Foreign Competition and New Product Creation: Evidence from Trademark Data*

Xin Chang[a], Yangyang Chen[b], Jian Huang[c], Edward J. Podolski[d], Wenrui Zhang[c]

[a] *Nanyang Business School, Nanyang Technological University, Singapore*
[b] *College of Business, City University of Hong Kong, Hong Kong*
[c] *CUHK Business School, Chinese University of Hong Kong, Hong Kong*
[d] *Deakin Business School, Deakin University, Australia*

This draft: November 2019

Abstract

We examine how U.S firms adjust their product development strategy to increases in foreign competition. Using a novel dataset of firms' trademark registrations to proxy for new products, we find a robust negative association between foreign competition and new product creation. The baseline effect is most pronounced in uncompetitive industries, when firms face lower financial constraints, and when managerial risk-taking incentives are low. These findings suggest that foreign competition disciplines managers and induces greater corporate conservatism. Additional results reveal that firms adjust their product development strategy only to imports from high-wage countries. Our final set of results suggests that foreign competition induces a more focused product market strategy and improved resource allocation. Specifically, when faced with increased import competition, firms cut back on low-value products, less novel products, and release a less diverse range of products. Overall, our results suggest that heightened foreign competition significantly influences the product market strategies of U.S. firms.

JEL Classification: F61; O31; O32
Keywords: Foreign competition; Product creation; Trademarks; Foreign competition

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Authors' contacts information: changxin@ntu.edu.sg (Xin Chang), ychen722@cityu.edu.hk (Yangyang Chen), jianhuang@link.cuhk.edu.hk (Jian Huang), edward.podolski@deakin.edu.au (Edward J. Podolski), and wrzhang@cuhk.edu.hk (Wenrui Zhang), respectively. We are grateful for the comments and suggestions from Warren Bailey, Jay Cao, Nicholas Zhiyao Chen, Si Cheng, Sudipto Dasgupta, Andrew Ellul, Caroline Flammer, Vyacheslav (Slava) Fos, Kangkang Fu, Xavier Giroud, Michael Hertzel, Clifford G. Holderness, Po-Hsuan (Paul) Hsu, Gustavo Manso, Jay Ritter, Kim Taejin, Wensi Xie, Le Zhang, Margaret Rui Zhu, and seminar participants at Deakin University and La Trobe University. The usual disclaimer applies.

1. Introduction

Schumpeter (1942) defines "creative destruction" as the process of industrial mutation that incessantly revolutionizes the economic structure from within. A key element of "creative destruction" is firms' creation of new products and services. Indeed, the introduction of new products and services is increasingly important for firms' bottom line. At 3M, for example, products less than 5 years old account for over 32% of sales, increasing from 25% in 1990. Despite the economic significance of new product creation, research on factors that affect corporate product development is scarce, largely due to data limitations.[1] Our paper contributes to this line of research by exploring the link between foreign competition and U.S. firms' product creation. Our study is motivated by the drastic increase in the exposure of domestic U.S. firms to foreign imports over the past 30 years. As Figure 1 demonstrates, global trade has grown substantially over the past 30 years, both in nominal terms and as a percentage of GDP.[2] However, whether this rapid increase in foreign competition has made domestic U.S. firms more active in terms of developing new products and services remains unclear.[3] We address this fundamental research question.

[Insert Figure 1]

Conceptually, the relation between foreign competition and firm's trademark development is unclear ex-ante. On the one hand, foreign competition can reduce corporate product development, by pressuring firms to pursue more conservative strategies, reducing available resources for investment, or both. With respect to corporate conservatism, a longstanding body of research shows that competition has a disciplining effect on managers (Alimov, 2015;

[1] Since the recent release of the U.S. Patent and Trademark Office (USPTO) Trademark Case Files Dataset, corporate trademarking activity has attracted significant academic interest. A number of recent studies investigate factors that affect firms' trademarking activities. For example, the contributes of information technology investments on trademark holdings (Gao and Hitt, 2012), the impact of corporate venture capital funding on trademark output (Uzuegbunam, Ofem, and Nambisan, 2019), the influence of market structure, customer type, and involvement of a venture capitalist on start-up firms' choice of patents versus trademarks (de Vries, Pennings, and Block, 2013), the effect of CEO compensation on firms' trademark creation (Faurel el al., 2018), the effect of mergers and acquisition on trademark registration and cancellation (Hsu, Li, Liu, and Wu., 2018), and the option trading volume on firm's new product trademark activities (Hsu, Li, and Nozawa, 2019).

[2] In particular, international trade has reached to an amount of $3 trillion in 2017 from less than $500 billion in 1980, which is a more than 500% increase over less than forty years. In addition, the contribution of trade to GDP has also increased steadily. The ratio of total trade to GDP climbs to 16% in 2017 from about 10% in 1980, highlighting the importance of globalization to world economic growth.

[3] For example, the evidence is mixed on the association between foreign competition and firms' technological innovation (Autor et al., 2017; Xu and Gong, 2017; Kueng, Li, and Yang, 2017; Hombert and Matray, 2018; and Chakravorty, Liu, and Tang, 2017), while the evidence points to a negative association between foreign competition, especially from China, and employment (Autor, Dorn, and Hanson, 2013; Acemoglu, et al., 2016).

Chhaochharia et al., 2017; Grullon, Larkin, and Michaely, 2018), which in turn can de-incentivize managerial risk-taking (Coles, Daniel, and Naveen, 2006; Bargeron, Lehn, and Zutter, 2010). Developing and bringing a new product to the market is an exceptionally risky and resource intensive endeavor (Faurel et al., 2018). These risks stem from the high likelihood of failure during the development phase, and highly uncertain cash flows associated with the product, even if successfully launched. Thus, in response to intensified foreign competition, managers are more likely to prioritize incremental responses, such as political activism (Schuler, 1996) or technological upgrades (Bustos, 2011), rather than engage in risky and long-term investments in developing new products. With respect to resource availability, foreign competition can reduce firms' profits (Xu, 2012) and weaken their ability to invest (Dasgupta and Stiglitz, 1980). Prior studies (e.g., Irvine and Pontiff, 2009; Valta, 2012) have shown that product market competition increases firms' business risk and the costs of external financing, thereby exacerbating their financial constraints. Taken together, these arguments imply that a higher level of foreign competition may induce firms to cut back on the development of new products, especially those that have higher risk and lower probabilities of success.

A competing view is that intense competitive pressures will motivate firms to adopt more aggressive corporate policies so as to enhance their competitive position and deter the entry or expansion of their competitors (Caves and Porter, 1977). For example, theory and evidence from the banking industry, suggests that with greater competition, the pressure on profits induces firms to make riskier investments (Hellmann et al., 2000; Allen and Gale, 2004). Furthermore, to escape price competition, firms often adopt a product differentiation strategy with a focus on superior product quality and related investments in brand equity (Srinivasan, Lilien, and Rangaswamy, 2008; Bloom, Draca, and Van Reenen, 2016; Lie and Yang, 2018). By creating new products, firms can distinctly signal their innovativeness and competitiveness in the product market and effectively threaten their competitors. As a result, a higher level of import penetration in an industry could stimulate product creation.

Following recent studies (e.g., Faurel et al., 2018; Hsu et al., 2019; Hsu, et al., 2018), we capture new product creation using firms' registrations for trademarks. Trademarks are distinct from other forms of intellectual property, as they are legally required to be used in commerce suggesting a close link with new product development. When a firm plans to launch a new product line, it will file and register a new trademark to market the new product line so that it can start establishing a brand name and preventing others from using similar trademarks to confuse customers (Millot, 2009). Prior studies have shown that trademarks play an important role in driving economic and firm growth. At the macro-level, trademarks have been shown to be a superior leading indicator of economic activity compared with conventional measures (deGrazia, Myers, and Toole, 2019). At the firm-level, several studies (Greenhalgh and Rogers, 2006, 2007; Sandner and Block, 2011) show a positive association between firm value and a firm's trademark output. Trademarks have also been shown to improve firms' financial performance (Krasnikov, Mishra, and Orozco, 2009), productivity and employment (Greenhalgh et al., 2011), and alleviate firms' financial frictions by serving as collaterals for additional debt capacity (Loumioti, 2012; Larkin, 2013; Chiu, Hsu, and Wang, 2019). Despite the economic significance of trademarks, research on factors that affect corporate trademarking on a large scale is still scarce due to data limitations.[4] This is in strong contrast with existing research on patents.

Using a large sample of U.S. public firms covered by the USPTO Trademark Case File Dataset, we examine the association between foreign competition and firms' product creation. Specifically, we follow prior literature (e.g., Faurel et al., 2018) and measure the output of new product creation using the number of product trademark registrations. Following Fresard (2010) and Xu (2012), we measure foreign competition using import penetration (i.e., the value of imports as a percentage of total domestic consumption) into an industry. Our baseline results show that import penetration into an industry is negatively associated with firms' product trademark creation in that industry, suggesting that foreign competition reduces corporate product creation. The association is not only statistically significant but also economically meaningful. For example, a one standard deviation increase in foreign competition leads to a 5.43% reduction in new product trademark registrations relative to its mean value.

We conduct a battery of checks to ensure our baseline results are robust to alternative specifications and to controlling for potential omitted variables related to firm's corporate

[4] Since the recent release of the U.S. Patent and Trademark Office (USPTO) Trademark Case Files Dataset, corporate trademarking activity has attracted significant academic interest. A number of recent studies investigate factors that affect firms' trademarking activities. For example, the contributes of information technology investments on trademark holdings (Gao and Hitt, 2012), the impact of corporate venture capital funding on trademark output (Uzuegbunam, Ofem, and Nambisan, 2013), the influence of market structure, customer type, and involvement of a venture capitalist on start-up firms' choice of patents versus trademarks (De Vries, Pennings, and Block, 2013), the effect of CEO compensation on firms' trademark creation (Faurel el al., 2018), the effect of mergers and acquisition on trademark registration and cancellation (Hsu, et al., 2019), and the option trading volume on firm's new product trademark activities (Hsu et al., 2019).

governance, stock performance and industry shocks. To establish the causal relation between foreign competition and firms' product creation, we adopt two empirical strategies. We first follow Xu (2012) and perform a two-stage least squares (2SLS) regression using important tariff rates and industry-specific foreign exchange rates as instruments. We find consistent results. In the second strategy, we follow Fresard and Valta (2016) and perform a difference-in-differences (DID) test by employing large tariff reductions in an industry as a quasi-natural experiment. We find that firms' product creation significantly declines after an industry experiences a large cut in import tariffs compared to those that have not experienced a large tariff cut. To further mitigate the reverse causality concern, we also examine the dynamics of firms' product creation around large tariff cuts. The results show that the reduction of product creation only appears after large tariff cuts. Collectively, our tests for endogeneity support a causal effect of foreign competition on new product creation, although we cannot completely rule out endogeneity as a potential confounding factor.

We next explore cross-sectional heterogeneity in our sample to further substantiate the channels through which import penetration affects new product creation. We hypothesize that factors such as the domestic competitive environment, financial constraints, and managerial risk-taking incentives influence the way in which foreign competition impacts new product creation. With respect to domestic competition, prior literature argues that the competitive environment is a substitute for internal managerial monitoring which induces greater corporate conservatism (Bargeron et al., 2010; Chhaochharia et al., 2017). If the negative association between foreign competition and product creation is driven by the monitoring channel, we should observe our baseline results to hold primarily for firms operating in uncompetitive environments, where managerial monitoring and incentives to avoid risky investments are lower. Increases in foreign competition will therefore have a greater marginal effect in such settings. Furthermore, if the monitoring channel dominates the resource constraint channel, we should observe the baseline results to hold more strongly among financially unconstrained firms, which have greater ability to invest in high risk innovative projects compared with financially constrained firms. Foreign competition should therefore have a greater disciplining effect on the unconstrained firms. Consistent with these expectations, we find that our baseline results hold only in uncompetitive environments and among financially unconstrained firms, supporting the monitoring channel.

Furthermore, we expect the baseline results to be exacerbated among firms with insufficient risk-taking incentives. The basic premise behind our baseline results is that foreign competition forces managers to increase short-term operating efficiency (e.g., Chhaochharia et al., 2017; Grullon et al., 2018), which acts as a disincentive against pursuing long-term and risky projects (Coles, Daniel, and Naveen, 2006; Bargeron et al., 2009). Consistent with these expectations, our results reveal that the association between import penetration and new product creation is significantly negative only in the subsample where firms' risk-taking incentives are low.

In further analysis, we examine how the source of foreign competition affects firms' product creation. We follow prior literature (e.g., Bernard, Jensen, and Scott, 2006; Lu and Ng, 2013) to decompose import competition from foreign countries into competition from high-wage and low-wage countries, respectively. Moreover, we decompose import competition from China and other countries, given the significant volume of the Sino-U.S. trade.[5] The results show that the negative effect of foreign competition on new product creation is primarily driven by import competition from high-wage countries and by import competition from countries other than China. These results imply that U.S. firms are more likely to change their product development strategies when faced with competition from more developed countries, rather than with imports from countries where the key comparative advantages are lower labor costs.

We proceed to examine the effect that foreign competition has on product quality as well as the breadth of new product creation. Given that trademarks have been shown to be an important factor of corporate long-run success (e.g., Krasnikov et al., 2009; Greenhalgh et al., 2011; Chiu et al., 2019), we expect that managers facing intensified foreign competition will adjust their product development strategies by allocating their limited resources towards products that can potentially create greater economic benefits. To test this conjecture, we utilize three measures of trademark value. The first measure is based on trademark renewal rates, which have been identified by prior studies (Millot, 2009; Hsu, Li, and Nozawa, 2018) as a key factor differentiating more valuable

[5] Total trade amount between U.S. and China reached \$734.1 billion in 2018, of which \$557.7 billion was imports (both goods and services). Imports from China accounted for 21.2% of total imports in U.S. in 2018. U.S. imported \$539.5 billion goods from China in 2018, making China the largest good supplier for U.S. The amount goods imported from China increased 6.7% from 2017, 59.7% from 2008 and up to 427% from 2001. See trade facts between U.S. and China issued by U.S. Trade Representative: https://ustr.gov/countries-regions/china-mongolia-taiwan/peoples-republic-china.

trademarks from less valuable ones.[6] The second measure follows the spirit of Kogan et al. (2017), where we employ the stock market reaction on trademark registration day as a signal of quality. Specifically, when the cumulative abnormal return around trademark registration is positive, we classify the trademark as valuable, and vice versa. The third measure explores trademark citations, which should be positively correlated with the economic value of trademarks (Chiu et al., 2019). Our results show that firms reduce the development of low-value trademarks but not high-value trademarks in response to intensified product competition from their foreign rivals. This finding suggests that the reduction in new trademark filings documented in the baseline results is primarily driven by firms' care in avoiding releasing low-value products. Although this result suggests that foreign competition has a positive effect on firm's resource allocation, it further highlights the greater risk-aversion that import competition induces.

Given that the entirety of our results imply that foreign competition induces greater corporate conservatism, we conclude our empirical analysis by evaluating the effects of import competition on firm's product market strategies. In particular, we expect that foreign competition induced corporate conservatism will result in firms' developing a less diverse product range with products being more exploitative in nature. A diverse product range, as well as an exploratory product market strategy, involve greater risks, since the outcomes are more variable (Balsmeier, Fleming, and Manso, 2016) due to the dilution of manager' attention and corporate resources (Hsu et al., 2019). Our results support the proposition that foreign competition reduces product diversity, as evidenced by the number of new product trademarks filed across a diverse range of trademark classes. This result highlights that foreign competition leads to a narrower product market strategy, where firms cut back on the range of new products as a way of avoiding releasing low quality goods. At the same time, our results do not lend support for the notion that foreign competition induced corporate conservatism leads to a more exploitative product market strategy. In contrast, our results show that firms cut back on releasing 'duplicate' products (ie. products in technology classes in which the firm has released products in the past), but not 'novel' products. Overall, our results suggest that foreign competition has mixed effects of corporate product market strategy. On the one hand, foreign competition induces greater conservatism which reduces the volume and

[6] The USPTO requires the trademark holder to reaffirm that the trademark is in use after 5 years and then every 10 years. If the trademark is not renewed by the firm, the trademark is cancelled automatically. If the firm renew its trademarks after ten years of trademark registration, the trademarks are considered as successful trademarks.

range of new products. On the other, foreign competition induces greater discipline in resource allocation, which results in firms cutting back primarily on low-value and 'duplicate' products, without adversely affecting high-value and novel products.

Our paper contributes to the existing literature in three important ways. First, our paper adds to the literature on the relation between foreign competition and corporate investment. Previous studies have investigated the effects of foreign competition on capital expenditures (Fresard and Valta, 2016) and technological innovation measured using corporate patents (e.g., Bloom, Draca, and Reenen, 2016; Autor et al., 2017; Lie and Yang, 2018). We add to this literature by investigating the effect of foreign competition on firms' investment in new product creation measured using trademarks. Compared with corporate patents, corporate trademarks have two distinct features. First, unlike patents that are concentrated in certain high-tech industries, trademarks are more evenly distributed in a broader range of industries (Faurel et al., 2018; Hsu et al., 2019). Second, patents are typically created in the earlier stages of the innovation process to protect firms' technological inventions. Trademarks, however, involve the commercialization of these inventions in new products and services, and thus are the output at the end of the innovation process. As such, corporate trademarking is more susceptible to product market conditions. By showing that foreign competition induces firms' to adopt more focused strategies for new product creation, our findings shed new light on the role of competitive pressures in shaping firms' investment and product innovation strategies.

Second, our paper contributes to the literature on the economic consequences of foreign competition at the corporate level. On the one hand, prior studies have documented that foreign competition can be beneficial in forcing incompetent CEOs to leave (Dasgupta, Li, and Wang, 2017), reducing value-destroying acquisitions (Alimov, 2017), and pressuring firms to pay out excess cash as dividend (Grullon, Larkin, and Michaely, 2018). On the other hand, a few recent studies reveal the dark side of foreign competition in inducing firms to pursue more aggressive tax avoidance strategies (Chen and Lin, 2018), engaging in earnings management and financial restatements (Lin, Officer, and Zhan, 2015), decreasing domestic firms' management forecasts (Huang, Jennings, and Yu, 2017), exacerbating managers' incentives to withhold bad news (Li and Zhan, 2018), and reducing the information transparency and stock liquidity (Atawnah et al., 2018). Our analyses show that greater competitive pressures from foreign rivals shift firms' new product creation into a reduced, albeit more focuses strategy, suggesting that foreign competition can improve the efficiency of resource allocation in product innovation.

Third, our paper contributes to the recent literature on the consequences of import competition from emerging countries, in particular China (Autor et al., 2016; Lie and Yang, 2018; Chen, Lin, and Shao, 2018). Prior literature documents the substantial economic dislocations caused by the surge of imports by the U.S. from China. In contrast, our paper finds that imports from low wage countries, which include China, has a negligible impact on U.S. firms' new product creation, suggesting that import competition from high-wage countries is far more consequential in terms of corporate product development strategies.

The remainder of the paper is structured as follows. Section 2 provides the basics of trademarks, reviews the related literature and develops the hypotheses. We discuss the sample and variables in Section 3. Section 4 presents the main empirical findings. Section 5 reports additional results and Section 6 concludes.

2. Trademark basics and related literature

2.1. Trademark Basics

The definition of a trademark by the United States Patent and Trademark Office (USPTO) is "*a brand name. A trademark or service mark includes any word, name, symbol, device, or any combination, used or intended to be used to identify and distinguish the goods/services of one seller or provider from those of others, and to indicate the source of the goods or services*." The emphasis on product, i.e., good and service, is consistent with a broader definition of innovation provided by Organization of Economic Innovation (OECD).[7] Trademarks are distinct from other forms of intellectual property, as they are legally required to be used in commerce suggesting a close link with new product development. When a firm plans to launch a new product line, it will file and register a new trademark to market the new product line so that it can start to establish a brand name and prevent others from using similar marks to confuse customers (Millot, 2009). Indeed, Gao and Hitt (2012) report that the consensus amongst attorneys who specialize in trademark law, trademark officers responsible for managing trademarks for their firms, and

[7] See OECD (2005): "*An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations*".

officers of the USPTO who they interviewed, is that trademark applications are strongly associated with new product development. Highlighting the close association between trademarks and new products creation, trademarks need to be renewed with USPTO after five years from its initial registration, and then be renewed periodically every ten years. To successfully renew their trademarks, firms must prove the trademark is in continued use and pay the corresponding renewal fee, otherwise the trademark will be cancelled automatically or will expire.[8] Trademarks are therefore more directly related to product development than, for example, patents, which have attracted the vast majority of attention of the empirical literature dealing with product market innovation.

Graham et al. (2013, 2018) argue that trademarks have a larger "perimeter of application" throughout the economy than patents. For example, patenting tends to be concentrated in specific industries, such as Petroleum and Coal Products, Transportation Equipment, Chemical and Allied Products, and Electronic and Other Electronic Equipment (SIC codes 29, 37, 28, and 36, respectively). In contrast, while there is some variation in trademark activity between industries, the variation is far smaller for trademarking than it is for patenting. For example, trademarking activity in our sample ranges from 6.836 registration per year for Miscellaneous Manufacturing Industry (SIC code 39) to 0.851 registration per year for Primary Metal Industries (SIC code 33). On the other hand, patenting activity ranges from 24.030 applications per year for Petroleum and Coal Products industry (SIC code 29) to 0.382 applications per year for Leather and Leather Products (SIC code 31). These statistics highlight the point that patenting activity tends to be unique to certain industries to a much greater extent than trademarking activity.[9]

[Insert Figure 2]

Similarly to other innovation activities, the trademark development process is a risky one. For example, Faurel et al. (2018) shows that trademark creation is associated with firm volatility. The value implications of trademarks are also widely documented by the extant literature. Specifically, registered trademarks represent an exclusive use of brand name, preventing loss caused by infringement from competitors (Heath and Mace, 2018). Additionally, a trademark can differentiate firms' product or service from their competitors' and signals product quality (Besen

[8] Millot (2009) shows that about 55% of trademarks seize to exist six or seven years after registration.
[9] In untabulated results, we find that the top five trademark industries account for roughly 40% of the total number of trademarks, while top five patent industries account for approximately 80% of the total number of patents.

and Raskind 1991). Furthermore, a trademark can accumulate awareness, attract potential customers, and foster existing customers' product loyalty (Crass, Czarnitzki, and Toole, 2016). As such, trademarks naturally can improve firm's financial performance (Krasnikov, Mishra, and Orozco, 2009), alleviate financial friction (Chemmanur, et al., 2018; Chiu, Hsu, and Wang, 2019), and support firm to achieve long-run growth and higher firm value (Greenhalgh and Rogers, 2006, 2007).

Despite their importance, research on firms' trademarking activity is only just emerging, largely due to data limitation. Recent studies on trademarks include investigating the effect of risk taking incentives on trademarking activity (Faurel et al., 2018), financial innovation on new product trademark registration (Hsu, Li, and Nozawa, 2018), M&A activities on firm's product line development (Hsu et, al., 2018), and the effect of financial reporting choices to meet earnings targets on the new product success (Bereskin et al., 2019). Recent literature also deals with trademarks as pledged assets backing loans (Chiu, Hsu, and Wang, 2019), the misvaluation of firms with trademarks (Hsu et al., 2018) and role of trademarks in financing and valuation of start-up firms (Chemmanur, Rajaiya, Tian, and Yu, 2018).

2.2. Related literature and hypothesis development

Prior literature does not offer an unambiguous view on the association between foreign competition and new product creation. Indeed, the empirical literature on the association between foreign competition and technological innovation offers mixed and contradictory evidence. For example, Autor et al. (2017) finds that Chinese import competition has a negative effect on U.S firms' innovative activities. In contrast, Chakravorty, Liu and Tang (2017) documents a positive effect of Chinese import on U.S. innovation. Lie and Yang (2018) somewhat reconciles these findings by presenting evidence that innovation activities of U.S. firm's first increase and then decline after years of competition from China. Liu and Zhou (2017) concludes that competition from high wage countries induce more innovation while competition in low wage countries discourage innovation in U.S. firms. A detailed summary of the literature dealing with the consequences of trade liberalization and firm innovation is provided by Shu and Steinwender (2017).

Conceptually, the association between foreign competition and new product development is unclear. On the one hand, foreign competition can deter investment into new product development by de-incentivizing managerial risk taking and reducing available resources for investment. In particular, a longstanding body of literature argues that product market competition incentivizes managers to behave efficiently. For example, since product market competition has a detrimental effect on corporate profits (Xu, 2012), managers have an increased incentive to exert more effort to avoid liquidation (Schmidt, 1997; Aghion, Dewatripont, and Rey, 1999). Furthermore, intensified competition has the potential to curb managerial slack through performance evaluation, since with increased competition there are more reference points to compare management against (Holmstrom, 1982; Nalebuff and Stiglitz, 1983; Shleifer, 1985). Empirically, numerous papers show supportive evidence for the disciplinary effect of competition. For example, Dasgupta et al. (2017) examine CEO turnover under large tariff reduction, and find that the probability of CEO turnover increases with foreign competitive threats. Giroud and Mueller (2010) find evidence that the competitive environment disciplines managers by mitigating their desire for a 'quiet life'. In a similar vein, Chhaochharia et al. (2017) shows that the Sarbanes-Oxley Act of 2002 (SOX) improves operation of firms in non-competitive industries. A recent study by Grullon, Larkin, and Michaely (2018) document that product market competition increases dividend payout ratio, thus offering support for the notion that product market competition mitigates agency problems. While this literature highlights the positive aspects of product market competition, with respect to firm efficiency and mitigation of agency problems, a potential downside of improved managerial monitoring is a reduction is risk taking below optimal levels (Coles, Daniel, and Naveen, 2006; Bargeron, Lehn, and Zutter, 2009).

In addition to potentially reducing the incentives to take risks, foreign competition also reduces a firm's availability of resources available for investment. Competitive pressure reduces market power and profits (Xu, 2012), which reduces pledgeable income and increases cash flow risk (Raith, 2003; Gaspar and Massa, 2006; Irvine and Pontiff, 2009), which in turn makes it more difficult for firms to raise funds (Tirole, 2006; Valta, 2012). Greater exposure to foreign competition thus would naturally make it harder for firms to fund long-term and risky projects. The idea that resource constraints influence firms' ability to be active on the product market is consistent with the evidence in Fresard and Valta (2016).

On the one hand, exposure to foreign competition can motivate firms to be more innovative in the product market to escape competition. For example, prior literature (e.g., Caves and Porter, 1977) shows that competitive pressure motivates firms to adopt aggressive corporate policies to enhance their competitive position and deter entry or expansion of their competitors. Although

Fresard and Valta (2016) document a reduction in overall investment following an increase in foreign competitive threats, they find that this decrease is entirely driven by competition in substitutes. In contrast, competition in complements has no effect of corporate investment, suggesting that firms adjust their investment decisions strategically to their competitive environment. In a similar spirit, Flammer (2015) finds that domestic firms invest more in corporate social responsibility schemes (CSR) in response to foreign competition because CSR serves as a trade barrier. Cookson (2018) shows that to deter competitor's entry, incumbent firms in American casino industry increase investment in physical capacity when they are threatened by an entry plan from their competitors. To escape price competition, firms often adopt a product differentiation strategy with a focus on superior product quality and related investments in brand equity (Srinivasan, Lilien, and Rangaswamy 2008; Bloom, Draca, and Reenen, 2016; Lie and Yang, 2018). By creating these new products, firms can distinctly signal their innovativeness and competitiveness in the product market and effectively threaten their competitors.

Given the discussion leading up to this point, the relation between foreign competition and firms' product trademark development is not clear ex-ante. We therefore formulate two competing hypotheses:

Hypothesis 1A: There is a negative relation between foreign competition and product trademark development.

Hypothesis 1B: There is a positive relation between foreign competition and product trademark development.

3. Data, sample, and variable construction

We obtain data from various sources. Trademark data are collected from the United States Patent and Trademark Office (USPTO) Trademark Case File 2017 Dataset (TCFD). Import and export data are downloaded from Peter Schott's webpage, while tariff rate data are obtained from Laurent Fresard's webpage.[10] Finally, financial variables are from Compustat and CRSP. Due to the limited coverage of the import penetration data, our sample is limited to manufacturing industries (SIC codes 2000 to 3999). We keep in our sample firms without trademark registration

[10] See import and export data from http://faculty.som.yale.edu/peterschott/ and tariff rate data in https://people.lu.usi.ch/fresal/, respectively.

during the same period, but exclude firm-year observations that are not available. Our final sample consists of 42,055 firm-year observations over the period 1977 to 2010.

3.1. Measuring trademarks

We collect data on a firm's trademark registrations from the TCFD. We require that trademarks applied for must be eventually registered with the USPTO and have at least one U.S. listed firm as the owner. Since the TCFD only provides trademark owners' names and locations, we must manually match the names obtained from TCFD to firms in the Compustat database. We employ a name matching algorithm for this purpose, and check the accuracy of these matches manually.

We construct a number of variables capturing the trademark registrations of a given firm. Our first measure (*TM*), captures the total number of new trademarks that a firm filed for (and is subsequently granted) in a given year. While this simple and crude measure captures the trademarking activity of a given firm, it does not distinguish between the different types and uses of trademarks. As noted by Faurel et al. (2018), not all trademarks filed by firms are related to product development, with many trademarks being registered exclusively for marketing purposes. Since our study focuses on product development, we need to separate product trademarks and marketing trademarks from total trademarks registered. Our classification scheme follows Faurel et al. (2018) and Hsu et al. (2018).

For the purposes of distinguishing between product trademarks and marketing trademarks, we rely on two variables in the USPTO case file: *mark drawing code* and *mark identification characters*.[11] There are several scenarios in the classification. First, we classify trademarks without text as marketing trademarks. Second, we classify trademarks with stylized text as marketing trademarks. Third, we classify trademarks with standard text but more than three words as marketing trademarks. Fourth and finally, trademarks with standard text and three words or less are classified as product trademarks.

Following this classification scheme, we define two variables, which identify the number of product and marketing trademarks registered and subsequently granted to firms in a calendar year. The first variable, defined as *PrdTM*, is the number of product trademarks registered in a given

[11] According to TCFD, *mark drawing code* identifies whether a filed trademark contains standard character, stylized text, with or without text, while *mark identification characters* provides specific letters or any texts for the applied trademarks.

year by a given firm. The second, defined as *MktTM*, is the number of marketing trademarks registered in a given year by a given firm. The sum of *PrdTM* and *MktTM* is always equal to *TM*.

In our empirical analysis, we not only examine the link between import competition and trademark creation, but also the eventual value and success of trademarks. For the purposes of capturing the relative value of trademarks, we track the survival of newly generated trademarks, since Millot (2009) argues that high value trademarks tend to be renewed. We concentrate on the long term renewal rate when evaluating the value of a trademark, following Crass, Czarnitzki, and Toole (2019) who show that trademark payoff takes over a decade to reach its maximum. For the purposes of determining the value of a trademark, we use trademark cancellation date, renewal date and status code date provided by TCFD. Specifically, for trademarks that registered before November 16, 1989, we define a trademark as having low value if the trademark was not renewed 21 years after its registration. For trademarks registered after November 16, 1989, we treat trademarks as having low value if the trademark was not renewed 11 years after registration.[12] Trademarks that were not canceled are treated as high-value trademarks ($PrdTM_{high}$), while trademarks that were cancelled are treated as low-value trademarks ($PrdTM_{low}$).

Another alternate measure of trademark value is based on trademark citations. This approach is motivated by Chiu, Hsu, and Wang (2019), who argues that more famous, and therefore more valuable, trademarks are cited by later trademarks. We therefore define a high value trademarks ($PrdTM_{high}$) as those that are subsequently cited, and low value trademarks ($PrdTM_{low}$) as those that are not subsequently cited. As an alternate trademark valuation approach, we utilize the stock market reaction when the trademark was granted. We follow the spirit of Kogan et al. (2017), and calculate the announcement day cumulative abnormal returns (CARs) around the trademark registration date. We classify trademarks associated with positive CARs as high value trademarks ($PrdT\,M_{high}$), and trademarks associated with negative CARs as low value trademarks ($PrdTM_{low}$).

We are also interested in the product market strategy that exposure to foreign competition induces. Towards this goal, we follow Hsu et al. (2019) and develop two separate variables

[12] We use different cut-offs around 1989 because the second round of renewal period changed from 20 years to 10 years after 1989 (Graham et al., 2013). The Trademark Manual of Examining Procedure (TEMP) reads as follows: "*The Trademark Law Revision Act of 1988, Pub. L. No. 100-667, 102 Stat. 3935, which took effect on November 16, 1989, amended §9 of the Trademark Act of 1946 to reduce both the duration of registration and the term of renewal from twenty to ten years. All registrations issued or renewed on or after November 16, 1989 are issued or renewed for a ten-year period.*"

measuring the level of diversity across technology classes of newly filed trademarks. Trademark diversity is related to a firm's level of risk taking with respect to their product market strategy, since launching products outside of the firm's experience has a higher likelihood of failure compared with launching products within the firm's area of expertise. Our first measure of trademark diversity ($Diversity_{nclass}$) is the natural logarithm of one plus the number of opf unique trademark classes of new trademarks filed by a firm from year *t* to *t*+2. Our second measure of trademark diversity ($Diversity_{hhi}$) is one minus the Herfindahl index based on new trademarks files by a firm from *t* to *t*+2 across the trademark classes. In a similar vein, we also construct variables to measure whether new trademarks are in old or new technology classes. Specifically, the variable *OldTech* captures the number of newly filed trademarks which are in the same technology class as trademarks filed within the past 10 years. The variable *NewTech* captures the number of newly filed trademarks which are in a technology class in which the firm has not filed a trademark in the previous 10 years.

3.2. Measuring foreign competition

Following Bernard, Jensen and Schott (2006), Lu and Ng (2013), and Li and Zhou (2017), we calculate the import penetration ratio as imports over domestic consumption, which is computed as domestic production plus imports minus exports for each four-digit SIC industry each year. We take the natural logarithm of one plus the import penetration ratio (*ImpPen*) and use it in the analysis. We collect data on U.S. imports and exports from Schott's International Economics Resource Page at the Yale University. The import and export data are available at four-digit SIC (from 2011 to 3999). Domestic production is measured as value of shipment produced domestically. Value of shipment for each industry are obtained from NBER-CES Manufacturing Industry Database (Becker, Gray, and Marvakov, 2016).[13]

In our further analysis, we examine whether the origin of import competition is an important factor influencing the way in which firms alter their trademarking activity. For this purpose, we distinguish imports from low-wage and high-wage countries and define additional variables that capture the source of import competition. This first alternate measure captures an industry's exposure to imports from low-wage countries as the share of imports from low-wage countries to

[13] This version of The NUBR-CES Manufacturing Industry Database contains U.S. manufacturing sector from 1958 to 2011. The data used come from various sources including U.S. Census Bureau, the Bureau of Economic Analysis (BEA) and the Bureau of Labour Statistics (BLS) (Becker, Gray and Marvakov, 2016).

total domestic consumptions. Following Bernard, Jensen, and Schott (2006), we define countries as low wage if their GDP per-capita in a year is below 5% of the GDP per-capital of the U.S. Second, as China become increasingly important in international trade and is attracting researcher's attention (Acemoglu et al., 2016; Lie and Yang, 2018; Hombert and Matray, 2018), we construct an additional measure of import penetration from China. This variable captures the portion of total industry level domestic consumptions made up by imports from China.

3.3. Control variables

To isolate the effect of foreign competition on firms' product and marketing development, we control for a large set of firm characteristics that may potentially affect firms' product and marketing development according to prior literature. In particular, Faurel et al. (2018) find that advertising intensity, R&D intensity, firm size, and growth opportunity have a positive and significant impact on trademark creation among S&P 1500 firms. We hence include in the regressions proxies for these determinants, i.e., advertising expenses scaled by total assets (*Adv/Assets*), R&D expenses scaled by total assets (*R&D/Assets*), the natural log of assets (*Ln* (*Assets*)), market-to-book ratio (*MB*) and sales growth (*SalesGrowth*). Also included in the regressions are the net plant, property, and equipment over the total assets (*Tangibility*) and capital expenditure over the lag of one period total assets (*Capex*) to account for the effect of capital intensity and capital investment. We also include return on assets (*ROA*) as a proxy for operating profitability. Cash-to-assets ratio (*Cash/Assets*) and the leverage ratio (*Leverage*) are included to account for the effects of cash holdings and capital structure on firms' product and marketing development. To capture the effect of existing industrial competitive status, we include in the regressions the concentration ratio of each four-digit SIC industry (*HHI*). *HHI* is four-digit Compustat Herfindahl-Hirschman Index.

3.4. Descriptive statistics

We present the descriptive statistics for our main variables in Table 1. The average firm in our sample makes 2.43 trademark registrations each year, of which 0.309 are marketing trademarks and 2.121 are product trademarks. There is nevertheless substantial variation in trademarking activity across firms, with the standard deviation on total trademarks being 8.312. Turning our attention to the explanatory variables, the average firm spends the equivalent of 1.4% of their assets on advertising and 4.4% of their assets on R&D. The natural logarithm of total assets of the average firm is 5.732, the market-to-book ratio is 2.751, sales growth is 6.3%, and 28.2% of total assets are made up of tangible assets. The average firm has a leverage ratio of 0.221, cash makes up 14.2% of total assets, ROA is 0.047, capital expenditure represents 7% of total assets, and the Compustat Herfindahl-Hirschman Index is 0.377.

[Insert Table 1 about here]

In Table 2, we report the sample distribution by industry. We are specifically interested in comparing the trends and norms with respect to trademarking activity with patenting activity. In the table, we report the average number of trademarks registered for by firms in each 2-digit SIC code industry as well as the average number of patents. We divide trademarks into product trademarks and marketing trademarks. The table shows total trademarks and product trademarks exhibit large industry variations, while the industry variation of marketing trademarks is relatively small. The miscellaneous manufacturing industry has the highest average number for both total and product trademarks, while the primary metal industry has the lowest for both. The industry variation for patents is large as well. The petroleum and coal products industry has the highest average number of patents, while the apparel and other textile products industry has the lowest.

[Insert Table 2 about here]

4. Main findings

In this section, we report the baseline results on the association between import penetration and corporate trademarking activity. We supplement our OLS regression analysis with a robust set of additional results addressing endogeneity concerns. Specifically, we first include a battery of potential omitted variables and then we utilize an instrumental variables methodology, where we employ tariff rates and an industry foreign exchange index as our instruments, as well as use large tariff cuts as a quasi-natural experiment.

4.1. The baseline regression

We begin our empirical analysis with a parsimonious OLS model specification. We regress our three measures of trademark activity (*Ln*(1+*TotTM*), *Ln*(1+*PrdTM*), *Ln*(1+*MktTM*)) on *ImpPen* and the full set of control variables discussed in sub-section 3.3 (denoted as *X* in equation 1). The regression model is estimated as follows:

$$Ln\left(1 + TM_{i,j,t}\right) = \alpha + \beta ImpPen_{j,t-1} + \gamma X_{i,t-1} + \theta Year_t + \lambda Firm_i + \varepsilon_{i,j,t} \quad (1)$$

All explanatory variables are lagged by one year. To mitigate the concern that unobserved variables jointly correlated with trademark activity and import penetration are influencing our results, we control for firm and year fixed effects. Firm fixed effects control for all time invariant firm level characteristics, while year fixed effects account for macroeconomic conditions that affect all firms in a given year. We correct standard errors for clustering at the industry level, since our main explanatory variable is measured at the industry level.

[Insert Table 3 about here]

The results presented in columns (1) and (2) of Table 3 reveal that the coefficient on *ImpPen* is negative and statistically significant at the 1% level. This result suggests that import competition increases are associated with future decreases in overall trademarking activity and product trademark activity. The effect is not merely statistically significant but also economically meaningful. For example, an increase in import penetration of one standard deviation is associated with a decrease in annual product trademark applications of 0.124.[14] This represents a decline of 5.43% relative to the sample mean of *PrdTM*. Interestingly, import competition is unrelated to *Ln*(1+*MktTM*), as evidenced by the statistically insignificant coefficient on *ImpPen* in column (3). Given the relatively small proportion of marketing trademarks compared with product trademarks, this finding is unsurprising. In the remainder of our analysis, we concentrate exclusively on product trademarks, which the results in Table 3 indicate are the most sensitive to import competition.

We report a large set of robustness tests in Appendix A. Specifically, we find consistent results when we employ a negative binomial regression with firm fixed effects, or after limiting the sample to the post-1989 period. Our results are also unaffected by using aggregated trademarks in future three years as dependent variable, or when we measure import penetration at the 3-digit SIC code level. We still find negative significance when we replace firm fixed effects for industry by time fixed effects.[15] We do not find any evidence of non-linearity in the relation.

4.2. Tests on endogeneity

Although we document a strong and negative association between foreign competition and new product trademark creation, our baseline analysis does not deal exhaustively with potential

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[14] Because $d[Ln(1+y)]/d[Ln(1+x)]=[(1+x)/(1+y)]\ dy/dx$, $dy=d[Ln(1+y)]/d[Ln(1+x)]\times[(1+y)/(1+x)]dx$. When quantifying the effect of the change in import penetration on the change in trademark registration, we increase import penetration by one standard deviation (0.211), so dx=0.211. The change in product trademarks (dy) from its mean value (2.121) is then equal to (1+2.121)*(-0.175)*0.211 =-0.124, which accounts for 5.43% of its mean value.

[15] Industry by time fixed effects are stronger controls compare with industry and time FE, since industry by time FE control for an industry's characteristics that vary over time. Since our import penetration is at the 4-digit SIC level, we define industry at the 2-digit SIC code level for this test.

endogeneity issues. Our results are particularly susceptible to omitted variable bias. The negative relation we observe may be spurious if an unobserved variable, which affects both new product creation and import penetration, is omitted. To address this concern, we first control for potential omitted variables. Second, we adopt two strategies to further address endogeneity concerns. The first strategy is to implement a two-stage instrumental variable approach. Specifically, we adopt tariff rate and foreign exchange rate index as instrument variables for *ImpPen*. Our second strategy is to adopt difference-in-difference (DID) approach using large tariff reduction as exogenous events for import penetration.

4.2.1. Controlling for omitted variables

We include a number of additional control variables to the baseline model specification to alleviate concerns relating to omitted variables biasing our results. Specifically, we control for the number of trademark registrations in the previous year (*PastTotTM* and *PastPrdTM*), number of active trademarks held by the firm (*StockTotTM* and *StockPrdTM*), number of patents granted (*Lnpat*), institutional ownership (*IO*), and stock return and stock volatility (*StockReturn* and *StockVolatility*), respectively. We present the results in Table 4. In all the tests, the coefficient on *ImpPen* is negative and statistically significant at the 1% or 5% levels. Our results are not affected when we incorporate all control variables mentioned above into a single regression, although these results are not tabulated for brevity. Overall, the tests suggest that our main results are robust to controlling for potential omitted variables.

[Insert Table 4 about here]

4.2.2. The instrumental variable approach

In this sub-section, we supplement our baseline results discussed in sub-section 4.1 with an instrumental variables methodology. In our instrumental variables analysis, we follow the extant literature and utilize two instrumental variables to capture the exogenous variations in import competition (Xu, 2012; Atawnah et al., 2018). Specifically, our first instrumental variable is lagged industry-specific tariff rate (*Tariff*). Tariff rates are a direct factor influencing the level of foreign competition, because they form an entry barrier for foreign competitors (Helpman and Krugman, 1989; Bernard et al., 2006). At the same time, tariff rates as an instrumental variable meet the exclusion restriction, as they are orthogonal to corporate tax avoidance in the sense that they do not reflect choices by individual firms. Our second instrumental variable is industry-specific foreign exchange rate index (*FX Index*). The exchange rate is positively correlated with import penetration, since higher exchange rate makes the goods cheaper in U.S. dollars, which encourages imports. It also satisfies the exclusion restriction because, the dollar's exchange rates are determined by macroeconomic factors that affect its aggregate demand and supply, such as interest rates, inflation and the balances of payments between the U.S. and its trade partners. At the same time, none of these macroeconomic factors is likely to be caused by individual firm-level characteristics.

We follow Feenstra (1996), Feenstra, Romalis, and Schott (2002), and Schott (2010), and calculate the annual ad valorem tariff rate as the duties collected by U.S. custom divided by the total Free on Board custom value of imports. We then calculate annual percentage change of the import tariff rate and compute the median industry change over the sample period. A detailed description of this database can be found in Feenstra et al. (2002) and Schott (2010). To construct the industry-level foreign exchange rate variable, we use the foreign exchange rates, expressed as the amount of foreign currency per U.S. dollar. We first use the exchanging countries' consumer price indices to transform the raw exchange rates to real exchange rate. The exchange rate and consumer price index data are from the International Financial Statistics of the International Monetary Fund (IMF). For each three-digit SIC industry, we compute the source-weighted average of exchange rates across all countries exporting to the U.S. in the base year of 1995. The weights are the share of each exporting country in total U.S. imports in 1995. Finally, we divide the resulting exchange rates by one thousand to obtain the industry exchange rate index variable expressed in thousands.

[Insert Table 5 about here]

We present our instrumental variable results in Table 5. The first stage results are presented in column (1) of Table 5. The coefficient estimate on *Tariff* is negative and significant at the 1% level, while the coefficient estimate on *FX Index* is positive and significant at the 1% level. The negative sign on *Tariff* indicates that higher tariff rates decrease the level of import competition while the positive sign on *FX Index* suggests that imports of foreign goods increase as the value of U.S dollars appreciate. The F-statistic of 12.78 with p-value of 0.00 rejects the null hypothesis that the two instrumental variables are jointly equal to zero. The results suggest that our instrumental variables are significantly associated with import competition and relevance condition for instrumental variables is valid.

In the second stage, we replace *ImpPen* with predicted value of *ImpPen* using the coefficients from column (1). The results are presented in column (2) of Table 5. The coefficient estimate on instrumented *ImpPen* is negative and significant at the 1% level.[16] The Hansen *J*-statistic that tests over identifying restriction as well as zero correlation between the IVs and error tem is insignificant, with *p*-value of 0.73. The test indicates that our IVs are uncorrelated with error term of our model. In addition, we also conduct Anderson-Rubin (AR) test. The AR chi-square statistic is significant with *p*-value of 0.01, further indicating that our IVs estimates are robust to weak instruments.

Overall, the findings presented in Table 5 support our baseline results from Table 3, and suggests that the negative association between import competition and product trademark creation is causal.

4.2.3. Large tariff cuts as a quasi-natural experiment

Our second identification strategy involves employing large tariff cuts as a quasi-natural experiment, which allows us to more cleanly identify the causal effect of import competition on product trademark creation. Specifically, we follow Fresard and Valta (2016) and define large tariff reductions occurring in an industry-year when the negative tariff reduction is three times larger than the industry's absolute mean tariff change. Consistent with Dasgupta et al. (2017), we define an industry at the 3-digit SIC code level. We follow the same filtering criteria as Fresard and Valta (2016), and exclude tariff changes between 1988 and 1989 due to changes in coding conventions, exclude non-transitory tariff cuts where a large tariff cut was followed by a large tariff increase over the subsequent three-years, and exclude tariffs that are below 1%. We identify 57 large tariff reductions between 1979 and 2005 across 51 unique 3-digit SIC code industries.[17] Our number of events are comparable with that in Dasgupta et al. (2017). On average, the tariff cut associated with a treatment event was 1.75%, which is slightly below the magnitude reported by Fresard and Valta (2016), but qualitatively similar. In Figure 3, we visually present the

[16] There are at least two reasons that can explain the fact that the IV estimation has a higher coefficient than the OLS estimate. First, the gap between the two estimators may be caused by the downward bias in the OLS estimates attributable to measurement errors (Li and Zhan, 2018; Angrist and Krueger, 2001). Second, OLS captures the overall average treatment effect (ATE), while the IV estimator captures the local average treatment effect (LATE). With heterogeneous treatment effects, LATE may differ from ATE (Card, 2001; Angrist and Krueger, 2001). For instance, firms with products more susceptible to competitions caused by tariff and exchange rate changes may have a larger effect on crash risk and thus IV estimates are larger. Angrist and Krueger (2001) emphasize that the local effects provide useful insights.

[17] We identify 15 events in 1980 (corresponding with the Trade Agreement Act (1979) and the General Agreement on Tariffs and Trade (Tokyo round, 1980-1982)), 6 events in 1995 (corresponding to NAFTA, 1994).

comparison of treatment and control industries around a tariff cut in our sample and contrast it with the magnitudes reported by Fresard and Valta (2016).

[Insert Figure 3 about here]

We match firms that experienced large tariff reductions (treated firms) to firms that have not experienced large tariff reductions (control firms) using propensity score matching (PSM), and select matched firms based on firm characteristics one year preceding the events. Specifically, for each treated firm, we select, with replacement, its nearest neighbor from the group of all the firms that operate in a different SIC code industry during the same year. Our matching variables follow Fresard and Valta (2016), who conduct matching based on assets, market-to-book ratio, leverage, cash holdings, and cash flow. We apply the following filtering criteria. First, control firms cannot be treated the three-year period leading up to and following the event. Second, control firms must have valid observations one-year prior to and following the event. Third and finally, the difference in the PSM score cannot exceed 0.1. We have 1,250 treated firm-year observations matched to 1,250 control firm-year observations. We present the descriptive statistics of key matching for treatment and control firms in Panel A of Table 6. The table highlights that treatment and control firms are comparable with the difference in all firm characteristics not being statistically different.

[Insert Table 6 about here]

With respect to our empirical design, we define a dummy variable, denoted as *Cut*, which equals to one if a given industry has experienced a tariff cut by time *t*. The regression model is estimated as follows:

$$Ln\left(1 + TM_{i,j,t}\right) = \alpha + \beta Cut_{i,t} + \gamma X_{i,t-1} + \theta Year_t + \lambda Firm_i + \varepsilon_{i,j,t} \quad (2)$$

We present our DID regression results in Panel B of Table 6. The main result from equation (2) is presented in column (1). Specifically, the coefficient estimate on *Cut* is negative and significant at the 5% level, suggesting that a large cut in the tariff rate, which subsequently results in a substantial increase in import competition, is negatively associated with future trademark creation. This result further supports the notion that the negative association between import competition and product trademark creation reported in Table 3 is causal. Next, we replicate the methodology from column (1). However, we create additional indicator variables which capture the time point with respect to the large tariff cut. For example, the variable $Year^{-3}$ is equal to one for a treatment firm three years prior to the large tariff cut and zero otherwise. The variable $Year^{+3}$ is equal to one for a treatment firm three years after the large tariff cut and zero otherwise. The results presented in column (2) of Table 6, Panel B, further highlight the negative effect that large tariff reductions have on product trademark creation. In particular, we find that product trademarks decrease following the tariff cuts, with no decrease observed in the period preceding the tariff cut.

5. Cross-sectional analysis

In this section, we examine the effect that various industry and firm characteristics have on the association between import competition and trademark creation. Specifically, we are interested in whether firms in more competitive environments, firms with higher financial constraints, and firms with weaker risk-taking incentives have a greater proclivity to respond to foreign competition by reducing new product development. We present our partitioning results in Table 7. The results are based on the parsimonious OLS model specification from Table 3, although we only present the coefficient estimates on *ImpPen* as well as the difference in coefficients between the high and low sub-samples.

[Insert Table 7 about here]

5.1. Competitive environment

In this sub-section, we examine the effect that a firm's competitive environment has on the way in which it adjusts its trademarking activity to changes in import competition. A number of recent papers show that the competitive environment is a substitute for internal governance mechanisms (Dasgupta et al., 2017; Chhaocharia et al., 2017; Grullon et al., 2018). If foreign competition influenced corporate product market strategy by inducing lower risk-aversion, one would expect to observe a stronger effect in industries where the domestic competitive environment is weaker. The marginal influence on product market strategies should be weaker in industries where firms are already exposed to a fierce competitive environment.

We partition our sample on industry concentration. Specifically, we construct two measures of industry concentration. *Compustat HHI* is Herfindahl-Hirschman index computed using Compustat sales. *Census HHI* is Herfindahl-Hirschman index from U.S. Census Bureau at the U.S. Department of Commerce. A firm operates in a high (low) competitive environment if its *Compustat HHI* or *Census HHI* is lower (higher) than the sample median. We find that the negative association between import penetration and product trademark creation only holds in the sub-sample of firms that are exposed to low levels of competition. Specifically, in Panel A test A.1, we find that the coefficient estimate on *ImpPen* is negative and significant in the low competition sub-sample, while not significant in the high competition sub-sample. We find consistent results in test A.2. Our results are consistent with the view that foreign competition has the potential to influence firm's strategic investment decisions by affecting the governance environment and inducing greater risk-aversion.

5.2. Financial constraints

In this subsection, we examine the effect that financial constraints have on the association between import competition and product trademark creation. Financial constraints have a significant constraining effect on corporate investment (Campello, Graham, and Harvey, 2010), meaning that financially constrained firms are plausibly less capable of investing in new product development. Prior studies show that foreign competition can reduce firms' profits (Xu, 2012) and weaken their ability to invest (Dasgupta and Stiglitz, 1980). Since foreign competition is expected to reduce firms' available resources for new product creation, one would expect to observe a stronger negative association between foreign competition and product trademarks among firms that have low financial constraints. In contrast, firms with high financial constraints are expected to be significantly constrained from investing in new product development, with foreign competition having only a marginal effect on such firms.

For the purposes of testing the effect that financial constraints have on the association between import competition and product trademark creation, we utilize the Whited and Wu (2006) and Hadlock and Pierce (2010) proxies of financial constraints. We define a firm to be financially constrained when their financial constraint index is above the sample median, and not constrained otherwise.

The results presented in Panel B of Table 7, reveal that financial constraints are a strong determinant of the association between import competition and product trademark creation. For both measures of financial constraints employed in Panel C, we find that the negative association between import competition and product trademark creation only hold amongst the sample of firms that are financially unconstrained. In both tests, the coefficient estimate on *ImpPen* is negative and significant in the low financial constraints subsample and not statistically significant in the high financial constraints subsample. The difference between the coefficients is statistically significant in both tests.

5.3. Managerial risk-taking incentives

In this sub-section, we examine the effect that managerial risk-taking incentives have on the baseline relation between foreign competition and product trademark creation. Managerial risk-taking incentives are a key channel through which we argue foreign competition can affect new product creation. Following prior literature, we use CEO remuneration sensitivity to stock price volatility and the amount of unvested options as our proxy of managerial risk-taking incentives. These proxies of risk-taking incentives is informed by standard principal-agent models where CEOs are assumed to be averse to exercising effort and to assume risk (Hirshleifer and Suh, 1991; Manso, 2011), with convex CEO incentives mitigating such problems. We partition the sample according to amount of unvested options, and define the high-risk taking sample as the sample of firms with above median amounts of unvested options, and vice versa.

Our results, presented in Panel C of Table 7, indicate that risk-taking incentives are an important moderating variable. Specifically, we find that the association between foreign competition and product trademarks creation in the high risk-taking sub-sample is positive and significant, whereas the association is negative and significant only in the low risk-taking sub-sample. These findings are consistent with our basic argument that foreign competition induces excess risk-aversion from executives. In the absence of remuneration incentives overcoming this risk-aversion, foreign competition induces reduced activity with respect to developing new products.

6. Further Analysis

6.1. Import penetration from high and low wage countries

We first examine whether the negative association between foreign competition and product trademark creation documented in the baseline results is predominantly driven by competition from low-wage or high-wage countries. This is an important question since Li and Zhou (2017) find that firms adopt different innovative strategies when facing foreign competition from high-wage countries and low-wage countries. Specifically, they find that foreign competition from high wage countries intensifies firms' innovative activities, while foreign competition from low wage countries discourages firms' innovative activities. Likewise, Aghion et al. (2014) documents an increase in R&D expenditure primarily by firms exposed to 'neck-and-neck' competition. These findings highlight the importance of the origin of foreign competition in affecting firms' incentives to innovate.

To address this issue, we first calculate import penetration by high-wage countries (*ImpPen HWC*) and low-wage countries (*ImpPen LWC)* separately as well as import penetration from China

(*ImpPen China)* and countries other than China (*ImpPen Others*), and then re-estimate the baseline regression. We present our results in Table 8. In column (1), we present the results after differentiating import competition into import competition from high- and low-wage countries. In column (2), we present the results after differentiating import competition into import competition from China and import competition from outside China.

[Insert Table 8 about here]

The results presented in Table 8, reveal a negative and significant coefficient on *ImpPen HWC* and an insignificant coefficient on *ImpPen LWC*. In column (2), we find a negative and significant coefficient on *ImpPen Others* and an insignificant coefficient on *ImpPen China*. The findings suggest that firms reduce their trademarks in reaction to competition from high-wage countries, but their trademarking activities are not affected by import competition from low-wage countries, even competition from China.

The results in Table 8 suggests that competition from low-wage countries has no perceptible effect on firm's product market strategies. In contrast, competition from 'neck-and-neck' competitors from high-wage countries results in a reduction in new product creation, presumably due to a focusing of product market strategies. In the following sub-sections we explore the association between foreign competition and firms' trademarking quality and breadth.

6.2. Foreign competition and product trademarking quality

In this section we examine the differential effect that foreign competition has on trademark quality. Specifically, we are interested in whether import competition induced reductions in trademark activity reflect cuts in high- or low-value trademark creation. We report our results in Table 9. The model specification is identical to that in Table 3, except that our dependent variables now capture the number of low-value trademarks ($Ln(1+PrdTM_{low})$ as well as the number of high-value trademarks ($Ln(1+(PrdTM_{high})$. As discussed in sub-section 3.1, we define low and high value trademarks based on trademark renewal, citations, and market reaction.

[Insert Table 9 about here]

The results presented in Table 9 reveal that import penetration primarily reduces the number of low-value trademarks, without having any statistically significant effect on the number of high-value trademarks. Specifically, in column (1) of Table 9, where the dependent variable is $Ln(1+PrdTM_{low})$, the coefficient on *ImpPen* is negative and significant at the 1% level. In contrast, in column (2), where the dependent variable is $Ln(1+PrdTM_{high})$, the coefficient estimate on

ImpPen is not statistically significant. We observe consistent results using alternate schemed to define trademark quality, presented in columns (3) to (6).

The results presented in Table 9 are instructive, as they illustrate the disciplining effect of foreign competition. Although the results presented up to this point suggest that import penetration has a negative effect on firms' development of new products, the results in Table 9 highlight that this is not necessary the case. Instead, it appears that import competition reduces the creation of low-value trademarks while not affecting the creation of high-value trademarks. Our results indicate that import competition forces firms to be more focused and ensure that their resources are not allocated towards the production of low value products.

6.3. Foreign competition and product trademarking strategy

In this final sub-section, we examine the effect foreign competition has on trademark strategy. In particular, we are interested in whether foreign competition narrows or broadens the scope of firms' product creation. Towards this goal, we examine the association between foreign competition with trademark diversity ($Diversity_{nclass}$ and $Diversity_{hhi}$) and trademarks in old/new technology classes (*Ln*(1+*OldTech*) and *Ln*(1+*NewTech*)). These variables are defined in sub-section 3.1. We report our results in Table 10, which are based on the model specification from Table 3 with the exception that the dependent variables now capture trademark breadth.

[Insert Table 10 about here]

The results presented ion Table 10 reveal that foreign competition is associated with a narrower product market strategy. Specifically, in columns (1) and (2) of Table 10, we observe a negative association between foreign competition and trademark diversity. This result implies that companies exposed to greater foreign competition leads to firms filing for trademarks across a narrower range of technology classes.

In columns (3) and (4), we examine whether foreign competition affects the mix between new products that are in old technology classes versus new technology classes. In column (3) our dependent variable is the natural logarithm of one plus the number of trademarks in new technology classes, and in column (4) our dependent variable is the natural logarithm of one plus the number of trademarks in old technology classes. Our results show that foreign competition reduces the number of trademarks in old technology classes, while the number of trademarks in new technology classes is unaffected. This result is consistent with the findings in Table 9, which highlight that firms sacrifice low-value trademarks in the first instance.

Overall, the results presented in Table 10 suggest that firms follow a narrower trademarking strategy when faced with greater foreign competition. Specifically, firms develop fewer products, and the products which are developed range across a narrower range of technology classes (ie. products are less diverse). However, new products are not necessarily more exploitative, since firms seem to cut back on duplicate products in the same technology class as products released in the past.

7. Conclusion

Using a comprehensive trademark database to proxy for product line development amongst a sample of U.S. publicly listed manufacturing firms, we document a negative association between import competition and product line development. Our baseline results are robust and economically meaningful. The results are not sensitive to alternate model specifications which account for endogeneity concerns. The baseline results hold most strongly among firms operating in relatively uncompetitive environments, among firms with low financial constraints, and in firms with low risk-taking incentives. Our baseline results are consistent with the notion that foreign competition induces greater corporate risk-aversion through the monitoring channel, which acts as a disincentive from investing in risky, yet necessary, product market innovation.

Further analysis reveals that the negative association between foreign competition and new product creation is entirely driven by competition from high-wage, as opposed to low-wage, countries. Furthermore, import competition from China has no perceptible effect on the baseline results. With respect to product quality and breadth, we find that foreign competition reduces the breadth new products while also increasing the relative quality of new products. Specifically, firms produce fewer low-value products, and new products are less likely to be similar to products developed by the firm in the past. At the same time, firms' tend to release a less diverse range of products each year. Overall, our results suggest that foreign competition induces firms to be more disciplined and conservative with their product market strategy. While this results in fewer and less diverse products being released, these products tend to be less exploitative and of higher value. Our paper highlights the nuanced ways in which foreign competition affects corporate product market strategies.

Appendix A: Robustness checks

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *TotTM* is total number of trademarks filed and eventually registered. *PrdTM* is the number of product trademarks filed and eventually registered. $TotTM_{t\ to\ t+2}$ is total number of trademarks filed and eventually registered from year t to year t+2. $PrdTM_{t\ to\ t+2}$ is the number of product trademarks filed and eventually registered from year t to year t+2. *ImpPen* is the import penetration ratio which is defined as imports over domestic consumption. All regressions include the same control variables as those in Table 3, but their coefficients are not tabulated. Detailed variable definitions are in the legend of Table 3. The *t*- or *z*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic-consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

(a): *Negative binomial regressions with firm fixed effects* (N_{TotTm} = 32,658; N_{PrdTM} = 32,081)		
	TotTM	*PrdTM*
ImpPen	-0.191***	-0.213***
	(-3.3)	(-3.5)
(b): *Post* 1989 (N = 25,346)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.160***	-0.160***
	(-2.7)	(-2.7)
(c): *Trademark filed from year t to t*+2 (N = 42,055)		
	$Ln(1+TotTM_{t\ to\ t+2})$	$Ln(1+PrdTM_{t\ to\ t+2})$
ImpPen	-0.273***	-0.273***
	(-2.9)	(-2.9)
(d): *Import penetration in SIC*3 (N_{TotTm} = 41,541; N_{PrdTM} = 42,055)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.163**	-0.160**
	(-2.3)	(-2.2)
(e): *Control for industry-year fixed effects* (N = 42,055)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.144**	-0.154***
	(-2.3)	(-2.7)
(f): *Examine non-linear relation* (N = 42,055)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.307**	-0.286**
	(-2.2)	(-2.1)
$ImpPen^2$	0.156	0.128
	(1.1)	(1.0)

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Figure 1: US Trade with the rest of the world

This figure shows the time series of the total trade that the US conducts with the rest of the world. International trade is represented as total trade (imports plus exports) as well as the total trade to GDP in percentage terms.

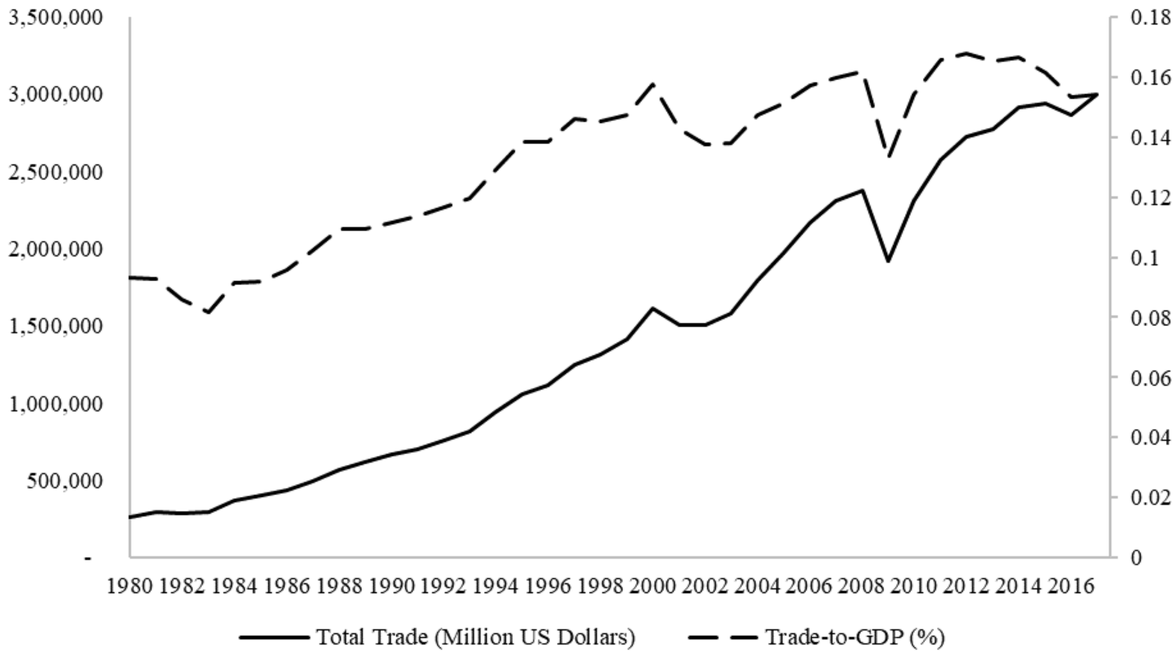

Figure 2: Trademarks and patents across industries

The figure shows average number of trademark filed and eventually registered and number of patents granted across 2-digit SIC. The vertical axis denotes the average number of trademark filed and eventually registered. The horizontal axis denotes the names of 2-digit SIC. *PrdTM* is the average number of product trademarks filed and eventually registered for each 2-digit SIC. *MktTM* is the average number of marketing trademarks filed and eventually registered for each 2-digit SIC. *Patent* is the average number of patents granted for each 2-digit SIC industry.

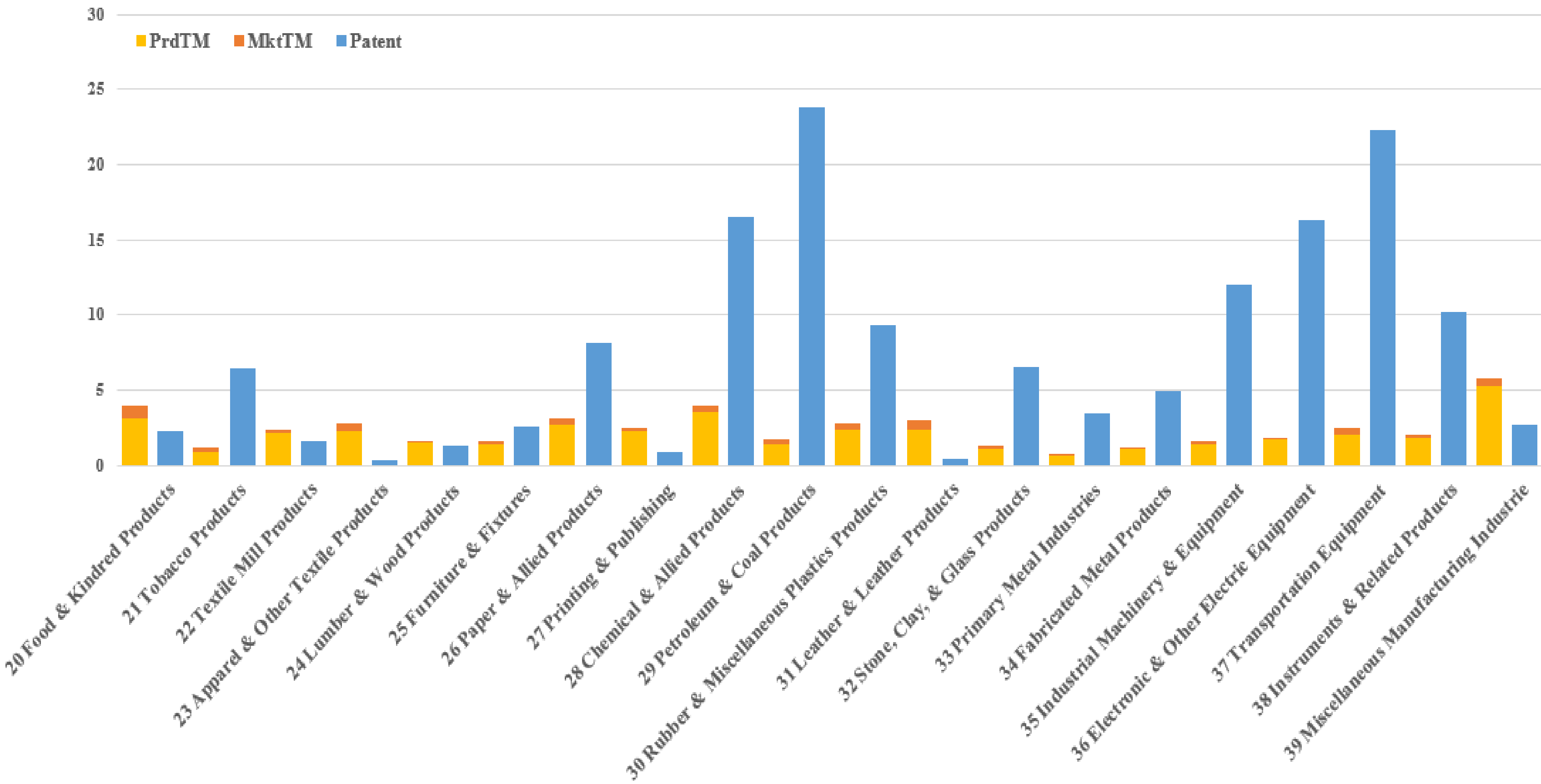

Figure 3: Large Tariff Reductions: Comparison with Fresard and Valta (2016)
The figure shows the magnitude of the reduction in tariff rates around a large tariff cut for treatment (blue line) and control (red line) industries. Data from our sample is reported on the left hand side, while data from Fresard and Valta (2016) is reported on the left hand side.

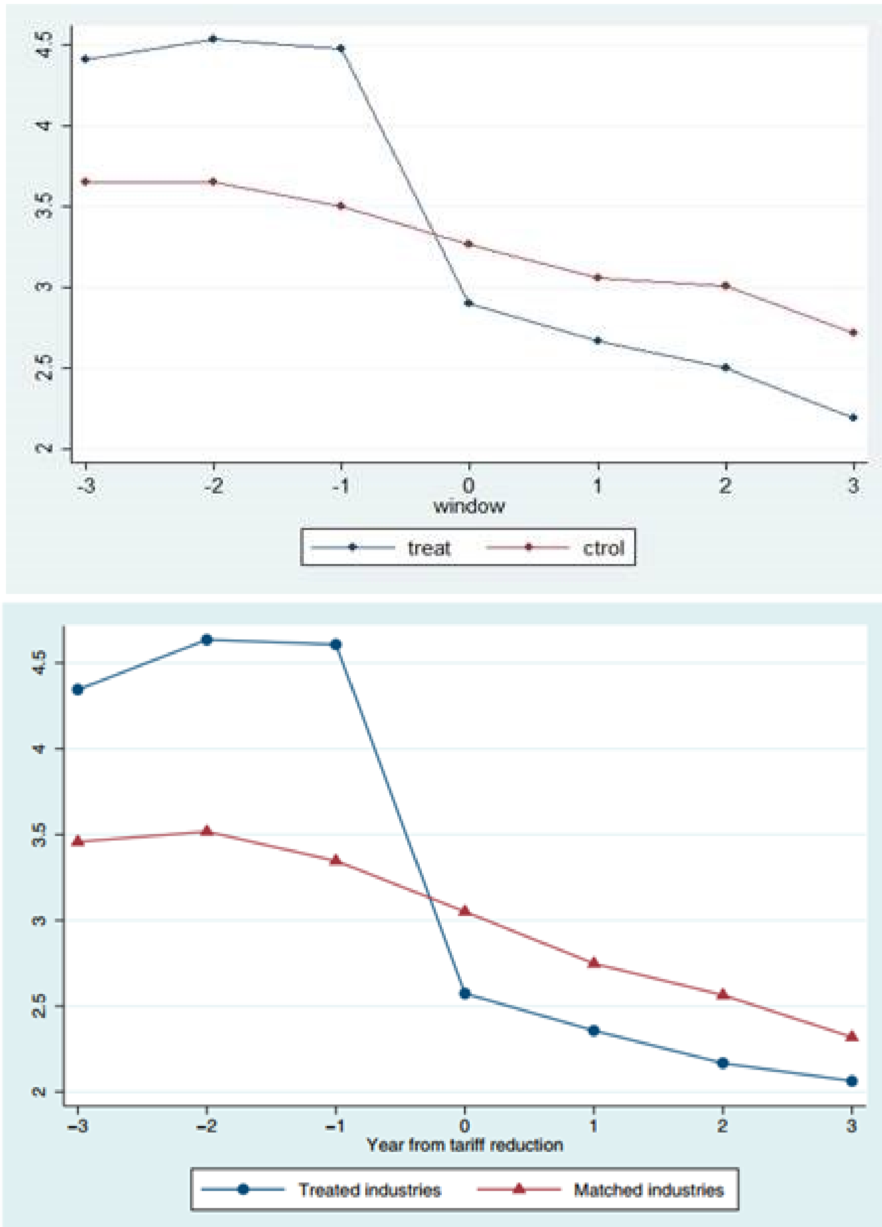

Table 1: Descriptive statistics

The sample consists of firms jointly covered by the United States Patent and Trademark Office (USPTO) Trademark Case File Database (TCFD), the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *Panel A* is summary statistics. *TotTM* is total number of trademarks filed and eventually registered. *PrdTM* is the number of product trademarks filed and eventually registered. *MktTM* is the number of marketing trademarks filed and eventually registered. *ImpPen* is the import penetration ratio, which is defined as imports over domestic consumption. *Advertising/Assets* is advertising expenses scaled by total assets. *R&D/Assets* is R&D expenses scaled by total assets. *Ln* (*Assets*) is the natural logarithm of assets. *MB* is the market-to-book ratio. *Sales Growth* is the log of one plus the change in net sales scaled by lagged net sales. *Tangibility is* property, plant and equipment divided by total assets. *Leverage* is total debt over total assets. *Cash/Assets* is cash-to-assets ratio. *ROA* is return on assets. *Capex* is capital expenditure scaled by lagged total assets. *HHI* is the concentration ratio from the Compustat.

Summary statistics					
Variables	Mean	SD	Q1	Median	Q3
Panel A: *Trademark measures* (*N*= 42,055)					
TM	2.430	8.312	0.000	0.000	2.000
Ln(1+*TM*)	0.589	0.863	0.000	0.000	1.099
PrdTM	2.121	7.437	0.000	0.000	2.000
Ln(1+*PrdTM*)	0.546	0.823	0.000	0.000	1.099
MktTM	0.309	1.557	0.000	0.000	0.000
Ln(1+*MktTM*)	0.121	0.332	0.000	0.000	0.000
Panel B: *Explanatory variables* (*N* = 42,055)					
ImpPen	0.211	0.211	0.057	0.145	0.287
Advertising/Assets	0.014	0.034	0.000	0.000	0.013
R&D/Assets	0.044	0.099	0.000	0.012	0.045
Ln(*Assets*)	5.732	2.251	4.089	5.64	7.352
MB	2.751	4.488	0.964	1.611	2.801
SalesGrowth	0.063	0.37	-0.033	0.072	0.177
Tangibility	0.282	0.174	0.152	0.257	0.383
Leverage	0.221	0.167	0.082	0.209	0.329
Cash/Assets	0.142	0.185	0.023	0.069	0.182
ROA	0.047	0.228	0.027	0.087	0.141
Capex	0.07	0.075	0.026	0.049	0.086
HHI	0.377	0.266	0.163	0.312	0.514

Table 2: Sample distribution by industry

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *TotTM* is the average total number of trademarks filed and eventually registered within each 2-digit SIC. *PrdTM* is the average number of product trademarks filed and eventually registered within 2-digit SIC. *MktTM* is average number of marketing trademarks filed and eventually registered for each 2-digit SIC. *Patent* is average number of patents granted for each 2-digit SIC. *ImpPen* is the average natural import penetration ratio for each 2-digit SIC.

		(1)	(2)	(3)	(4)	(5)	(6)
SIC	SIC description	N	*TotTM*	*PrdTM*	*MktTM*	*Patent*	*ImpPen*
20	Food & Kindred Products	2,792	3.952	3.094	0.857	2.258	0.080
21	Tobacco Products	267	1.232	0.888	0.345	6.446	0.030
22	Textile Mill Products	641	2.359	2.154	0.204	1.621	0.129
23	Apparel & Other Textile Products	1,019	2.739	2.251	0.488	0.348	0.326
24	Lumber & Wood Products	749	1.642	1.489	0.154	1.287	0.117
25	Furniture & Fixtures	560	1.566	1.432	0.134	2.561	0.091
26	Paper & Allied Products	1,049	3.088	2.694	0.394	8.197	0.190
27	Printing & Publishing	1,228	2.438	2.212	0.226	0.858	0.026
28	Chemical & Allied Products	6,176	3.984	3.517	0.467	16.560	0.144
29	Petroleum & Coal Products	1,033	1.716	1.409	0.307	23.855	0.089
30	Rubber & Miscellaneous Plastics Products	797	2.763	2.391	0.371	9.351	0.170
31	Leather & Leather Products	552	2.995	2.370	0.625	0.397	0.516
32	Stone, Clay, & Glass Products	1,042	1.238	1.110	0.128	6.503	0.099
33	Primary Metal Industries	1,836	0.742	0.647	0.095	3.442	0.209
34	Fabricated Metal Products	2,494	1.204	1.088	0.117	4.955	0.123
35	Industrial Machinery & Equipment	4,991	1.583	1.390	0.193	12.038	0.271
36	Electronic & Other Electric Equipment	6,659	1.833	1.673	0.160	16.261	0.348
37	Transportation Equipment	2,787	2.488	2.084	0.404	22.344	0.214
38	Instruments & Related Products	4,221	2.030	1.842	0.188	10.163	0.225
39	Miscellaneous Manufacturing Industry	1,162	5.760	5.247	0.513	2.707	0.380

Table 3: Import penetration and trademark registration

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *TotTM* is total number of trademarks filed and eventually registered. *PrdTM* is the number of product trademarks filed and eventually registered. *ImpPen* is the import penetration ratio, which is defined as imports over domestic consumption. *Advertising/Assets* is advertising expenses scaled by total assets. *R&D/Assets* is R&D expenses scaled by total assets. *Ln*(*Assets*) is the natural logarithm of assets. *MB* is the market-to-book ratio. *SalesGrowth* is the natural logarithm of one plus the change in net sales scaled by lagged net sales. *Tangibility* is property, plant and equipment divided by total assets. *Leverage* is total debt over total assets. *Cash/Assets* is cash-to-assets ratio. *ROA* is return on assets. *Capex* is capital expenditure scaled by lagged total assets. *HHI* is the concentration ratio from the Compustat. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic-consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	*Ln*(1+*TotTM*) (1)	*Ln*(1+*PrdTM*) (2)	*Ln*(1+*MktTM*) (3)
ImpPen	-0.172***	-0.175***	-0.022
	(-3.0)	(-3.1)	(-0.8)
Advertising/Assets	0.114	0.061	-0.022
	(0.3)	(0.2)	(-0.1)
R&D/Assets	0.166**	0.150**	0.090**
	(2.4)	(2.0)	(2.3)
Ln(*Assets*)	0.128***	0.119***	0.039***
	(8.7)	(7.8)	(8.0)
MB	0.004***	0.004***	0.002**
	(4.1)	(3.9)	(2.4)
SalesGrowth	0.026***	0.024***	0.008**
	(2.9)	(2.8)	(2.5)
Tangibility	-0.124**	-0.124**	-0.053*
	(-2.1)	(-2.1)	(-1.8)
Leverage	-0.100*	-0.096*	0.003
	(-1.9)	(-1.8)	(0.2)
Cash/Assets	-0.034	-0.038	-0.017
	(-0.9)	(-1.1)	(-1.0)
ROA	0.007	0.001	0.022**
	(0.3)	(0.0)	(2.1)
Capex	0.091*	0.069	0.044*
	(1.8)	(1.5)	(1.8)
HHI	-0.023	-0.020	-0.006
	(-0.5)	(-0.5)	(-0.3)
Year and firm fixed effects	Yes	Yes	Yes
Observation	42,055	42,055	42,055
R-squared	0.68	0.67	0.43

Table 4: Additional control variables

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *TotTM* is total number of trademarks registration. *PrdTM* is the number of product trademarks registration. *ImpPen* is the import penetration ratio, which is defined as imports over domestic consumption. *PastTotTM* is total number of trademarks filed and eventually registered in the previous year. *PastPrdTM* is total number of product trademarks filed and eventually registered in previous year. *StockTotTM* is total number of active trademarks held by firm. *StockPrdTM* is total number of active product trademarks held by firm. *Lnpat* is natural logarithm of patent granted. *IO* is institutional ownership. *StockReturn* is accumulated monthly stock returns in year t-1. *StockVolatility* is monthly stock return volatility during year t-1. All regressions include the same control variables as those in Table 3, but their coefficients are not tabulated. Detailed variable definitions are in the legend of Table 3. The *t*- or *z*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic-consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

(a): *Control for past trademark application* (N = 42,055)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.142***	-0.144***
	(-3.1)	(-3.2)
PastTotTM	0.234***	
	(16.0)	
PastPrdTM		0.231***
		(15.7)
(b): *Control for active trademark stock* ($N_{Ln(1+TotTm)}$ = 41,080; $N_{Ln(1+PrdTM)}$ = 40,388)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.178***	-0.180***
	(-3.1)	(-3.2)
StockTotTM	0.065***	
	(4.1)	
StockPrdTM		0.067***
		(4.2)
(c): *Control for patent granted* (N = 42,055)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.197***	-0.199***
	(-3.4)	(-3.6)
Lnpat	0.084***	0.081***
	(8.2)	(8.2)
(d): *Control for institutional ownership* (N = 42,055)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.172***	-0.175***
	(-3.0)	(-3.1)
IO	-0.044	-0.037
	(-1.0)	(-0.9)
(e): *Control for stock return and stock volatility* (N = 37,135)		
	Ln(1+*TotTM*)	*Ln*(1+*PrdTM*)
ImpPen	-0.186***	-0.189***
	(-3.0)	(-3.2)
StockReturn	0.005	0.003
	(0.9)	(0.6)
StockVolatility	-0.467***	-0.407**
	(-2.9)	(-2.6)

Table 5: The instrumental variable approach

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. This table summarizes results from the IV regressions. *PrdTM* is the number of product trademarks registration. *ImpPen* is the import penetration ratio which is defined as imports over domestic consumption. Column (1) reports first-stage regression results using both tariff (*Tariff*) and foreign exchange rate (*FX Index*) as instruments and Columns (2) presents second-stage regression results. The instrument variables are lagged by two years. χ^2-statistics and *p*-values are for the Anderson-Rubin test. The *F*-statistic and *p*-value in Column (1) are for the test of the null hypothesis that the coefficients on the IVs are jointly zero. The Control variables are the same as in Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	*ImpPen* (1)	*Ln*(1+*PrdTM*) (2)
ImpPen		-1.061**
		(-2.5)
Tariff	-0.008***	
	(-3.1)	
FX Index	0.042***	
	0.032	
Advertising/Assets	(0.4)	0.077
	-0.020	(0.2)
R&D/Assets	(-1.3)	0.133*
	-0.003	(1.9)
Ln(*Assets*)	(-1.0)	0.117***
	-0.001***	(7.6)
MB	(-2.7)	0.003***
	-0.002	(3.2)
SalesGrowth	(-1.5)	0.021**
	0.005	(2.6)
Tangibility	(0.2)	-0.118*
	-0.016	(-1.8)
Leverage	(-1.6)	-0.111**
	0.011	(-2.2)
Cash/Assets	(1.1)	-0.024
	-0.014*	(-0.7)
ROA	(-1.9)	-0.011
	0.011	(-0.4)
Capex	(0.9)	0.078
	-0.009	(1.6)
HHI	(-0.5)	-0.026
	0.032	(-0.6)
Year and firm fixed effects	Yes	Yes
Observation	41,485	41,485
Hansen J-statistic (*p*-value)		0.73
Weak instrument robust test		
χ^2-statistic		8.82
p-value		0.01
Test of IVs jointly equal to zero		
F-statistic	12.78	
p-value	0.00	
R-squared	0.86	0.67

Table 6: Large tariff cuts as quasi-natural experiment

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *PrdTM* is the number of product trademarks filed and eventually registered. *ImpPen* is the import penetration ratio, which is defined as imports over domestic consumption. This table presents results of the difference-in-differences tests on the effect of competition on trademark application using large tariff cuts as quasi-natural experiment. The sample comprises treated and matched firms that experience a significant import tariff reduction between 1977 and 2010. In the year before large tariff cuts, treated firms are matched with controlled firms by *Ln*(*Assets*), *MB*, *Leverage*, *Cash/Assets* and *Cash flow*. *Panel A* presents the matched results. *Panel B* shows the effect of large tariff cuts on product trademark application in column (1) and dynamics of trademark application around large tariff cuts in column (2). *Cut* is an indicator equals to one if a given industry has experienced a tariff cut at time t. $Year^{-3}$ ($Year^{-2}$, $Year^{-1}$) is a binary variable that takes value of one if a firm is treated and is three (two, one) years prior to large tariff cut events and zero otherwise. $Year^{+1}$ ($Year^{+2}$, $Year^{+3}$) is a binary variable that equals one if a firm is treated and is one (two, three) year after large tariff cut events and zero otherwise. Control variables are the same as those in Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: The matched results

Variables	N	Treated	Control	Difference	*t*-statistic
Ln (Assets)	1,250	4.96	4.96	0.00	0.02
MB	1,250	2.76	2.77	-0.01	0.05
Leverage	1,250	0.19	0.19	0.00	-0.27
Cash/Assets	1,250	0.17	0.17	0.00	0.08
Cash flow	1,250	-0.01	-0.02	0.01	-0.80
Propensity score	1,250	0.13	0.13	0.00	-0.01

Table 6: (cont'd)

Panel B: The effect of large tariff cuts on trademark applications		
Dependent variables	*Ln*(1+*PrdTM*)	*Ln*(1+*PrdTM*)
	(1)	(2)
Cut	-0.051***	
	(-3.1)	
$Year^{-3}$		-0.016
		(-0.4)
$Year^{-2}$		-0.015
		(-0.4)
$Year^{-1}$		-0.047
		(-1.4)
$Year^{+0}$		-0.081**
		(-2.5)
$Year^{+1}$		-0.084***
		(-2.8)
$Year^{+2}$		-0.070**
		(-2.4)
$Year^{+3}$		-0.069**
		(-2.2)
Advertising/Assets	0.608*	0.656*
	(2.0)	(1.9)
R&D/Assets	0.190**	0.108
	(2.1)	(1.5)
Ln(*Assets*)	0.100***	0.097***
	(6.3)	(6.3)
MB	0.001	0.002
	(0.7)	(1.0)
SalesGrowth	0.019	0.027***
	(1.6)	(2.7)
Tangibility	-0.167	-0.083
	(-1.2)	(-0.6)
Leverage	-0.091	-0.115
	(-1.1)	(-1.6)
Cash/Assets	-0.089	-0.061
	(-1.6)	(-1.0)
ROA	-0.004	0.009
	(-0.1)	(0.3)
Capex	-0.005	-0.019
	(-0.1)	(-0.3)
HHI	-0.020	-0.014
	(-0.5)	(-0.3)
Year and firm fixed effects	Yes	Yes
Observations	12,797	12,797
R-squared	0.70	0.70

Table 7: Cross-sectional difference in results

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *PrdTM* is the number of product trademarks filed and eventually registered. *ImpPen* is the import penetration ratio which is defined as imports over domestic consumption. In *Panel A*, *Compustat HHI* is Herfindahl-Hirschman index computed using Compustat sales. *Census HHI* is Herfindahl-Hirschman index from U.S. Census Bureau at the U.S. Department of Commerce. A firm operates in a high (low) competitive environment if its *Compustat HHI* or *Census HHI* is lower (higher) than the sample median. In *Panel B*, a firm is defined as financial constrained (unconstrained) if its Whited and Wu's (2006) financial constrained index or Hadlock and Pierce's (2010) index is above (below) the sample median. In *Panel C*, *CEO vega* refers to the sensitivity of CEO stock options to equity risk. *Unvested option* is the CEO's unvested stock option holdings. A firm is defined as higher (lower) risk-taking if its *CEO vega* or *unvested option* is higher (lower) than the sample median. Control variables are the same as those in Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Partitioning the sample according to competition environment		
	Low competition	High competition
A1. Partitioning the sample according to Compustat HHI ($N_{High\ competition}$ = 18,132; $N_{Low\ competition}$ = 22,969)		
ImpPen	-0.213***	-0.004
	(-3.3)	(-0.0)
Difference: High-Low	0.209***	
p-value	0.00	
A2. Partitioning the sample according to Census HHI ($N_{High\ competition}$ = 18,597; $N_{Low\ competition}$ = 18,606)		
ImpPen	-0.252***	-0.117
	(-2.8)	(-1.4)
Difference: High-Low	0.105***	
p-value	0.00	

Panel B: Partitioning the sample according to financial constrain		
	Less constrained	More constrained
B1. Partitioning the sample according to Whited and Wu index ($N_{More\ constrained}$ = 20,332; $N_{Less\ constrained}$ = 20,423)		
ImpPen	-0.199**	-0.065
	(-2.4)	(-1.2)
Difference: More-Less	0.134***	
p-value	0.00	
B2. Partitioning the sample according to Hadlock and Pierce index ($N_{More\ constrained}$ = 20,472; $N_{Less\ constrained}$ = 20,868)		
ImpPen	-0.176**	-0.057
	(-2.2)	(-1.1)
Difference: More-Less	0.119***	
p-value	0.00	

Panel C: Partitioning the sample according to risk-taking incentive		
	Low risk-taking	High risk-taking
C1 Partitioning the sample according to CEO vega ($N_{High\ risk\text{-}taking}$ = 3,005; $N_{Low\ risk\text{-}taking}$ = 2,981)		
ImpPen	-0.390***	-0.014
	(-2.6)	(-0.1)
Difference: High-Low	0.376***	
p-value	0.00	
C2. Partitioning the sample according to unvested options ($N_{High\ risk\text{-}taking}$ = 3,082; $N_{Low\ risk\text{-}taking}$ = 3,065)		
ImpPen	-0.343***	0.024
	(-2.8)	(0.1)
Difference: High-Low	0.364**	
p-value	0.02	

Table 8. The effects of import penetration from high and low wage countries

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2010. *PrdTM* is the number of product trademarks filed and eventually registered. *ImpPen HWC* is import penetration ratio calculated using imports from high wage countries. *ImpPen LWC* is the import penetration ratio calculated using imports from low wage countries. *ImpPen Others* is the import penetration ratio calculated using imports from countries other than China. *ImpPen China* is the import penetration ratio calculated using imports from China. Control variables are the same as those in Table 3. The *t*-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Dependent variables	*Ln*(1+*PrdTM*) (1)	*Ln*(1+*PrdTM*) (2)
ImpPen HWC	-0.190***	
	(-3.2)	
ImpPen LWC	-0.124	
	(-1.4)	
ImpPen Others		-0.182***
		(-2.8)
ImpPen China		-0.152
		(-1.1)
Advertising/Assets	0.021	0.061
	(0.1)	(0.2)
R&D/Assets	0.148**	0.150**
	(2.0)	(2.0)
Ln (*Assets*)	0.119***	0.119***
	(7.8)	(7.8)
MB	0.004***	0.004***
	(3.9)	(3.9)
Sales Growth	0.024***	0.024***
	(2.8)	(2.8)
Tangibility	-0.125**	-0.124**
	(-2.1)	(-2.1)
Leverage	-0.094*	-0.096*
	(-1.8)	(-1.8)
Cash/Assets	-0.039	-0.038
	(-1.1)	(-1.1)
ROA	0.001	0.001
	(0.0)	(0.0)
Capex	0.069	0.069
	(1.5)	(1.5)
HHI	-0.021	-0.020
	(-0.5)	(-0.5)
Year and firm FE	Yes	Yes
Observations	42,055	42,055
R-squared	0.67	0.67

Table 9: Import penetration and high- vs. low-quality trademarks

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2006. *ImpPen* is the import penetration ratio which is defined as imports over domestic consumption. In column (1) and (2), $PrdTM_{low}$ is the total number of product trademarks that are not renewed after 11(21) years from its registration, if the trademark is registered after (before) November 16, 1989. $PrdTM_{high}$ is the total number of product trademarks that are renewed after 11(21) years from its registration, if the trademark is registered after (before) November 16, 1989. In column (3) and (4), $PrdTM_{low}$ is the total number of product trademarks that are not cited by other trademarks registered afterwards. $PrdTM_{high}$ is the total number of product trademarks that will be cited by other trademarks registered afterwards. In column (5) and (6), $PrdTM_{low}$ is the total number of product trademarks that have negative market reaction two days before and after registration date. $PrdTM_{high}$ is the total number of product trademarks that have positive market reaction two days before and after registration date. Market reaction is computed based on market model. Control variables are the same as those in Table 3. The t-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Renewal		Citation		Market Response	
Dependent variables	*Ln*(1+$PrdTM_{Low}$)	*Ln*(1+$PrdTM_{High}$)	*Ln*(1+$PrdTM_{Low}$)	*Ln*(1+$PrdTM_{High}$)	*Ln*(1+$PrdTM_{Low}$)	*Ln*(1+$PrdTM_{High}$)
	(1)	(2)	(3)	(4)	(5)	(6)
ImpPen	-0.193**	-0.154	-0.207**	-0.091	-0.169**	-0.120
	(-2.0)	(-1.6)	(-2.3)	(-1.0)	(-2.0)	(-1.4)
Advertising/Assets	1.123	0.161	1.056	0.281	0.502	0.529
	(1.6)	(0.3)	(1.6)	(0.5)	(0.7)	(0.8)
R&D/Assets	0.405	0.170	0.185	0.505**	0.298	0.354
	(1.5)	(0.5)	(0.5)	(2.2)	(1.2)	(1.5)
Ln(*Assets*)	0.166***	0.134***	0.179***	0.099***	0.126***	0.173***
	(6.7)	(5.2)	(6.9)	(5.3)	(6.0)	(8.4)
MB	0.001	0.006**	0.002	0.005*	0.002	0.005*
	(0.4)	(2.2)	(0.7)	(1.8)	(1.0)	(1.9)
SalesGrowth	0.057*	0.072**	0.072**	0.062**	0.036	0.078**
	(1.9)	(2.4)	(2.4)	(2.4)	(1.3)	(2.3)
Tangibility	-0.226	-0.351*	-0.187	-0.370***	-0.284**	-0.258*
	(-1.6)	(-1.9)	(-1.2)	(-3.0)	(-2.1)	(-1.7)
Leverage	-0.025	0.010	-0.043	-0.013	0.022	-0.023
	(-0.2)	(0.1)	(-0.4)	(-0.2)	(0.2)	(-0.2)
Cash/Assets	-0.164*	-0.180*	-0.175**	-0.145**	-0.271***	-0.104
	(-1.9)	(-1.8)	(-2.1)	(-2.4)	(-3.6)	(-1.4)
ROA	0.238**	0.110	0.275***	0.087	0.154*	0.280***
	(2.4)	(1.4)	(2.8)	(1.3)	(1.7)	(2.9)
Capex	0.113	0.180	0.110	0.156	0.142	0.011
	(0.8)	(1.3)	(0.8)	(1.4)	(1.0)	(0.1)
HHI	0.031	0.058	0.016	0.035	-0.014	0.025
	(0.5)	(1.0)	(0.3)	(0.7)	(-0.3)	(0.4)
Year and firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,116	13,116	13,116	13,116	14,182	14,182
R-squared	0.55	0.52	0.55	0.49	0.51	0.52

Table 10: Import penetration and trademark breadth

The sample consists of firms jointly covered by the USPTO TCFD, the U.S. industry-level import and export data from Schott (2010) and the Compustat between 1977 and 2006. *ImpPen* is the import penetration ratio which is defined as imports over domestic consumption. In column (1), $Diversity_{nclass}$ is the natural logarithm of one plus the number of unique trademark classes across which trademark applications are made between *t* to *t*+2. In column (2), $Diversity_{hhi}$ is one minus the Herfindahl index based on new trademarks files by a firm from *t* to *t*+2 across the trademark classes. In column (3), *OldTech* is defined as the number of trademark applications in old technology trademark classes. Old technology classes refer to technology classes in which trademark applications have been made in the previous 10 years. In column (4) *NewTech* is defined as the number of trademark applications in new technology trademark classes. New technology classes refer to technology classes in which trademark applications have not been made in the previous 10 years. Control variables are the same as those in Table 3. The t-statistics in parentheses are calculated from the Huber/White/Sandwich heteroskedastic consistent errors, which are clustered by industry. The symbols ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Product Diversity		Exploration	
Dependent variables	*Diversity*$_{nclass}$	*Diversity*$_{hhi}$	*Ln*(1+*OldTech*)	*Ln*(1+*NewTech*)
	(1)	(2)	(3)	(4)
ImpPen	-0.152***	-0.090**	-0.211**	-0.003
	(-2.6)	(-2.5)	(-2.5)	(-0.1)
Advertising/Assets	0.696**	0.393**	0.605	-0.050
	(2.2)	(2.5)	(1.0)	(-0.2)
R&D/Assets	0.231	0.109	0.250	0.257
	(1.2)	(0.8)	(0.8)	(1.6)
Ln(*Assets*)	0.099***	0.051***	0.183***	0.032***
	(6.7)	(5.9)	(7.6)	(3.3)
MB	0.002	0.000	0.002	0.003*
	(0.9)	(0.1)	(0.9)	(1.8)
SalesGrowth	0.037**	0.026*	0.051	0.043**
	(2.1)	(1.8)	(1.5)	(2.2)
Tangibility	-0.237**	-0.083	-0.172	-0.121
	(-2.3)	(-1.4)	(-1.2)	(-1.3)
Leverage	0.025	0.015	-0.057	0.074
	(0.3)	(0.4)	(-0.5)	(1.6)
Cash/Assets	-0.089	-0.000	-0.233***	0.013
	(-1.6)	(-0.0)	(-2.9)	(0.2)
ROA	0.124**	0.068*	0.137	0.163***
	(2.4)	(1.7)	(1.6)	(2.9)
Capex	0.043	0.040	-0.030	0.204*
	(0.5)	(0.6)	(-0.2)	(1.7)
HHI	0.073**	0.039*	0.053	0.036
	(2.0)	(1.8)	(0.9)	(1.2)
Year and firm FE	Yes	Yes	Yes	Yes
Observations	12,546	12,546	15,368	15,368
R-squared	0.54	0.46	0.54	0.46