs between 1974 and 2005 that occur in 74 unique U.S. manufacturing industries and affect 1,116 publicly listed firms. During these liberalization episodes, the average import tariff drops by more than 50%. We estimate firms' reaction to changes in entry threat using a difference-in-differences specification surrounding tariff reductions. We focus on short windows around tariff cuts because we are interested in firms' reaction to increased entry threat and not in rivals' actual entry. This distinction is key for our analysis because unlike other types of events that may affect firms' profitability (e.g., demand or technology shocks), firms can strategically influence the actions of potential entrants following a shock to entry costs to protect their competitive advantage (Goolsbee and Syverson 2008; Ellison and Ellison 2011). We thus compare the change in investment from one year before to one year after the tariff cut for firms that operate in affected industries to that of similar firms that operate in unaffected industries and that are matched on multiple dimensions.

We find that, on average, U.S. firms significantly reduce capital expenditures after tariffs decrease in their industry. The economic magnitude of the reduction is large. Relative to matched firms, the capital expenditures of treated firms decline by 7.2% of capital following tariff cuts, a 16.7% drop relative to the investment level prior to the tariff cuts, or $9.27 million per firm. Our estimates are robust to various

[1] Throughout the paper we use the term "strategic" to characterize situations in which a firm takes into account the effect that its actions can have on other firms in its product market space.

specifications, such as modifications of the matching techniques, matching covariates, estimation windows, or placebo tests.

We show that the results are unlikely to be driven by unobserved differences between affected and unaffected industries, such as tariff cuts occurring in only declining industries, where growth opportunities are disappearing. We find no differences in the investment, profitability, or sales patterns between treated and matched firms over a three-year period preceding the reductions of tariffs. Moreover, we find virtually no change in proxies for firms' growth opportunities and uncertainty in response to tariff cuts. Furthermore, the estimated reduction of investment remains significant even after we control for various time-varying proxies for investment opportunities and uncertainty. These results suggest that the investment decrease is not mechanically tied to lower growth prospects or higher uncertainty after tariff reductions.

Instead, our results are broadly consistent with strategic investment models predicting that incumbent firms could either decrease or increase investment in response to higher entry threat (Fudenberg and Tirole 1984; Bulow, Geanakoplos, and Klemperer 1985). Fudenberg and Tirole (1984) predict that when firms interact with rivals in the product market and face entry threats, the change in their investment following a decrease of entry costs should depend predictably on three elements of market structure: (1) whether competitive actions are strategic substitutes or complements, (2) whether firms can feasibly deter entry or need to strategically accommodate entry, and (3) whether investment signals that a firm will be a soft or a tough competitor. To further understand whether the drop in investment following tariff cuts contains a strategic dimension, we analyze the variation of incumbents' response across these different market structures. We specifically focus on cross-sectional variations in investment responses that are unlikely to be observed if firms' behavior only reflects a nonstrategic response. In particular, we concentrate the analysis on the nature of strategic interactions and on whether investment choices make firms look like tough or soft competitors, because there is little reason to expect differential responses along these two dimensions when firms' investment response does not contain any strategic dimension.

We find that the reduction of investment is only observed in markets featuring competition in strategic substitutes. The change in investment is negligible in markets featuring competition in strategic complements. Moreover, we estimate that only firms with constrained financial resources reduce investment after large tariff reductions. Arguably, because financially weak firms may not be able to fund further investment if entry occurs, lower investment spending in response to tariff cuts makes these firms credibly look "soft." In addition, the reduction of investment is concentrated in product markets in which the costs of entry are low–where it might be too costly for incumbents to deter entry. We only observe an investment decline in markets in which firms are less protected by natural barriers to entry, measured for instance by a low degree of product differentiation, a high redeployability of assets, or high cash holdings of foreign rivals.

These cross-sectional results are broadly consistent with the idea that the reduction of investment following tariff cuts is partly strategic in that it can modify the actions of potential foreign entrants. As such, the results highlight the importance of market structures for corporate investment. The fact that firms' investment is related to product market characteristics is intuitive and perhaps not surprising. The novelty of our analysis, however, is to identify empirically how and why product market specificities and the nature of interactions among firms shape their investment decisions. The heterogeneity in firms' response to higher entry threat can have important implications for the evaluation of a firm's capital budgeting decisions (by investors, analysts, rivals, or policy makers) and for the comparison of investment choices with industry peers. When firms interact in the product market, ignoring the underlying market structures could lead to incomplete conclusions about the adequacy of firms' decisions.

Our findings primarily add to studies that examine the role of product market competition in corporate finance, especially to the few empirical papers relating corporate investment to product market structures (Khanna and Tice 2000; Akdogu and MacKay 2008; Simintzi 2013). Our paper is distinct in three dimensions. First, we rely on plausibly exogenous variations from tariff changes to identify the causal effect of entry threat on firms' investment choices. Second, we concentrate on firms' investment response to entry threat, as opposed to investment behavior after entry has occurred (measured with a concentration index, for instance). Third, because our sample covers a wide range of industries and market structures, we can contrast mixed theoretical predictions and hence shed new lights on the economic channels through which product-market interactions impact corporate investment.

More generally, our paper is related to the large literature on corporate investment. The bulk of existing studies focuses on how capital market imperfections, such as collateral constraints, agency costs, or information asymmetries influence firms' investment policy. It is well established empirically that this type of imperfections affect corporate investment (see Stein 2003 for a survey). However, much less is known about how interactions among firms relate to their investment decisions. A recent stream of research indicates that such interactions matter. For instance, Dougal, Parsons, and Titman (2015) show that firms' investment is sensitive to the investment of other firms located nearby, Foucault and Frésard (2014) show that firms' investment depends on the stock prices of their product market peers, and Shue (2013) and Fracassi (2014) show that the similarity of investment between two firms increases with executives' social ties. The results in this paper add to this literature by showing that the nature of interactions with rivals in the product market–or the lack thereof–have implications for corporate investment.[2]

1. Testable Hypotheses

To discuss how and through which mechanisms an increase in entry threat affects a firm's investment when it interacts with rivals in the product market, we focus on the investment reaction of an incumbent (a U.S. firm) in response to increased threat from new entrants (foreign rivals). We distinguish between two types of explanations, depending on whether the incumbent accounts for the effect of its investment on rivals' actions, or whether it ignores such a strategic effect.

1.1 Nonstrategic explanations

When the incumbent ignores the effect of its investment on rivals, the effect of increased entry threat depends solely on how the threat of new entry alters the incumbent's expectation about the marginal contribution of new capital to future profits–the marginal productivity of capital.[3] Absent strategic actions, the incumbent's marginal productivity of capital is exogenous to the level of investment it chooses. In this setting, the incumbent is expected to lower investment in response to higher entry threat, either because a higher threat modifies its expectation about future profits, or because higher risk of entry raises uncertainty about future profits. Existing research indicates that more intense competition in the product market may lower firms' profits by putting pressure on margins through thinner market shares or lower prices (Nickel 1996). Accordingly, the incumbent is expected to decrease investment in response to higher entry threat, reflecting the erosion of expected investment opportunities generated by a higher threat of rivals' entry (Grenadier 2002; Aghion et al. 2005).

Higher entry threat could also increase the risk of the incumbent's expected profits. Less intense competition reduces uncertainty about future profits and also enables the incumbent to smooth out fluctuations in profits (Gaspar and Massa 2006; Irvine and Pontiff 2009). The increase in uncertainty associated with higher threat of entry could lead the incumbent to delay investment spending, especially when investment is

[2] In addition, our findings also speak to the literature that studies the real effects of trade liberalization (for recent surveys, see Tybout 2003 or Bernard et al. 2007). As emphasized by Neary (2010), most of the existing research ignores the potential influence of strategic interactions among firms. Our findings suggest that interactions and the resultant product market structures condition how firms respond to trade liberalization.

[3] In the language of the q theory of investment, this corresponds to marginal q. See, for instance, Lucas and Prescott (1971) or Hayashi (1982).

partly irreversible, creating a valuable option to wait before investing. Indeed, real option models of investment predict that the option to wait and delay investment increases with uncertainty (Dixit and Pindyck 1994; Abel and Eberly 1996). Hence, if higher entry threat increases business uncertainty, the incumbent is expected to decrease investment.

1.2 Strategic explanations

When the incumbent behaves strategically, it accounts for the fact that its investment affects rivals' competitive behavior and thereby modifies the equilibrium distribution of expected profits in the market. As a result, the incumbent's marginal productivity of capital is endogenous to the chosen level of investment. In this context, the effect of higher entry threat is ambiguous. Fudenberg and Tirole (1984) or Bulow, Geanakoplos, and Klemperer (1985) suggest that the incumbent's reaction depends on three distinct elements of product market structures. First, it depends on whether the incumbent finds it advantageous to deter rivals' entry or strategically accommodate their entry. Second, it depends on the type of competition in the product market (i.e., Cournot or Bertrand), which determines whether competitive choices are strategic substitutes or complements. Finally, it depends on whether the investment choice of the incumbent makes it look like a tough or soft competitor. Table 1 summarizes the predicted investment response to higher entry threat as a function of each element (eight possible scenarios). We formally derive these predictions in the Appendix using a simple two-period, two-firm model as in Tirole (1988).

The intuition is as follows. When entry deterrence is feasible, the incumbent wants to commit to being a tough competitor in the future to drive down the expected profits of rivals and render entry unattractive. Therefore, if investment makes the incumbent look tough, it is optimal to increase investment in response to higher entry threat so as to limit entry. This may happen, for instance, when excess capacity credibly signals higher future quantity (or lower prices). By contrast, if investment makes the incumbent look soft, it is optimal to decrease investment following higher entry threat in an attempt to deter entry. This could happen in situations in which lower capacity credibly signals greater future flexibility and faster competitive responses.

Alternatively, when entry deterrence is not feasible, the incumbent may strategically accommodate entry and still use investment to influence the rivals' actions and equilibrium profits. In this case, the sign of the incumbent's investment response to higher entry threat depends on whether investment makes the incumbent look tough or soft (as before), but also on whether firms' actions are strategic substitutes or complements. In particular, the incumbent should optimally increase investment following increased entry threat if investment makes it look tough and actions are strategic substitutes, or when investment makes the incumbent look

Table 1
Market structures and investment

Expected sign of investment response?	Investment makes incumbent:			
	tough		soft	
	Deter	Accommodate	Deter	Accommodate
Strategic complements	> 0	< 0	< 0	> 0
Strategic substitutes	> 0	> 0	< 0	< 0

This table presents the predictions that are discussed in Section 1 and formally derived from the model in the Appendix. The table shows how an incumbent firm should optimally modify its investment when entry costs decrease, that is, when import tariffs drop. The predictions depend on (1) whether competitive actions are strategic substitutes or complements, (2) whether the incumbent wants to deter or accommodate entry, and (3) whether investment signals that the incumbent will be a soft or tough competitor should entry occur. The table summarizes the predictions as a function of these elements.

soft and actions are strategic complements. By contrast, we expect the incumbent to reduce investment in situations in which investment makes it look tough and actions are strategic complements or when investment makes the incumbent look soft and actions are strategic substitutes.

Because deterrence is infeasible, the incumbent's objective is to maximize profits in the presence of entrants. Therefore, it uses its investment to influence rivals' equilibrium production (as opposed to expected profits). When actions are strategic substitutes, the incumbent's profits decrease when rivals produce more. This arises typically in markets in which firms compete in market shares, such as the food and beverage industry and the transportation industry (Kedia 2006). Hence, the incumbent uses investment to strategically limit rivals' production. This is achieved by increasing investment if investment makes the incumbent look tough and by decreasing investment if investment makes it look soft. When actions are strategic complements, the incumbent's profits increase when rivals produce more. This typically happens in markets in which firms compete on prices among differentiated goods (e.g., department stores, as described in Kedia 2006), or in markets featuring important network effects. In this case, the incumbent's objective is to induce rivals to increase production. This is done by lowering investment when it makes the incumbent look tough and by investing more when investment makes it look soft.[4]

[4] Existing research on strategic investment, which is mostly industry-specific, is broadly consistent with the heterogeneity of theoretical predictions. For instance, Gilbert and Lieberman (1987) report that larger capital investment temporarily reduces rivals' expansion in the chemical product sector. Focusing on the supermarket industry, Khanna and Tice (2000) document that large and profitable incumbents raise investment after WalMart entered their market. Simintzi (2013) reports that U.K. manufacturing firms invest more when rivals announce restructurings indicative of a better competitive position. Cookson (2014) finds that incumbents expand capacity when threatened by a nearby entry plan in the U.S. casino industry. By contrast, Smiley (1988) surveys corporate executives and finds no evidence that firms increase investment to limit entry. Similary, Goolsbee and Syverson (2008) find no evidence that airlines increase investment when threatened by the entry of Southwest. Khanna and Tice (2000) report a reduction of investment for financially weak supermarkets following WalMart's entry. Ellison and Ellison

1.3 Contrasting predictions

Overall, theory predicts that the incumbent may increase or decrease investment in response to increased threat of entry. While observing an increase in investment is only consistent with a strategic explanation, observing a decrease in investment could reflect both a strategic and nonstrategic response. To assess whether incumbents react strategically to increased entry threat, our empirical strategy consists of three main steps. First, we use large reductions of tariffs across many manufacturing industries and periods to identify how on average corporate investment responds to a plausibly exogenous increase in entry threat. Second, by including a host of variables capturing investment opportunities and uncertainty in our tests, we verify that our results cannot be solely explained by nonstrategic explanations. Third, we exploit the multi-industry nature of our sample to study whether firms' investment reaction to lower entry costs varies across market structures as predicted by the strategic explanation. We focus on cross-sectional variations that are unlikely to be observed if firms' behavior only reflects a nonstrategic response. In particular, we concentrate on the nature of strategic interactions (strategic substitutes or complements) and whether investment choices make firms look like tough or soft competitors, because there is little reason to expect differential responses along these two dimensions when firms' investment response does not contain any strategic dimension.[5]

2. Empirical Strategy and Data

2.1 Reductions of import tariffs

Over the last three decades, the U.S. authorities have gradually removed obstacles to international trade and substantially reduced import tariffs on a large variety of goods and services. Andersen and Van Wincoop (2004) emphasize that import tariffs amount to a significant fraction of overall trade costs and, as a result, represent an important barrier to trade.[6] In the U.S. manufacturing sector the average tariff dropped by about 75% in thirty years, from 8.23% in 1974 to 2.15% in 2005. According to the vast literature on international trade, reductions of

(2011) also find that incumbents decrease investment in advertising prior to patent expiration in the pharmaceutical industry.

[5] Contrasts based on whether incumbents find it optimal to strategically deter or accommodate entry are less specific to the strategic explanations, since this choice is likely related to underlying structural barriers to entry and hence potentially linked to investment opportunities and business uncertainty.

[6] Other barriers to trade include nontariff policy barriers (e.g., quotas, import bans, or import licenses), transportation costs (both freight costs and time costs), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs (e.g., employment or intellectual property laws), or local distribution costs. See Anderson and Van Wincoop (2004) for a survey on trade barriers.

import tariffs lower the cost of entering U.S. product markets, facilitating the penetration of foreign rivals on domestic markets. Because goods and services supplied by foreign rivals become relatively cheaper on domestic markets, reductions of import tariffs magnify the threat of entry by foreign competitors. This idea forms the backbone of our tests.

To capture this idea in the data, we follow Frésard (2010) and identify significant reductions of import tariffs as events that decrease entry barriers.[7] We measure reductions of import tariffs at the industry level by using product-level import data compiled by Feenstra (1996), Feenstra, Romalis, and Schott (2002), and Schott (2010). The data span the period 1974-2005 and include 508 manufacturing industries. Because tariff data are only available for manufacturing industries (2000-3999 SIC codes), we restrict our focus to these industries. Products imported to the United States are coded based on the Harmonized System (HS), which was established by the World Customs Organization (WCO). Each product is assigned a ten-digit HS code. Feenstra (1996) and Schott (2010) develop concordance tables that map each HS product code into four-digit SIC codes.[8] Using this mapping we compute, for each industry-year, the ad valorem tariff as the duties collected by U.S. custom divided by the Free-on-Board value of imports. After merging the tariff data with the firm-level accounting data from COMPUSTAT, we are left with 133 industries.

Next, we compare the tariff reduction in a given industry to the same industry's average change over the whole sample period. Specifically, we define a significant tariff reduction occurring in an industry-year when the negative tariff change is three times larger than the industry's average as Cut#3. Because the coding of imports changed in 1989, we ignore the tariff changes that occurred between 1988 and 1989. To make sure that tariff cuts truly reflect nontransitory and relevant changes in the competitive environment, we exclude tariff cuts that are followed by equivalently large increases in tariffs over the three subsequent years, as well as instances in which the tariff is smaller than 1%. With this definition, we identify 91 events between 1974 and 2005. These events occur in seventy-four unique industries.

Figure 1 shows that the tariff reductions are not clustered in any specific period and that they are in line with the recent U.S. trade history.[9] This repartition helps to ensure that our tests do not mix confounding

7 Several recent papers use the variation of tariffs to measure changes in competition, see, for example, Trefler (2004), Lileeva and Trefler (2010), Guadalupe and Wulf (2010), Valta (2012), Xu (2012), or Barrot, Loualiche, and Sauvagnat (2015).

8 Because HS codes are solely based on product characteristics, and SIC codes also take into account the method of production, HS codes cannot be directly matched to SIC codes. As a result, it is possible that a given HS category matches to several four-digit SIC codes. Yet, we find no case in which a specific product (HS code) was assigned to multiples (four-digit) SIC codes in the industries that compose our sample.

9 For instance, we identify large tariff cuts occurring in fourteen industries in 1976. This wave corresponds to the implementation of preferential tariff arrangements under the so-called "generalized system of

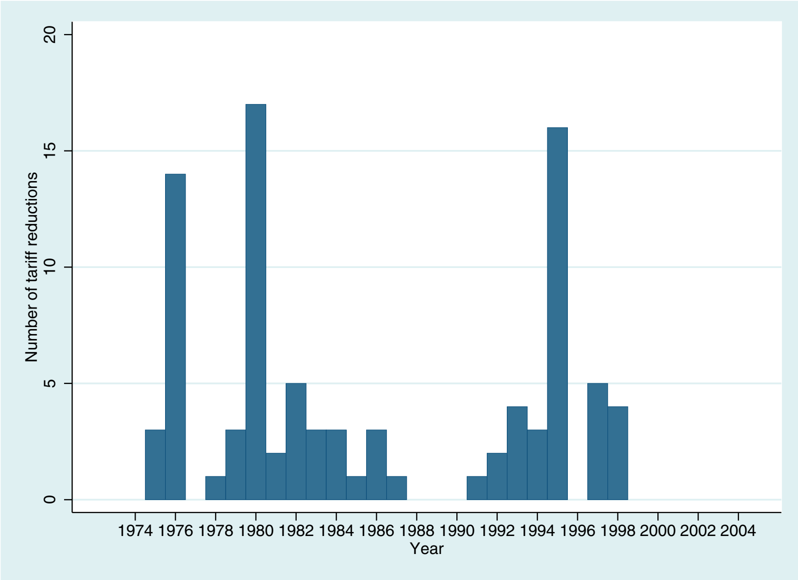

Figure 1
Tariff reductions through time
This figure shows the number of tariff cuts by year for our sample firms. Tariffs are computed at the four-digit SIC industry level as duties collected at U.S. Customs divided by the Free-On-Board custom value of imports. An industry experiences a tariff cut if the tariff reduction is three times larger than the average tariff reduction in that industry.

effects that are time specific such as economic downturns or stock market booms and busts. Figure 2 confirms that the average tariff plummets by almost 50% in affected industries, from 4.60% one year prior to the event to 2.57% in the event year. In contrast, it declines by only 8% in other industries, from 3.33% to 3.04%. Although such a change might appear modest at first sight, it is not.[10]

2.2 Empirical methods

To measure the effect of an increased threat of entry on firms' investment decisions, we define firms that operate in industries experiencing a tariff cut in a given year as the "treated" firms. Because treated firms could significantly differ from unaffected firms, we compare them to matched firms. From the set of nontreated firms, we construct a sample of

preferences (GSP)" on various products from developing countries, such as wood products, cigarettes, electrical items, or toys (Baldwin and Murray 1977).

[10] As a comparison, Trefler (2004) reports that the passage of the FTA between the United States and Canada in 1989 lowered the average tariff for Canadian products from 4% in 1988 to about 2% in 1992, and 1% in 1996. This event is considered by international economists as a sizable event that affected U.S. firms on various levels. In terms of magnitude, the average tariff cut in our sample is close to that generated by the FTA.

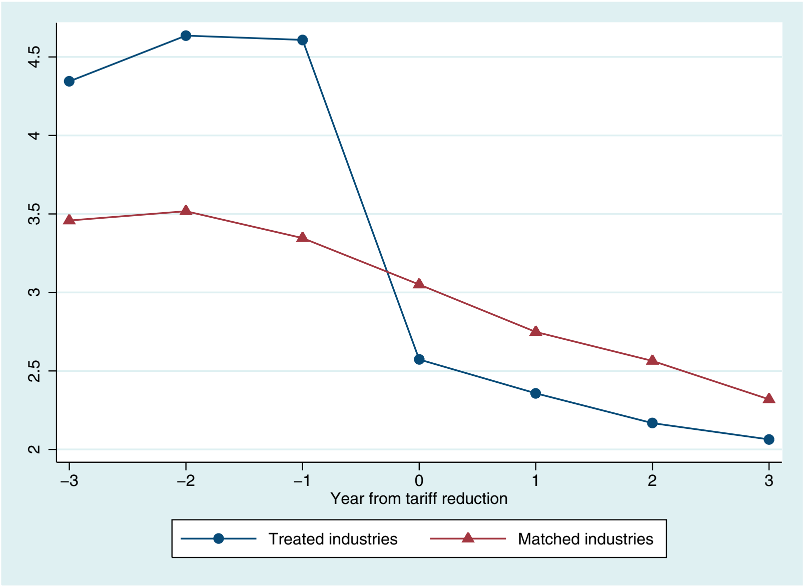

Figure 2
Tariffs around tariff reductions
This figure shows the average tariff in event time for the sample of treated and matched industries. The sample comprises 91 industries that experience a tariff cut between 1974 and 2005. Tariffs are computed at the four-digit SIC industry level as duties collected at U.S. Customs divided by the Free-On-Board customs value of imports.

"matched" firms that are similar to the treated firms, except for the change in entry threat they experience. We select matched firms based on characteristics one year before the event. For each treated firm we choose, with replacement, its nearest neighbor from the group of all the firms that operate in a different four-digit SIC code industry during the same year. We follow Almeida et al. (2012) and match firms on the basis of their size (the logarithm of total assets), investment opportunities (Tobin's q), cash flow, cash holdings, and long-term debt-to-asset ratio.[11]

We estimate the following difference-in-differences specification on a sample comprising only treated and matched firms:

$$I_{i,j,t} = \beta CUT_{j,t} + \theta X_{i,j,t-1} + \eta_i + \delta_t + \varepsilon_{i,j,t}, \tag{1}$$

[11] We use a matching algorithm that simultaneously minimizes the Mahalanobis distance across all these matching characteristics. For each treated firm i, we find a matched firm j such that the Mahalanobis distance between the i's and j's covariates (matching variables) is the smallest. The Mahalanobis distance is given by: $||X_i - X_j|| = ((X_i - X_j)' W_X^{-1}(X_i - X_j))^{1/2}$, where X is a k-dimensional vector of covariates and W_X^{-1} is the inverse of the covariance matrix of the covariates. In a robustness test we also use a propensity score matching estimator and obtain very similar results.

where i indexes firm, j indexes industry, and t indexes time. $I_{i,j,t}$ is capital expenditures scaled by the beginning of the year capital stock (net PPE). The variable of interest, $CUT_{j,t}$, is a dummy variable that equals one for treated firms (i.e., if the industry in which the firm operates experienced a tariff cut over the last year) and zero for matched firms. We consider only the years that surround each event (one year before and one year after) and exclude the year of the event to better isolate the effect of the entry threat engendered by tariff cuts from that of actual entry.

The vector $X_{i,j,t}$ contains control variables known to correlate with investment decisions that could be directly affected by tariff reductions. In particular, we control for potential changes in expected profits between treated and matched firms after tariff reductions. We include firms' Tobin's q (measured as the market value of assets divided by the book value of assets) in all our estimations. Similarly, we control for the natural logarithm of assets and for cash flow. In addition, we include firm fixed effects (η_i) to control for time-invariant differences across firms, particularly fixed differences between treated and matched firms. Similarly, we include year fixed effects (δ_t) to control for differences between time periods, such as aggregate shocks or common trends. To account for potential correlation between observations, we cluster the error term $\varepsilon_{i,j,t}$ at the industry-year level (as in Bertrand, Duflo, and Mullainathan 2004).

To be considered in our final sample, treated and matched firms need to have no missing observations for the matching variables for the years surrounding the event. We use accounting and financial data from COMPUSTAT over the period 1974-2005. We exclude firm-year observations for which information is not available and winsorize all ratios at the 1% level in each tail. Moreover, we exclude observations with negative assets, sales, and capital expenditures, as well as observations with sales growth larger than 500%. The Appendix details the definition of all variables. Our final sample comprises 1,116 treated firms and the same number of matched firms. The matched firms are from 120 different industries. On average, each treated industry is matched to firms operating in 9.04 distinct industries.[12]

Table 2 presents the summary statistics for the treated and matched firms during the year that precedes the tariff reductions. Overall, the treated and matched firms are very similar. The Kolmogorov-Smirnov tests reveal that there are no significant differences in the distributions of the matching variables between treated and matched firms. The p-values

[12] This heterogeneity further reduces the concern that our estimates are driven by specific links between treated and matched industries. To make sure that treated and matched firms truly are from unrelated industries, we have also used the 1992 input-output tables from the Bureau of Economic Analysis and computed interindustry relatedness following Fan and Lang (2000). Our results do not change if we remove from the matching sample industries that are related to treated industries (relatedness coefficient larger than 5%).

Table 2
Descriptive statistics

		Obs	Mean	25%	Median	75%	K-S test
Tobin's q	treated	1,116	2.06	1.04	1.50	2.37	0.48
	matched	1,116	1.98	1.03	1.43	2.26	
Log(total assets)	treated	1,116	4.06	2.69	3.76	5.17	0.98
	matched	1,116	4.07	2.71	3.74	5.22	
CF to assets	treated	1,116	-3.00%	-1.86%	4.90%	9.25%	0.22
	matched	1,116	-2.13%	-0.16%	5.30%	9.11%	
Cash to assets	treated	1,116	17.51%	3.02%	8.89%	24.37%	0.26
	matched	1,116	16.88%	2.95%	8.21%	23.22%	
LT leverage	treated	1,116	14.01%	1.39%	9.77%	21.84%	0.89
	matched	1,116	13.85%	0.99%	9.79%	21.28%	
Investment	treated	1,116	48.34%	16.16%	28.84%	55.94%	0.01**
	matched	1,116	42.66%	14.63%	25.47%	46.08%	

This table presents descriptive statistics for the main variables in the paper. The baseline sample consists of 1,116 treated and matched firms, respectively. In the year before a tariff cut, firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. The table reports statistics for the matching variables and for investment (capital expenditures over lagged net PP&E). Please refer to the Appendix for a definition of the variables. The last column shows the *p*-value from a two-sample Kolmogorov-Smirnov test (K-S test) for equality of distribution functions across treated and matched firms. The null hypothesis is that the distributions are equal. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

range between 0.22 for cash flow to 0.98 for the logarithm of total assets. In sum, the matching process removes any meaningful differences along matching observables from the two groups. We note, however, that treated firms display a higher level of investment prior to the tariff reductions.

The main coefficient of interest in Equation (1) is β, which measures how on average treated firms modify investment compared to matched firms following a large tariff reduction. For β to have a causal interpretation, reductions of tariffs should satisfy two requirements. First, the occurrence of these events should be unrelated to individual firms' underlying investment opportunities. Second, tariff reductions should generate relevant shifts in the threat of entry in U.S. product markets. We provide several pieces of evidence supporting both conditions and present them in an Internet Appendix for brevity. In the following, we focus our attention on the sign, the magnitude, and the variation of β across market structures.

3. Firms' Response to Entry Threat

3.1 Average response

Table 3 presents the results of our baseline specification (1). We observe that, all else equal, firms respond to tariff cuts by significantly reducing investment. In Column 1, the coefficient on CUT has a value of -0.072 and is statistically significant at the 1% level. The estimate implies that from

Table 3
Entry threat and corporate investment: Average response

Specification:	Baseline (1)	Aggregate (2)	(-2/+2) (3)	(-3/+3) (4)
CUT	-0.072***	-0.006**	-0.043***	-0.027**
	(0.023)	(0.002)	(0.014)	(0.012)
Tobin's q	0.060***	0.001	0.063***	0.063***
	(0.010)	(0.003)	(0.007)	(0.006)
Log(total assets)	-0.038*	0.001	-0.059***	-0.057***
	(0.021)	(0.003)	(0.016)	(0.012)
CF to assets	0.221***	0.037*	0.269***	0.258***
	(0.082)	(0.021)	(0.045)	(0.033)
Year FE	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes
Observations	4,264	383	8,275	11,873
Adjusted R^2	0.32	0.59	0.30	0.28

This table presents the estimates from difference-in-differences regressions for corporate investment around import tariff reductions (tariff cuts). The dependent variable is capital expenditures scaled by net PP&E (except in Column 2). *CUT* is a dummy variable equal to one if a given industry has experienced a tariff cut by time *t*. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1974 and 2005. In the year before a tariff cut, treated firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. In the baseline specification (Column 1), we keep treated and matched observations from one year before and one year after the tariff cut, and we use tariff cuts that are larger than three times the average tariff reduction in an industry. In Column 2, the dependent variable is the growth rate of the capital stock at the industry level, and the specification is estimated at the four-digit SIC industry level. Column 3 extends the sample to include treated and matched observations from two and one years before and after the tariff cut. Column 4 extends the sample to include treated and matched observations from three, two, and one years before and after the tariff cut. All specifications include year and firm fixed effects, and Tobin's q, the logarithm of total assets, and cash flow to total assets as control variables. Please refer to the Appendix for a definition of the variables. Standard errors adjusted for heteroscedasticity and within industry-year clustering are in parentheses below the coefficient estimates. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

one year before to one year after the tariff cut the ratio of capital expenditures to capital of treated firms declines by 7.2 percentage points relative to the ratio of matched firms. This effect is economically large: the investment drop represents a relative decline of 16.7% from the pre-event level of capital expenditures and corresponds to an average decrease of $9.27 million per firm. Aggregating this effect over firms and time, it amounts to an approximate $11 billion decline in capital spending over thirty years (or $365 million decline per year). Across all estimations the control variables display the expected signs. The reduction of investment in response to tariff cuts is also apparent when we use aggregate industry data from the NBER-CES database that aggregate the total capital stock of all public and private firms in manufacturing industries. Column 2 of Table 3 indicates that the growth rate of the capital stock decreases significantly in affected industries compared to unaffected industries (taken as the industries forming the matched sample) following tariff reductions.

Figure 3 further displays the dynamic investment response to increased threat of entry. We modify specification (1) by interacting the treatment dummy (*CUT*) with (annual) event-time dummies around the tariff cuts.

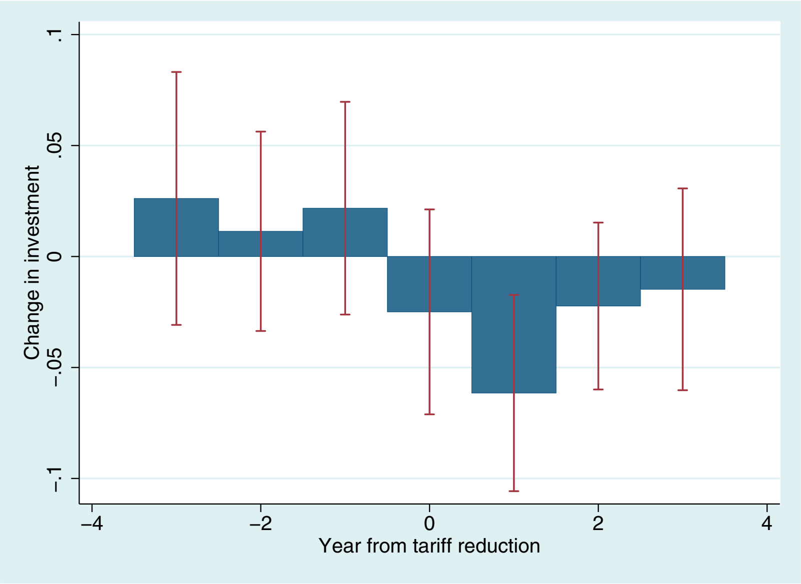

Figure 3
Investment response to tariff cuts
This figure shows how treated firms change investment relative to matched firms. The figure displays the difference-in-differences estimates for the treatment dummy interacted with yearly dummies around the tariff cut. The red lines indicate the 95% confidence interval. The sample comprises ninety-one industries that experience a tariff cut between 1974 and 2005.

Before the tariff reduction, treated and matched firms invest similarly: the difference between the two groups is not distinguishable from zero. This result indicates that treated firms do not modify investment in anticipation of the event. We observe a clear temporal break in the investment pattern of treated firms compared to that of matched firms coinciding with tariff reductions. Moreover, the bulk of the investment drop materializes during the year that immediately follows the event. In Columns 3 and 4 of Table 3, we extend the sample to include two years and three years before and after the tariff cut, respectively. The coefficients on *CUT* have marginally lower values of -0.043 and -0.027, but remain statistically significant.

3.2 Robustness tests

We perform several robustness tests that we report in Table 4. First, we replace the dependent variable with capital expenditures scaled by total assets (Column 1), and with growth in net Property, Plant, and Equipment (column 2). In both columns, the coefficient on *CUT* is negative and statistically significant. Second, we modify the “dosage” of the increase in entry threat. Specifically, we define that a tariff cut occurs in a

Table 4
Entry threat and corporate investment: Robustness tests

Specification:	Capx to AT (1)	PPE growth (2)	Cut#1 (3)	Cut#5 (4)	Placebo (-3) (5)	Placebo (-4) (6)	Multilateral (7)	PS match (8)	Rel. ind (9)
CUT	-0.010***	-0.088***	-0.010	-0.070**	-0.024	-0.034	-0.073**	0.048**	-0.049**
	(0.003)	(0.032)	(0.011)	(0.034)	(0.018)	(0.022)	(0.032)	(0.023)	(0.022)
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm FE	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	4,264	4,264	8,577	1,614	2,802	2,835	1,892	4,268	4,278
Adjusted R^2	0.43	0.19	0.35	0.34	0.42	0.30	0.52	0.31	0.33

This table presents the estimates from difference-in-differences regressions for corporate investment around import tariff reductions (tariff cuts). The dependent variable is capital expenditures scaled by net PP&E (except in Columns 1 and 2). *CUT* is a dummy variable equal to one if a given industry has experienced a tariff cut by time t. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1974 and 2005. In the year before a tariff cut, treated firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. In Column 1, the dependent variable is capital expenditures scaled by total assets. In Column 2, the dependent variable is net PP&E growth from year t to $t+1$. Column 3 repeats the baseline estimation for tariff cuts that are larger than one time the average tariff reduction in an industry (Cut#1). Column 4 is for tariff cuts that are larger than five times the average tariff reduction in an industry (Cut#5). Columns 5 and 6 contain placebo tests, for which the baseline estimation is done three or four years before the actual tariff cuts, respectively. Column 7 focuses on multilateral agreements and only retains the following years in the data: 1976-1983 and 1993-1995. Column 8 uses propensity score matching. In Column 9, firms are matched based on the same covariates, but all matching variables are expressed relative to industry peers. All specifications include year and firm fixed effects, and Tobin's q, logarithm of total assets, and cash flow to total assets as control variables. Please refer to the Appendix for a definition of the variables. Standard errors adjusted for heteroscedasticity and within industry-year clustering are in parentheses below the coefficient estimates. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

specific industry-year when a negative change in tariffs is one (small change in entry threat) or five (large change in entry threat) times larger than the average tariff change in that industry. We then estimate the baseline specification for these samples. The Columns 3 and 4 of Table 4 present the results (labeled cut#1 and cut#5). We find a small and insignificant coefficient for cut#1 (-0.010), where the average tariff decreases by 1.44 percentage points (from 4.85% to 3.41%). By contrast, the estimated investment reaction is much larger and statistically significant for cut#5 (-0.070), where the average tariff drops by 3.45 percentage points (from 5.49% to 2.04%).

Third, we repeat the baseline experiment during placebo periods that precede the reduction of tariffs. We use years (-4) and (-3) relative to the actual event years to sort firms into treated and matched firms. We then examine the change in investment from year (-4) to year (-2) and from year (-3) to year (-1). We perform these falsification tests using the exact same sampling criteria and matching variables as we use in the baseline tests. The Columns 5 and 6 present the results. The coefficient on *CUT* is small and not significantly different from zero in these two columns, consistent with our interpretation that the observed changes in investment really stem from tariff reductions.

While we show in the Internet Appendix that our results are unlikely to be driven by specific industry effects (see the parallel trend tests), they might still be affected by the endogeneity of trade policy to lobbying activity. To help lessen this concern, we focus our attention on tariff reductions that are part of multilateral agreements. As argued by Krugman, Obsfeld, and Melitz (2012), lobbying groups are less likely to influence tariff changes resulting from multilateral trade agreements. Indeed, the multi-country-industry dimension of such agreements limits the ability of government officials to acquiesce to political pressures. Furthermore, the participation of international institutions imposes rules and formal obligations that restrict the influence of special interest groups. For that reason, these reductions can be viewed as relatively "more" exogenous than reductions resulting from bilateral agreements. Hence, we only consider years around the GSP, GATT, and NAFTA multilateral trade agreements and keep the following years in the analysis: 1976-1983, and 1993-1995. This focus on these trade events reduces our sample to 1,892 observations. Column 7 of Table 4 displays the result, which is very similar to the baseline result.

Finally, we change the matching method in two ways. First, we implement a propensity score matching approach using the same matching variables as in the nonparametric matching (Tobin's q, the logarithm of total assets, cash flow, cash holdings, and long-term leverage).[13] Second, we repeat our baseline nonparametric matching but match on relative-to-industry median covariates, as in Gormley and Matsa (2012). Columns 8 and 9 of Table 4 indicate that these changes in the matching procedure have no bearing on the results.

3.3 Cross-industry heterogeneity

We estimate firms' investment response ($\hat{\beta}$) separately for each of the ninety-one events. Because for some events (industry-year combinations) the number of treated and matched observations is insufficient to obtain statistically meaningful estimates, we also include the matched observations from other events occurring in the same year. We present the results of these estimations in Figure 4: the top panel displays the estimated $\hat{\beta}$ across events (sorted in ascending order), and the bottom panel plots the associated *t*-statistics.

Figure 4 reveals a substantial variation across industries, as firms' investment response to tariff cuts varies between -0.90 and +0.75. Yet despite this large heterogeneity, Figure 4 indicates that a vast majority of firms in our sample reduce investment following tariff cuts. We observe

[13] Note that there is almost no overlap between the matched samples obtained from the propensity score matching and nonparametric matching (Mahalanobis). Only fourteen matched firms are present in both samples.

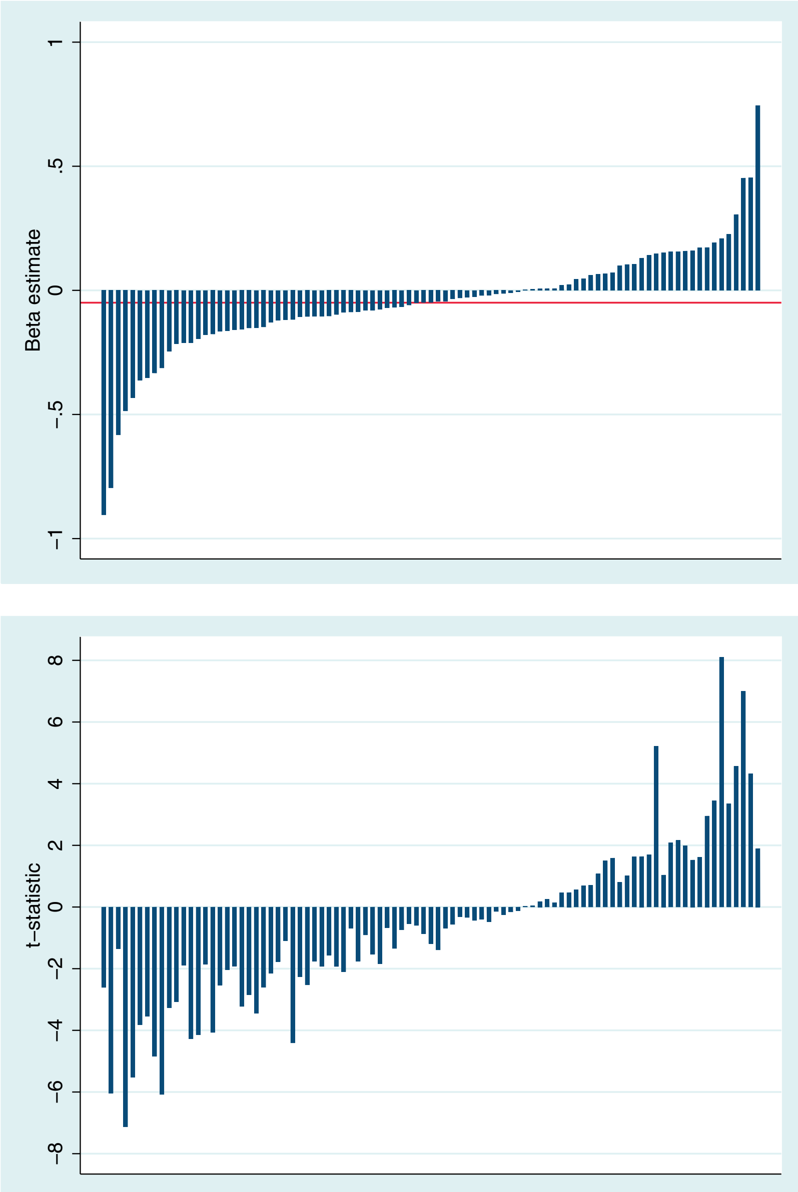

Figure 4
Heterogeneity of investment response across industries
This figure shows the difference-in-differences estimates of *CUT* for each tariff cut event individually (top) and the associated *t*-statistics (bottom). The sample comprises ninety-one industries that experience a tariff cut between 1974 and 2005. The horizontal line in the top panel corresponds to the average estimate of *CUT* across the ninety-one events.

that two-thirds of the events exhibit negative $\hat{\beta}$ (58 out of 91), 33 of which are significant at the 10% level, and 24 are significant at the 5% level. In line with our baseline results, the cross-event average for $\hat{\beta}$ is -0.050 and the median is -0.049. Moreover, we observe increases in investment for thirty-three events. But only eleven industries feature increases in investment that are significant at the 5% level. These are diverse industries including for instance "Machine Tools", "Ophthalmic Goods", "Mobile Homes", or "Flat Glass".[14] Besides the fact that half of these investment-increasing events appear in 1976, these industries do not seem to be otherwise related in any systematic way.

4. What Explains the Decline in Investment?

Our analysis so far shows that, all else equal, increased entry threat causes incumbents to significantly reduce investment. As explained in Section 1, this result could be consistent with a strategic explanation, but also with a nonstrategic explanation whereby tariff cuts modify firms' future growth opportunities and business uncertainty. This section attempts to better understand why do firms decrease investment following tariff cuts.

4.1 Changes in growth prospects and uncertainty

To assess the possibility that our findings are due to changing investment opportunities and uncertainty, we include additional proxies in the baseline specification. We use risk-adjusted stock returns (from a market model) and sales growth as proxies for investment opportunities, and idiosyncratic stock return volatility (estimated using weekly returns) as a proxy for profit uncertainty. We conjecture that if the observed decline of investment only reflects a nonstrategic adjustment to lower investment opportunities or higher uncertainty, we should observe a large reduction of the estimated coefficient on CUT once we add these extra control variables.

Column 1 of Table 5 indicates that adding these additional proxies only slightly attenuates the magnitude of the investment response, which remains strongly negative (-0.052) and significant. As an alternative way to control for the impact of changing investment opportunities and uncertainty, we include two-digit SIC$\times$year fixed effects. These additional fixed effects capture any time-varying unobserved factors that are common across all firms in a broadly defined industry, such as industry

[14] These events include the following SIC industries (years): 3541 (1979), 3851 (1976), 2891 (1979), 3559 (1995), 3711 (1986), 3211 (1976), 3555 (1995), 2451 (1993), 3949 (1976), 3944 (1976), 2531 (1976).

Table 5
Changes in growth opportunities and uncertainty

Specification:	Controls (1)	SIC2 × Year FE (2)	GMM (3)	No controls (4)
CUT	-0.052**	-0.089***	-0.065***	-0.089***
	(0.022)	(0.029)	(0.020)	(0.024)
Tobin's q	0.074***	0.057***	0.260***	
	(0.012)	(0.010)	(0.32)	
Log(total assets)	-0.080***	-0.039	-0.009	
	(0.026)	(0.025)	(0.007)	
CF to assets	0.052	0.201**	0.566***	
	(0.060)	(0.080)	(0.077)	
Year FE	yes	yes	yes	yes
Firm FE	yes	yes	no	yes
Observations	3,486	4,264	4,264	4,264
Adjusted R^2	0.36	0.29		0.26
p-value (χ^2)			0.02	

This table presents the estimates from difference-in-differences regressions for corporate investment around import tariff reductions (tariff cuts). The dependent variable is capital expenditures scaled by net PP&E. *CUT* is a dummy variable equal to one if a given industry has experienced a tariff cut by time t. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1974 and 2005. In the year before a tariff cut, treated firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. We keep treated and matched observations from one year before and one year after the tariff cut, and we use tariff cuts that are larger than three times the average tariff reduction in an industry. Column 1 estimates the baseline specification with additional controls for growth options and uncertainty (risk-adjusted stock returns, sales growth, and idiosyncratic stock return volatility). Column 2 estimates the baseline specification including firm and SIC2×year fixed effects. The specification in Column 3 is estimated using the fifth-order GMM estimator from Erickson and Whited (2002, 2012). Column 4 estimates the baseline specification without control variables. Please refer to the Appendix for a definition of the variables. Standard errors adjusted for heteroscedasticity and within industry-year clustering are in parentheses below the coefficient estimates. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

and time-specific shocks to the profitability of investment. Column 2 indicates that our conclusion remains unaffected.

Because investment opportunities are notoriously hard to measure, the proxies we use (especially Tobin's q) could contain measurement errors (see Erickson and Whited, 2002, 2012). A concern could thus arise if measurement errors become larger, and hence, "true" investment opportunities shrink after tariff reductions. This concern, however, is largely dispelled by the results in column 3, which reports estimates using the Erickson and Whited (2012) fifth-order moment estimator to account for mismeasurement in proxies for firms' investment opportunities. The estimated investment response is barely affected by this change in estimation procedure.

While controlling for changes in growth prospects is important in our setting, the validity of our baseline specification could be jeopardized by the presence of "bad controls." Indeed, the inclusion of bad controls in a difference-in-differences model–control variables that are themselves affected by the treatment–can lead to biased inference (Roberts and Whited, 2012). The results reported in Column 4 of Table 5 mitigate this concern as we estimate a similar drop in investment when we exclude all control variables.[15]

Overall, the results in Table 5 suggest that the observed decline in investment is hard to reconcile with a nonstrategic story in which the drop of investment following tariff cuts is solely reflecting lower growth prospects or higher uncertainty, or a combination of these two explanations. Indeed, the response of corporate investment to higher entry threat appears much larger than what may be justified by observable changes in investment opportunities and uncertainty.

4.2 Strategic response to entry threat

To assess whether the decline in investment contains a strategic dimension, we rely on the theoretical predictions from Section 1 and assess how firms' investment response varies across three key elements of market structure (as summarized in Table 1): (1) whether competitive actions are strategic substitutes or complements, (2) whether investment signals that incumbents will be soft or tough competitors should entry occur, and (3) whether incumbents deter or accommodate entry.

4.2.1 The nature of strategic interactions. We rely on the characterization of Bulow, Geanakoplos, and Klemperer (1985) to distinguish between markets in which firms' competitive actions are strategic substitutes or complements. Accordingly, the quantity of interest is the cross-partial derivative of a firm's value with respect to rivals' competitive actions. A positive value for the cross-partial derivative indicates competition in strategic complements, whereas a negative value indicates competition in strategic substitutes. To approximate this cross-partial derivative in the data, we use the competitive strategy measure (CSM) developed by Sundaram, John, and John (1996). For a given firm, CSM is defined as the correlation between the ratio of the change of its profits to the change of its sales, and the change in the combined sales of its rivals. As in Chod and Lyandres (2011), we use quarterly data and compute this correlation for each firm-year using rolling windows over the past five years. Next, we aggregate the CSM at the four-digit SIC industry level by taking the average across all firms in each industry. A positive value for CSM indicates that actions are strategic complements, and a negative value indicates that actions are strategic substitutes.

We also use the sign of rivals' market reactions to firms' expansion decisions as proxies for the cross-partial derivative. We focus on three types of "expansion" events: initial public offerings (IPO), seasoned

[15] We further show in the Internet Appendix that there are in fact little changes in several proxies for growth prospects in response to tariff cuts. This further limits the risk of bad controls and reveals that the reduction of investment cannot be solely a response to lower investment opportunities after tariff cuts.

equity offering (SEO), and mergers and acquisitions (M&A). For each manufacturing industry, we collect the announcement dates of every such event over the period 1980-2005 from SDC Platinum. Then, for every event, we estimate the abnormal market reaction of rivals (i.e., the other public firms in the industry) using a market-model with daily stock returns from CRSP (based on 250 days rolling windows). We concentrate our analysis on cumulative abnormal returns (CARs) over a [-1,+1] window, where day 0 corresponds to the event announcement date, and take the average market reaction for each industry and event type. We posit that average rivals' market reactions are linked to the sign of the cross-partial derivative: positive rivals' reactions reflect strategic complementarity, and negative reactions reflect strategic substitution.

In Table 6 we separate treated firms based on the nature of strategic interactions in their market, using the indicator variable $D_{SUBSTITUTE} = 1$, when actions are substitutes, and $D_{COMPLEMENT} = 1$, when actions are complements. The results show that the reduction of investment to tariff cuts is concentrated in markets featuring competition in strategic substitutes: the coefficients on the interaction $CUT \times D_{SUBSTITUTE}$ are negative and significant across all specifications. In these markets, the economic magnitude of the investment drop is substantial: it ranges between 9.7 and 12 percentage points. In sharp contrast, the coefficients on $CUT \times D_{COMPLEMENT}$ are insignificant, indicating that investment in markets featuring competition in strategic complements is largely insensitive to tariff reductions. Overall, the difference in firms' investment response to tariff cuts between markets in which action are strategic substitutes or complements is consistent with firms' response being strategic. If firms' investment response solely reflects changes in investment opportunities and uncertainty, there is no reason why the observed reduction of investment should vary systematically with the nature of strategic interactions.

4.2.2 Soft or tough investment signal. The second element of market structure predicted by strategic models to influence the sign of firms' response to higher entry threat is whether investment signals to entrants that incumbents will turn into soft or tough competitors if entry occurs. As this element depends on the anticipations of the potential entrants, it is difficult to capture empirically. Nevertheless, we rely on incumbents' access to financial resources as an indirect proxy. We argue that using limited financial resources to invest today makes financially weak firms credibly look like "softer" rivals, as they may not be able to fund future aggressive competitive actions.[16] In contrast, perfectly unconstrained

[16] Supporting this hypothesis, Frésard (2010) shows that financially strong firms gain market shares at the expense of their rivals, and that this effect is stronger when rivals face tighter financing constraints.

Table 6
Market structures: Nature of strategic interactions

Sorting variable:	CSM (1)	CAR_{IPO} (2)	CAR_{SEO} (3)	$CAR_{M\&A}$ (4)
$CUT \times D_{SUBSTITUTE}$ (i)	-0.120***	-0.097***	-0.112***	-0.109***
	(0.036)	(0.030)	(0.035)	(0.031)
$CUT \times D_{COMPLEMENT}$ (ii)	-0.033	-0.038	-0.026	-0.025
	(0.023)	(0.031)	(0.023)	(0.025)
Control variables	yes	yes	yes	yes
Year and firms FE	yes	yes	yes	yes
Observations	4,264	4,025	4,204	4,239
Adjusted R^2	0.32	0.31	0.32	0.32
p-value (i)=(ii)	0.03	0.01	0.03	0.03

This table presents the estimates from difference-in-differences regressions for corporate investment around import tariff reductions (tariff cuts). The dependent variable is capital expenditures scaled by net PP&E. CUT is a dummy variable equal to one if a given industry has experienced a tariff cut by time t. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1974 and 2005. In the year before a tariff cut, treated firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. We separate treated firms based on the nature of strategic interactions in their market, using the indicator variable $D_{SUBSTITUTE}=1$ when actions are substitutes, and $D_{COMPLEMENT}=1$ when actions are strategic complements. We use four variables to sort markets into strategic substitutes and complements. First, we use the competitive strategy measure (CSM). A positive value for CSM indicates that actions are strategic complements, while a negative value indicates that actions are strategic substitutes. The remaining three variables are based on the sign of rivals' market reactions to IPOs, SEOs, or mergers and acquisitions. Positive rivals' reactions indicate that actions are strategic complements, while negative reactions reflect strategic substitution. Please refer to the Appendix for a definition of the variables. The bottom of the table reports the p-values of a Wald test that tests whether the estimated coefficients (i) and (ii) are equal. All specifications include year and firm fixed effects, and Tobin's q, the logarithm of total assets, and cash flow to total assets as control variables. Standard errors adjusted for heteroscedasticity and within industry-year clustering are in parentheses below the coefficient estimates. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

firms will always be able to finance future actions, so that lowering investment is not a credible signal. On this ground, we consider four variables to measure whether firms have limited financial resources: the index of financial constraints developed by Whited and Wu (2006), the index of external finance dependence of Rajan and Zingales (1998), the presence of a credit rating, and the aggregate borrowing costs captured by the three-month Treasury-bill rate. For each variable we assign treated firms into two groups based on median splits: we classify firms into a "soft" subgroup when they face tighter financing constraints ($D_{SOFT}=1$), and into a "tough" subgroup when they face little constraints ($D_{TOUGH}=1$).

Table 7 indicates that the negative effect of increased entry threat on investment is largely concentrated among firms that are more financially constrained. The coefficients on $CUT \times D_{SOFT}$ are significantly more negative than those on $CUT \times D_{TOUGH}$ for three out of four proxies. For instance, we estimate a 11.5 percentage points reduction of investment following tariff cuts for firms that are more constrained based on the Whited and Wu (2006) index, compared to a 3.4-percentage-points reduction for firms that are less constrained. Similarly, the reduction of

Table 7
Market structures: Soft or tough behavior

Sorting variable:	WW index (1)	External dep. (2)	Rating (3)	3-month Treasury-bill (4)
$CUT \times D_{SOFT}$ (i)	-0.115***	-0.108***	-0.057	-0.120***
	(0.034)	(0.038)	(0.035)	(0.030)
$CUT \times D_{TOUGH}$ (ii)	-0.034	-0.046*	-0.002	-0.039
	(0.022)	(0.025)	(0.028)	(0.032)
Control variables	yes	yes	yes	yes
Year and firm FE	yes	yes	yes	yes
Observations	4,234	4,264	4,264	4,264
Adjusted R^2	0.32	0.32	0.31	0.32
p-value (i)=(ii)	0.02	0.16	0.10	0.06

This table presents the estimates from difference-in-differences regressions for corporate investment around import tariff reductions (tariff cuts). The dependent variable is capital expenditures scaled by net PP&E. *CUT* is a dummy variable equal to one if a given industry has experienced a tariff cut by time t. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1974 and 2005. In the year before a tariff cut, treated firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. We use measures of financing constraints to proxy for whether investment makes incumbents look soft or tough. We separate treated firms based on their access to financing, using the indicator variable $D_{SOFT}=1$ when their access is low, and $D_{TOUGH}=1$ when their access is high. We assign treated industries into the soft group if the Whited and Wu (2006) index is above the median, the index of external finance dependence of Rajan and Zingales (1998) is above the median, the firm does not have a credit rating, and the three-month Treasury-bill rate is above the median, and into the tough group otherwise. Please refer to the Appendix for a definition of the variables. The bottom of the table reports the p-values of a Wald test that tests whether the estimated coefficients (i) and (ii) are equal. All specifications include year and firm fixed effects, and Tobin's q, the logarithm of total assets, and cash flow to total assets as control variables. Standard errors adjusted for heteroscedasticity and within industry-year clustering are in parentheses below the coefficient estimates. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

investment is magnified in periods characterized by high borrowing costs. Overall results in Table 7 suggest that incumbents react to increased entry threat by reducing investment primarily when investment signals softer future competitive behavior. Hence, incumbents keep financial resources to withstand potential competition by entrants.[17] In contrast, when investment signals tough future behavior, we detect little change in investment following increased entry threat.

4.2.3 Deterrence or accommodation. To empirically capture situations in which incumbents are more likely to attempt to deter entry (as opposed to accommodate entry), we consider several measures of barriers to entry. We conjecture that deterring the entry of foreign rivals is more costly– and hence less optimal–when rivals face fewer barriers besides import tariffs. We consider five proxies for entry barriers. First, we follow Bain (1956) and Sutton (1991, who suggest that a high degree of product differentiation helps firms preserving their competitive advantage. We

[17] In unreported results, we show that financially constrained firms significantly increase their cash holdings in response to tariff cuts. This is further consistent with firms willing to maintain financial strength when entry threat increases.

consider patent protection as a proxy for product differentiation. We measure whether a firm's products are legally protected by using the logarithm of the number of patent citations it owns from the NBER patent database, and aggregate this measure to the industry level.

Second, we use the specificity of industries' assets. Bain (1956) and Williamson (1975) argue that specific assets are more difficult to acquire, develop, and imitate and hence provide incumbents with an absolute cost advantage that makes entry more difficult. We empirically capture asset specificity using the measure of asset redeployability developed by Kim and Kung (2014) that accounts for the "usability" of assets across industries, based on the 1992 Bureau of Economic Analysis (BEA) capital flow table, which breaks down the capital expenditures of industries into a variety of asset categories (e.g., software, cars, or office equipment). Following Kim and Kung (2014), we define an asset redeployability score as the proportion of industries by which a given asset is used. Intuitively, the more industries use a given asset in their production process, the higher is its redeployability and, by analogy, the lower its specificity. We compute industry-level specificity as the value-weighted average of the asset redeployability score for each industry.

Third, we use the intensity of product market competition to measure entry barriers, conjecturing that a higher degree of competition indicates lower barriers. We use the fitted Herfindahl-Hirschman index (HHI) at the three-digit SIC level obtained from the Hoberg-Phillips data library to measure competition intensity.[18]

Fourth, we use the financial strength of potential entrants. We use the cash reserves of foreign rivals to measure their financial strength. Based on data from Worldscope, we consider firms located in forty-five countries and compute for each four-digit SIC industry the average cash-to-asset ratio across these countries (represents 95% of the world (ex-U.S.) GDP). We posit that entry obstacles are lower for foreign rivals that are financially strong.

Finally, we measure entry barriers by directly estimating each industry's sensitivity of import penetration to tariff changes. We hypothesis that we should observe relatively less entry following tariff reductions in markets characterized by large (nontariff) barriers. We obtain industry-specific sensitivities by regressing for each industry the change in import

[18] As explained in Hoberg and Phillips (2010), the fitted Herfindahl-Hirschman industry concentration ratio combines Compustat data with Herfindahl data from the Bureau of Labor Statistics. As such, this measure covers private and public firms and varies through time. We obtain similar results when we use a Compustat-based HHI (at the three- or four-digit SIC level), or the HHI provided by the Census of Manufacturers that is updated every five years.

Table 8
Market structures: Deterrence or accommodation

Sorting variable:	Citations (1)	Redeployability (2)	HHI (3)	Foreign cash (4)	IP sensit. (5)
$CUT \times D_{LOW}$ (i)	-0.082***	-0.109***	-0.119***	-0.171**	-0.101***
	(0.024)	(0.029)	(0.031)	(0.074)	(0.029)
$CUT \times D_{HIGH}$ (ii)	-0.027	-0.041	-0.033	-0.048	-0.044
	(0.051)	(0.032)	(0.028)	(0.030)	(0.031)
Control variables	yes	yes	yes	yes	yes
Year and firm FE	yes	yes	yes	yes	yes
Observations	4,264	4,264	4,151	2,425	4,129
Adjusted R^2	0.32	0.32	0.31	0.27	0.31
p-value (i)=(ii)	0.29	0.10	0.03	0.08	0.15

This table presents the estimates from difference-in-differences regressions for corporate investment around import tariff reductions (tariff cuts). The dependent variable is capital expenditures scaled by net PP&E. CUT is a dummy variable equal to one if a given industry has experienced a tariff cut by time t. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1974 and 2005. In the year before a tariff cut, treated firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. We separate treated firms based on the entry barriers in their markets, using the indicator variable $D_{LOW}=1$ when barriers are low, and $D_{HIGH}=1$ when barriers are high. We use five variables to sort markets into low and high barriers. In Column 1, we assign treated industries into the low barrier group if the average number of patent citations are below the median, and in the high barrier group otherwise. In Column 2, we assign treated industries into the low barrier group if asset redeployability is above the median, and in the high barrier group otherwise. In Columns 3 and 4, we assign firms into the low barrier group if the fitted HHI of their industry is below the median, or the foreign rivals' cash holdings are above the median, respectively, and into the high barrier group otherwise. In Column 5, we assign firms into the low barrier group when the sensitivity of a change in import penetration to changes in import tariffs is below the median, and zero otherwise. Please refer to the Appendix for a definition of the variables. The bottom of the table reports the p-values of a Wald test that tests whether the estimated coefficients (i) and (ii) are equal. All specifications include year and firm fixed effects, and Tobin's q, the logarithm of total assets, and cash flow to total assets as control variables. Standard errors adjusted for heteroscedasticity and within industry-year clustering are in parentheses below the coefficient estimates. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

penetration from year t to $t+1$ on the lagged change in import tariffs using the full sample from 1974 to 2005.[19]

Table 8 reveals that firms' response to tariff cuts is significantly related to the costs of limiting entry. We find that the reduction of investment is only present when entry cost are relatively low–when incumbents are less protected by entry barriers. For instance, firms with no patents (measured prior to the tariff cuts) experience a larger drop in investment. The coefficient estimates on $CUT \times D_{LOW}$ is -0.082. Tariff reductions have virtually no impact on the investment of firms with more patents. Similarly, we observe that firms reduce investment more when they operate in more competitive industries, are facing foreign rivals with more cash, or are in industries where tariff reductions are followed by larger increases in import penetration.

[19] For each industry, we standardize changes in import tariffs by the standard deviation to obtain sensitivities in comparable units.

Finally, firms operating in industries characterized by more redeployable assets reduce investment significantly more after large reductions of tariffs compared to firms in industries relying on more specific assets. Remarkably, our results contrast with the findings of Kim and Kung (2014). They document that, following increases in uncertainty, firms reduce investment more if they operate in industries in which assets are more specific, consistent with the low redeployability of assets inducing firms to "wait and see" when uncertainty rises. We find the opposite response following shocks that increase entry threat, consistent with the idea that industry-specific assets help shielding incumbents against potential entrants. Hence, these findings suggest that the decrease in firms' investment cannot be solely explained by an increase in uncertainty.

4.2.4 Interpretation and further tests. The substantial variation of firms' investment response across market structures allows us to paint a more complete picture on the reasons why firms curtail capital investment in response to increased entry threat. Notably, across the sixteen cross-sectional partitions described already we find no instance in which incumbents significantly increase investment following tariff cuts.[20] More importantly, the reduction of investment is largely concentrated in specific market structures. Incumbents reduce investment in situations in which the competitive actions are strategic substitutes, when the costs of deterring entry are high, and when investment makes incumbents look soft. Taken together, this evidence suggests that incumbents react to lower entry costs by decreasing investment in an attempt to strategically accommodate entry and to induce softer competitive behavior by foreign rivals. In the terminology of strategic investment models, our estimates suggest that firms adopt a "lean and hungry look," remaining small and weak today in order to appear as tough competitors if entry occurs (Tirole, 1988).

To provide further evidence for this strategic interpretation, we test the unique prediction that incumbents should reduce investment when competitive actions are strategic substitutes and investment makes them look soft (see lower right corner of Table 1). To do so, we add the triple interaction $CUT \times D_{SUBSTITUTE} \times D_{SOFT}$ to our specification, including all simple terms and interaction terms. We expect the coefficient to be negative. We estimate this augmented specification for each possible combination of our proxies for strategic substitutes and soft behavior (4×4) and display the results in Table 9. We only report the coefficients on the triple interaction term to preserve space. In consistency with the "lean and hungry look" behavior, 15 coefficients out of 16 are negative.

[20] In unreported results, we use quartile-splits instead of median-splits and obtain virtually identical results. Also, our conclusions remain unaffected if we use interactions instead of sample splits.

Table 9
Market structures: Interaction of soft behavior and strategic substitutes

	WW index (1)	External dep. (2)	Rating (3)	3-month Treasury-bill (4)
CSM	-0.102	-0.180*	-0.030	-0.072
	(0.080)	(0.103)	(0.091)	(0.087)
CAR_{IPO}	-0.029	0.012	-0.031	-0.123
	(0.081)	(0.096)	(0.082)	(0.081)
CAR_{SEO}	-0.209***	-0.100	-0.013	-0.216***
	(0.065)	(0.084)	(0.071)	(0.073)
$CAR_{M\&A}$	-0.213***	-0.245***	-0.179***	-0.038
	(0.065)	(0.085)	(0.068)	(0.081)

This table presents the estimates from difference-in-differences regressions for corporate investment around import tariff reductions (tariff cuts). The dependent variable is capital expenditures scaled by net PP&E. We report the coefficient of the triple interaction between the dummies *CUT*, Soft, and Substitute. *CUT* is a dummy variable equal to one if a given industry has experienced a tariff cut by time *t*. Soft is a dummy equal to one if the Whited and Wu (2006) index is above the median, the index of external finance dependence of Rajan and Zingales (1998) is above the median, the firm does not have a credit rating, and the three-month Treasury-bill rate is above the median, and zero otherwise. Substitute is a dummy equal to one if the competitive strategy measure (CSM) has a negative value and if the rivals' market reactions to IPOs, SEOs, or mergers and acquisitions is negative, and zero otherwise. We only report the coefficient of the triple interaction term for each combination of Soft and Substitute. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1974 and 2005. In the year before a tariff cut, treated firms are matched by Tobin's q, the logarithm of total assets, cash flow to total assets, cash to total assets, and long-term debt to total assets. All specifications include year and firm fixed effects, and Tobin's q, the logarithm of total assets, and cash flow to total assets as control variables. Please refer to the Appendix for a definition of the variables. Standard errors adjusted for heteroscedasticity and within industry-year clustering are in parentheses below the coefficient estimates. The symbols ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Moreover, six coefficients are statistically significant. These tests reinforce our conclusion that strategic considerations are important drivers of the reduction of investment following tariff cuts.

5. Conclusion

We rely on large reductions of import tariffs that isolate exogenous variation in entry threat faced by domestic incumbents to study how firms change capital investment when the threat of entry suddenly increases. We document large reductions of investment in response to increased entry threat. This effect is economically large, pervasive, and statistically robust. We further uncover a large heterogeneity in the investment response across product markets. We find that the investment reductions are concentrated in product markets in which competitive actions are strategic substitutes, in markets in which entry barriers are low so that deterring entry is costly, and in situations in which additional investment makes the incumbents look soft. This variation across market structures is consistent with the predictions of strategic investment models.

Our analysis indicates that interactions among firms in the product market have first-order implications for firms' investment. This role, in turn, largely depends on product market structures and on firms' competitive positions in their market. Consistent with capital investment encompassing a strategic dimension, our results point to several further questions. In particular, our analysis remains silent on whether reductions of investment are effective and, if so, how they mold product market dynamics ex post. Measuring these aspects is challenging, but has the potential to shed light on whether firms actions really distort those of rivals. Similarly, it would be interesting to study how various product market structures and the nature of firms' interactions affect the equilibrium relation between investment and asset prices.[21] We plan to address these and other related questions in future research.

Appendix

A.1 Model of Entry Costs and Investment

This Appendix formally develops the predictions that we describe in Section 1 of the paper in the situation in which the incumbent behaves strategically. To do so, we consider a simple two-period, two-firm model as in Tirole (1988, chapter 8.3). Firm 1 is an incumbent and firm 2 is an entrant. In period 1, the incumbent chooses a level of capital I. Firm 2 observes I and decides whether to enter. If it does not enter it makes zero profit, and the incumbent enjoys a monopoly position and makes monopoly profits (Π^{1m}). If firm 2 enters, the firms compete in the second period and make simultaneous second-period choices x_1 and x_2. The second period competition game could be à la Cournot, where firms choose quantities, or à la Bertrand, where firms choose prices. The second period profits are given by $\Pi^1(I, x_1, x_2)$ and $\Pi^2(I, x_1, x_2)$. By convention, we assume that firm 2's entry costs ϕ are part of Π^2 and that, all else equal, Π^2 is strictly decreasing in ϕ.[22] We further assume that these profit functions are differentiable. The post-entry choice of x_1 and x_2 are determined by a Nash equilibrium $[x_1^*(I), x_2^*(I)]$, where the superscript * indicates equilibrium values.[23]

The object of interest in this context is the incumbent's first-period equilibrium choice of I and how I varies when entry costs decrease. Entry is deterred if the incumbent chooses I such that $\Pi^2(I, x_1^*(I), x_2^*(I)) \leq 0$. In contrast, entry is accommodated if $\Pi^2(I, x_1^*(I), x_2^*(I)) > 0$. Tirole (1988) shows that the incumbent's first-period equilibrium choice of I depends on three elements. First, it depends on whether the incumbent finds it advantageous to deter or to accommodate entry. Second, it depends on whether investment makes the incumbent tough or soft. Third, it depends on the type of competition in the second period (Cournot or Bertrand), which determines whether the strategic choices x_1 and x_2 are strategic substitutes (i.e., quantities) or complements (i.e., prices).[24]

To understand the effect of a decrease of entry costs on I in this model ($\frac{\partial I}{\partial \phi}$), we follow Tirole (1988) and consider separately the case in which the incumbent seeks to deter entry and the case in which the incumbent seeks to accommodate entry.

21 See, for instance, Aguerrevere (2009) or Bustamante (2015) for recent theoretical connections between strategic investment and asset prices.

22 Entry costs could be either fixed or variable (as an increasing function of output).

23 Following Tirole (1988), we assume that this equilibrium is unique and stable.

24 We follow the tradition in the literature and assume that quantities are strategic substitutes and prices are strategic complements. This simplifies the exposition, but has no bearing on our conclusions.

Table A1
Definition of variables

Variable	Definition
Investment	Capital expenditures (CAPX) at time $t+1$ divided by net PPE at time t
Cash to assets	Cash and short term investments (CHE) divided by total assets
LT leverage	Long-term debt (DLTT) divided by total assets
Tobin's q	Total assets minus common equity (CEQ) plus the market value of equity (CSHO × PRCC_F) divided by total assets
CF to assets	Income before extraordinary items (IBC) divided by total assets
Tariff	Duties collected at U.S. Custom divided by the Free-On-Board custom value of imports at the four-digit SIC industry. The data are available on Peter Schott's Web Site
Cut#x	Dummy variable equal to one if the reduction in the tariff is more than x times larger than the average tariff reduction in the industry, and zero otherwise
$CUT_{j,t}$	Dummy variable equal to one if industry j has experienced a tariff cut by time t
Aggr. capital stock	Aggregate capital stock in USD (NBER-CES database)
Return	Abnormal return (alpha) from the market model
Volatility	Idiosyncratic volatility from the market model
Sales growth	Growth in sales (SALE) from year $t-1$ to year t
CSM	Competitive strategy measure. Correlation between the ratio of the change in firm's profit to the change of its sales, and the change in the combined sales of its rivals (Sundaram, John, and John, 1996)
CAR_{IPO}	Cumulative abnormal returns of industry rivals around a firm's IPO announcement
CAR_{SEO}	Cumulative abnormal returns of industry rivals around a firm's SEO announcement
$CAR_{M\&A}$	Cumulative abnormal returns of industry rivals around a firm's M&A announcement
Citations	Median log number of citations in an industry
Redeployability	For each industry, the value weighted average of the proportion of industries that use a given asset (BEA capital flow data)
HHI	Fitted HHI at the three-digit SIC level obtained from the Hoberg and Phillips data library
Foreign cash	Average cash-to-asset ratio at the four-digit SIC industry level of foreign public firms (Worldscope data)
WW-index	Index of financing constraints from Whited and Wu (2006)
External dependence	Index of external finance dependence of Rajan and Zingales (1998)
Rating	Dummy variable for the presence of a credit rating
3-month Treasury-bill	Three-month Treasury-bill rate

A.2. Deterrence of Entry

To deter entry, the incumbent chooses a level of I such that the entry of firm 2 is unprofitable ($\Pi^2(I, x_1^*(I), x_2^*(I)) \leq 0$). Following Tirole (1988), we can write the effect of I on Π^2 as

$$\frac{d\Pi^2}{dI} = \frac{\partial\Pi^2}{\partial I} + \frac{\partial\Pi^2}{\partial x_1}\frac{dx_1^*}{dI}. \tag{2}$$

By modifying I, the incumbent could directly affect the entrant's profit ($\partial\Pi^2/\partial I$). Assuming that the choice of I only affects the incumbent's production function, we have $\partial\Pi^2/\partial I = 0$. Any effect of I on the entrant's profit originates in the strategic effect, which comes from the fact that I modifies the incumbent's post-entry behavior (by dx_1^*/dI), and thus affects the entrant's profit (in proportion of $\partial\Pi^2/\partial x_1$).

To see the effect of a decrease in entry cost on the incumbent's optimal investment, let us imagine that for some initial entry cost ϕ^a, we are at an equilibrium given by I^a, $x_1^{*,a}(I)$, and $x_2^{*,a}(I)$ so that entry is just deterred ($\Pi^2 = 0$). What happens to I if, all else equal, entry costs decrease from ϕ^a to ϕ^b? Because I^a, $x_1^{*,a}(I^a)$, and $x_2^{*,a}(I^a)$ is the no-entry equilibrium for initial entry costs ϕ^a and Π^2 is strictly decreasing in ϕ, we have

$$\Pi^2(I^a, x_1^{*,a}(I^a), x_2^{*,a}(I^a), \phi^a) = 0 < \Pi^2(I^a, x_1^{*,a}(I^a), x_2^{*,a}(I^a), \phi^b) \tag{3}$$

Hence, with entry costs $\phi^b < \phi^a$, I^a does not prevent entry. The new no-entry equilibrium investment I^b could be either larger or smaller than I^a. This depends only on whether investment makes the incumbent tough or soft. To see this, consider first the case in which the second-period competition game is in quantity (Cournot) so that firms' choice of quantities x_1 and x_2 are strategic substitutes.[25] When competition is in quantities, the incumbent needs to commit to increase second-period quantity x_1 to lower the entrant's profit ($\partial\Pi^2/\partial x_1 < 0$). Therefore, investment makes the incumbent tough when $dx_1^*/dI > 0$ and soft when $dx_1^*/dI < 0$. As a result, to prevent entry when $\phi^b < \phi^a$ the incumbent needs to choose $I^b > I^a$ if investment makes her tough, and $I^b < I^a$ if investment makes her soft.

Proposition 1
In the entry-deterrence case where competitive actions are strategic substitutes, the incumbent should react to a decrease in entry cost by increasing investment if investment makes her tough ($\partial I/\partial\phi < 0$), and by decreasing investment if investment makes her soft ($\partial I/\partial\phi > 0$).

Alternatively. when the second-period competition game is in prices (Bertrand), firms' choice of prices x_1 and x_2 are strategic complements.[26] When firms compete in prices, the incumbent needs to commit to decrease second-period prices to lower the entrant's profit ($\partial\Pi^2/\partial x_1 > 0$). Therefore, investment makes the incumbent tough when $dx_1^*/dI < 0$ and soft when $dx_1^*/dI > 0$. Hence, to prevent entry when $\phi^b < \phi^a$, the incumbent also needs to choose $I^b > I^a$ if investment makes her tough, and $I^b < I^a$ if investment makes her soft.

Proposition 2
In the entry-deterrence case where competitive actions are strategic complements, the incumbent should react to a decrease in entry cost by increasing investment if investment makes her tough ($\partial I/\partial\phi < 0$), and by decreasing investment if investment makes her soft ($\partial I/\partial\phi > 0$).

A.3 Accommodation of Entry

Now, suppose that deterring entry is too costly for the incumbent. Unlike in the entry-deterrence case in which the choice of I was dictated by the entrant's second-period profit (which had to be equalized to zero), it is dictated by the incumbent's profit in the entry-accommodation case. The incumbent thus chooses I to maximize second-period profit ($\Pi^1(I, x_1^*, x_2^*)$). Following Tirole (1988), we can write the total effect of I on Π^1 as

$$\frac{d\Pi^1}{dI} = \frac{\partial\Pi^1}{\partial I} + \frac{\partial\Pi^1}{\partial x_2}\frac{dx_2^*}{dI}. \tag{4}$$

25 In other words, both firms' reaction curves are downward sloping, or equivalently $\partial\Pi^i/\partial x_j < 0$.

26 In other words, both firms' reaction curves are upward sloping, or equivalently $\partial\Pi^i/\partial x_j > 0$.

The total effect of I on Π_1 is comprised of two effects. The direct effect is $\partial\Pi^1/\partial I$, and the strategic effect comes from the influence of I on the entrant's second-period choice of x_2.[27] To understand the effect of a decrease of entry costs on investment in the entry-accommodation case, imagine that for some initial entry costs ϕ^a we are at an equilibrium given by I^a, $x_1^{*,a}(I^a)$, and $x_2^{*,a}(I^a)$ so that the incumbent's second-period profit are maximized. What happens to I if, all else equal, entry costs decrease from ϕ^a to ϕ^b? Because the triplet I^a, $x_1^{*,a}(I^a)$, and $x_2^{*,a}(I^a)$ forms the entry-accommodation equilibrium for the initial ϕ^a and Π^2 is strictly decreasing in ϕ, we have

$$\Pi^1(I^a, x_1^{*,a}(I^a), x_2^{*,a}(I^a), \phi^a) > \Pi^1(I^a, x_1^{*,a}(I^a), x_2^{*,a}(I^a), \phi^b) \tag{5}$$

Hence, with entry costs ϕ^b, I^a does not maximize Π^1. The incumbent needs to choose a new entry-accommodation equilibrium investment I^b that increases its second-period profit Π^1 so as to reach a maximum (i.e., a new equilibrium). Again, I^b could be either larger or smaller than I^a. Unlike the entry-deterrence case, this depends not only on whether investment makes the incumbent tough or soft, but also on whether the choice variables x_1 and x_2 are strategic substitutes or complements.[28] To see this, let us rewrite Equation (4) as

$$\frac{d\Pi^1}{dI} = \frac{\partial\Pi^1}{\partial I} + \left(\frac{\partial\Pi^1}{\partial x_2}\right)\left(\frac{dx_2^*}{dx_1}\right)\left(\frac{dx_1^*}{dI}\right) \tag{6}$$

Consider first the case in which the second-period competition game is in quantity (Cournot) so that firms' choice of quantities x_1 and x_2 are strategic substitutes. When competition is in quantities, the incumbent's second-period profit decreases when the entrant chooses to produce more, so $\partial\Pi^1/\partial x_2 < 0$. Similarly, when actions are strategic substitutes, the reaction curves are downward sloping, so $dx_2^*/dx_1 < 0$. Moreover, with firms competing in quantities, investment makes the incumbent tough when $dx_1^*/dI > 0$ (and when $\partial\Pi^1/\partial I > 0$) and soft when $dx_1^*/dI < 0$ (and $\partial\Pi^1/\partial I < 0$). As a result, the sign of $d\Pi^1/dI$ (in Equations (3) and (5)) is positive when actions are strategic substitutes and investment makes the incumbent tough. In this case, the incumbent should optimally choose $I^b > I^a$ when $\phi^b < \phi^a$. In contrast, the sign of $d\Pi^1/dI$ is negative when actions are strategic substitutes and investment makes the incumbent soft, implying that the incumbent should optimally choose $I^b < I^a$ when $\phi^b < \phi^a$.

Proposition 3
In the entry-accommodation case where competitive actions are strategic substitutes, the incumbent should react to a decrease in entry cost by increasing investment if investment makes her tough ($\partial I/\partial\phi < 0$), and by decreasing investment if investment makes her soft ($\partial I/\partial\phi > 0$).

When the second-period competition game is in prices (Bertrand), firms' choice of prices x_1 and x_2 are strategic complements. In this case, the incumbent's second-period profit decreases when the entrant chooses to lower prices, so $\partial\Pi^1/\partial x_2 > 0$. Similarly, when actions are strategic complements, the reaction curves are upward sloping, so $dx_2^*/dx_1 > 0$. Moreover, when firms compete in prices, investment makes the incumbent tough when $dx_1^*/dI < 0$ (and when $\partial\Pi^1/\partial I < 0$) and soft when $dx_1^*/dI > 0$ (and $\partial\Pi^1/\partial I > 0$). As a result, the sign of $d\Pi^1/dI$ (in Equations (3) and (5)) is negative when actions are strategic complements and investment makes the incumbent tough, implying that the incumbent should optimally

27 Note that the presentation in Tirole (1988) compares the case in which firms act strategically to the case in which they do not. Hence, the direct effect is ignored as this direct effect exists in both cases. This is different for us as we focus on the effect of a change in entry cost when firms act strategically. Hence, we cannot ignore the direct effect.

28 Similarly to Fudenberg and Tirole (1984), we assume that the second-period actions of both firms have the same nature, such that $\partial\Pi^1/\partial x_2$ and $\partial\Pi^2/\partial x_2$ have the same sign.

choose $I^b < I^a$ when $\phi^b < \phi^a$. In contrast, the sign of $d\Pi^1/dI$ is positive when actions are strategic complements and investment makes the incumbent soft, implying that the incumbent should optimally choose $I^b > I^a$ when $\phi^b < \phi^a$.

Proposition 4
In the entry-accommodation case in which competitive actions are strategic complements, the incumbent should react to a decrease in entry cost by decreasing investment if investment makes her tough ($\partial I/\partial\phi > 0$), and by increasing investment if investment makes her soft ($\partial I/\partial\phi < 0$).

Table 1 in the paper summarizes the four propositions.

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