Competition and Product Development Innovation: The Case of Newly Launched Trademarks*

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Abstract

This paper examines the relationship between competition and product development innovation using the U.S. trademark database. We find that greater import competition spurs corporate product innovation measured by newly launched trademarks. However, such increase in foreign competition is associated with lower survival rate of new product trademarks. Moreover, firms tend to launch new trademarks in old and familiar areas in response to intensified import competition. We further show that the negative impact of competition on firm's future performance is mitigated by product innovation. Our main results are similar when we use common domestic competition measures. Overall, our results suggest that competitive markets can promote product innovation.

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* The usual disclaimer applies.

1. Introduction

Innovation is one of the most important drives of economic growth (Porter, 1992; Romer, 1990; Solow, 1957). A large literature in economics has studied the interaction between product market competition and corporate innovation in the past few decades. However, there is no consensus as to how competition would affect innovation in either the theoretical or empirical work.[1] Several recent papers utilize the arguably exogenous trade-liberalization events to explore the impact of foreign competition on domestic innovation. And yet, the results are still mixed, especially for developed countries like the United States (Xu and Gong, 2017; Autor, Dorn, Hanson Pisano, and Shu, 2016; Chakravorty, Liu, and Tang, 2017; Lie and Yang, 2017). In this paper, we re-investigate the impact of competition on innovation by focusing on US firms' product development innovation.

The *Oslo* Manual defines product innovation as the introduction of goods or service that is new or significantly improved.[2] Since the commercialization of new products is often associated with the creation of a new trademark, studies in economics suggest that trademarks can be used as a measure of product innovations (Lev, 1999; Schmoch, 2003, Mendonça, Pereira, and Godinho, 2004; Malmberg, 2005; Millot, 2009; Sandner and Block, 2011). A trademark is any sign (a word, a logo, a phrase, etc.) used to distinguish goods or services produced by a firm from those of competing firms (Landes and Posner, 1987; Besen and Raskind, 1991). It thus captures the launch, continuation, and termination of product lines. Since most technological innovation cannot influence firm performance until they have gone through the commercialization process (Katila, 2002; Mendonça et al., 2004), trademarks can reflect the commercial aspect of innovations. They allow consumers to be aware of the new products and firms to secure the benefits of their early innovation (Schmoch, 2003; Mendonça

[1] See Gilbert (2006) and Cohen (2010) for literature review.

[2] The *Oslo* Manual is published by the Organization for Economic Co-operation and Development and contains the reference guidelines for collecting and using data on industrial innovation.

et al., 2004; Malmberg, 2005). Moreover, trademarks are important for non-technological innovations, where patents are not applicable as a means of intellectual property (IP) protection (Millot, 2009). Therefore, in this paper, we use trademarks to measure firms' product development innovation.

To examine the relation between competition and product innovation, we first explore how increased import competition affects firms' newly launched trademarks. Using import penetration as a measure of foreign competition, we find a significant positive association between foreign competition and the number of new trademarks filed by US manufacturing firms. The results are robust to an instrumental variable approach, where import penetration is instrumented by foreign exchange rates (Bertrand, 2004; Xu, 2012). We further confirm the positive relation using the United States granting Permanent Normal Trade Relations (PNTR) to China in October 2000 as an exogenous shock to foreign competition.

We then examine the eventual success rate of these new products by tracking the renewal status of each trademark. We find that foreign competition is negatively associated with the survival rate of newly filed trademarks, suggesting that firms facing greater competition launch more new products, but these new products are more likely to be abandoned in the future. We further examine the diversity of a firm's new trademarks using the number of unique product/service classes covered by its trademark portfolio. We find that trademark diversity is lower for firms facing greater import competition. Moreover, firms tend to launch new products in familiar areas in response to intensified import competition. Additionally, we study the impact of competition, product trademark and their interaction on firm performance. We find that product innovation mitigates the negative effect of competition on firm performance.

Finally, we use alternative measures of competition and product innovation and find consistent results. Specifically, using domestic product market competition measures, we again find that product market competition increases product innovation. The results are also supported by difference-in-differences regressions based on industry deregulation. Additionally, using the number of new product announcements as an alternative proxy for product innovation, we find consistent results.

Our paper contributes to the literature that examine the relation between product market competition and firm decisions, and those that examine the determinants of innovation. In particular, our paper adds to the literature on competition and innovation. Schumpeter (1942) argues that competition decreases innovation, while Arrow (1962), in contrast, predicts that more competition spurs innovation. Boone (2001) and Aghion et al (2005) later argue that the relation between competition and innovation should be non-linear. The empirical evidence is also equivocal (Nickell, 1996; Blundell, Griffiths, and Van Reenen, 1999; Bloom, Draca, and Van Reenen, 2016; Aghion, et al 2005; Correa and Ornaghi, 2014). There are several papers focusing on the impact of foreign competition on innovation-related outcomes in the United States, and the evidence is again inconclusive. Using patent as a measure of innovation, Hashmi (2013), Xu and Gong (2017) and Autor et al. (2016) show that foreign competition curtails U.S. innovation, while Chakravorty et al. (2017) find some positive impact of import competition on US citation-weight patents. Relatedly, Hombert and Matray (2018) find that U.S. firms with large R&D stocks mitigate the negative impact of import competition through product differentiation. We contribute to the literature by examining the impact of import competition on product innovation in the U.S., using a novel measure of innovative activities. Consistent with a competitive market response, we find that competition increases new product introduction in the U.S. private sector. Our evidence also suggests that trademarks are likely to contain innovation-related information that is not fully captured by patents.

The remainder of the paper proceeds as follows. Section 2 describes trademarks basis and discusses the measure of product development innovation. Section 3 describes data, sample construction and our empirical design. Section 4 presents the empirical results. Section 5 concludes this paper.

2. Trademark and product development innovation

2.1 Trademark basis

In the U.S., the trademark system was first attempted to establish a federal trademark regime in 1870. According to the USPTO, a trademark is generally a sign that identifies and distinguishes goods or services produced by a firm from those of competing firms. To file a trademark, the applicant needs to select the appropriate content of the mark which is required to be unique and non-generic.[3] Meanwhile, the applicant needs to specify the trademark class. A trademark can be filed in one or more goods-and-services classes, which define the scope of trademark protection.[4] Another requirement for a successful trademark application is evidence of its actual use in commerce. Specifically, the applicant is obligated to provide evidence to prove that the new trademark is indeed in commercial use within a six-month period. Once approved, the trademark is registered and disclosed in the Official Gazette, a weekly publication by the USPTO.[5]

After registration, trademark owners must maintain the trademarks in the sixth year from registration dates and renew the trademarks every 10 years from registration dates.[6] The maintenance and renewal process also require owners to prove that the trademark is still used

[3] For the trademark contents, uniqueness requires no prior registration with the same content in the same class, and non-generic requires the mark itself be more arbitrary and less descriptive.
[4] There are 45 product/service classes according to the international NICE classification and 60 classes according to the U.S. trademark classification. The current cost of applying for a trademark is $225 per class of goods/services. According to Graham et al. (2013), 86.5% of trademark applications are registered in a single class.
[5] After a trademark is registered, the firm can use the ® symbol with their trademark and obtain legal trademark protection.
[6] The renewal frequency was 20 years prior to November 1989. After the enactment of Trademark Law Revision Act of 1988, the renewal frequency was reduced to 10 years thereafter.

in commerce and pay the fee on time; otherwise, the trademarks will be cancelled. Firms can maintain permanent ownership of their trademarks if the trademarks are successfully renewed in the sixth year from registration, as well as every ten years from registration.

Trademarks can be viewed as commercial links between companies and consumers that allow companies to transmit information. In particular, trademarks allow a company to build its reputation and get benefit from customer loyalty by preventing other competitors from using similar marks that would otherwise confuse customers (Millot, 2009). Furthermore, trademark could signal both origin and quality of the product and help consumers differentiate among competing products and thus reduce search costs (Graham et al., 2013).

2.2 Trademark as a proxy for product development innovation

According to Bereskin, Hsu, Na and Rotenberg (2018), it is common in the literature to use new trademarks to proxy for a firm's introduction of new products because filing new trademark is an important part of the process of product development. A firm often registers a new trademark when it launches new product lines that are different from its existing product lines and when it targets new markets (Millot, 2009). Therefore, trademarks are one of the important markers of corporate innovation in the literature on intellectual property. Besides, trademarks capture the development of novel/distinct goods or services and are prevalent in both high- and low-patent industries (Faurel et al, 2017). Millot (2009) finds that trademark is positively correlated with R&D and the number of patents and that it does not have the drawbacks associated with the other two measures. He argues that patent and R&D are more indicators of invention than indicators of innovation because many patented inventions are never commercialized, and R&D does not reflect the technical and commercial success of innovations. Contrary to these two traditional innovation indicators, trademarks are obviously linked to the commercialization of products, as they are fundamentally used to launch new products or services on the market. More importantly, trademarks are important for non-technological innovations, where patents are not applicable as a means of IP protection. In short, trademarks are an important and separate measure of product development innovation.

3. Data, Sample, and Methodology

To construct our sample, we start with all public US firms during the period of 1962 to 2017. The starting year is chosen due to the availability of SIC industry code. From the sample we exclude firms with headquarters outside the United States and firm years that have negative sales or missing values of our main control variables. This yields a sample of 194,092 firm-year observations associated with 18,649 unique firms. Table A1 in the appendix presents our sample selection procedure.

3.1 Trademark Dataset and Measure of Product Innovation

We collect the 2018 version of trademark data from the United States Patent and Trademark Office (USPTO) Trademark Case Files Dataset. This dataset contains detailed information on 9.1 million trademark applications and registrations between January 1870 and February 2018.[7] Following the existing literature, we focus on trademark applications that are finally registered to ensure that all trademarks we consider are in actual use by the trademark assignees.

To collect firms' trademarks information in each year, we follow Hsu, Li, Liu and Wu (2017), Faurel, et al (2017) and Heath and Mace (2017). First, we generate a list of names of public US companies from CRSP/Compustat dataset and expand it by a list of their subsidiaries, which are collected from LexisNexis Corporate Affiliation.[8] Next, we match

[7] The USPTO Trademark Case Files Dataset (updated 2018) is downloaded from the USPTO website: https://www.uspto.gov/learning-and-resources/electronic-data-products/trademark-case-files-dataset-0
It includes data on trademark contents, ownership, classification, filing, registration and renewal or abandoned date, etc.
[8] LexisNexis Corporate Affiliation dataset contains details time series subsidiary information for 18,388 parent firms starts from 1993 to 2017. For the year before 1993, we use the subsidiary information in 1993 to match with the trademark.

company names with the owner names in the trademark dataset. We manually verify each match and make necessary adjustments using firms' location information. In the end, we matched 257,947 registered trademark records to 5,781 unique U.S. public companies over the sample period.

As our study focuses on a company's product innovation, we further separate a firm's trademark portfolio into product and marketing trademarks. Following Hsu, Li, Liu and Wu (2017), we classify trademarks that have no text (i.e., pure logos), or have text comprising 4 or more words (i.e., advertising slogans) as marketing trademarks. Conversely, trademarks that have text of fewer than 4 words, and the text is the first time to appear in a trademark class are classified as product trademarks (i.e., product names). Any subsequent marks with the same text in the same class are marketing trademarks (i.e., updating logos). According to this classification, 84% of the trademarks are product trademarks, which are more likely to be related to product development innovation. We then calculate the total number of new product trademarks filed by a firm and its subsidiaries from year t+1 to t+3 and from year t+1 to t+5 respectively. Since the distribution of these variables is right skewed with a median of 0, we use the natural logarithm of one plus the number of new product trademarks in our regression analysis.

3.2 Measures of Competition

Our main analysis uses *Import penetration* to proxy for foreign product market competition. We collect import related data during 1972-2005 from Peter Schott's website. Following Bertrand (2004) and Xu (2012), we compute import penetration for each 3-digit SIC industry in each year as

$$Import\ penetration = \frac{Imports}{Imports + Domestic\ production}.$$

Higher import penetration indicates greater competition from foreign producers. Due to the availability of import data, the import penetration measures are only available for manufacturing firms (i.e., two-digit SIC code range from 20 to 39).

Besides this foreign competition measure, we also employ a proxy for domestic product market competition. Specifically, we calculate the Herfindahl-Hirschman Index for each three-digit SIC industry in each year using Compustat firms. To mitigate measurement problems, we follow Valta (2012) and construct *Competition dummy*, an indicator variable equal to one if an industry's Compustat HHI is in the lowest quartile of the yearly sample distribution, and zero otherwise. *Competition dummy* equal to one indicates that firms in the industry face more domestic product market competition.

3.3 Descriptive Statistics

Table 1 presents descriptive statistics of the full sample. Detailed definitions of the variables are given in Appendix A2. To mitigate the influence of outliers, all continuous variables are winsorized at the 1st and 99th percentiles. All dollar values are adjusted to 2010 dollars. On average, a firm has 1.8 newly launched product trademarks from year *t*+1 to *t*+3, and 2.8 from year *t*+1 to *t*+5 across our sample. An average firm holds 9.2 valid product trademarks in our sample. The average values of our competition measures are also similar to the numbers in the literature (Xu, 2012; Valta, 2012). In our sample, an average firm has log sale of 5.04, log age of 2.48, M/B ratio of 2.08, log capital-labor ratio of 3.26, R&D stock (scaled by sales) of 0.45, advertising expense (scaled by sales) of 0.02, Capex (scaled by sales) of 0.13, ROA of 0.03, book leverage of 0.26, and KZ index of -8.55.

--Insert Table 1 about here--

4. Empirical Analysis

4.1 Baseline Results: Foreign Competition and Innovation

We first study the effect of foreign import competition on future product innovation by estimating the following ordinary least squares (OLS) regressions:

$$\text{Log (1+Trademark)}_{i,j} = \alpha + \beta \text{ Import penetration}_{j,t} + \gamma \text{ Controls}_{i,t} + \delta_j + \varphi_t + \varepsilon_{i,t}$$

The dependent variable is the natural logarithm of one plus the total number of new product trademarks filed by firm *i* (and its subsidiaries) in industry *j* from year *t*+1 to *t*+3 (*Trademark_3y*) or from year *t*+1 to *t*+5 (*Trademark_5y*). Following the literature (Faurel et al, 2017; Hsu, Li and Nozawa, 2018), we aggregate years *t*+1 to *t*+3 (or *t*+5) to account for the time lag between the underlying product development innovation activities of the firm and the trademarking process. Our main variable of interest is *Import penetration*, calculated as the ratio of imports to the sum of domestic production. We include a set of firm-specific controls measured in year *t*, including firm sales, firm age, M/B ratio, capital-labor ratio, R&D stock, advertising, capital expenditures, ROA, leverage, and financial constraint (*KZ index*). [9] To control for the fact that some unobserved firm or industry characteristics may affect a firm's trademarking strategies, we further include the total number of valid trademarks held by the firm (*Trademark stock*). Detailed variable definitions are provided in Appendix A2. Finally, we include industry fixed effects (two-digit SIC) to control for unobserved, time-invariant heterogeneity across industries and year fixed effects to control for intertemporal variation that may affect the relation between competition and trademarks.[10]

--Insert Table 2 about here--

[9] Following prior studies, we set the R&D and advertising to zero if they are missing.
[10] We control industry fixed effect as two-digit SIC level, the results are also robust when we control the industry effect at the three-digit SIC level.

Table 2 shows the regression results, with standard errors clustered at the firm level. The dependent variable is *Log (1+Trademark_3y)* in columns (1) and (2) and *Log (1+Trademark_5y)* in columns (3) and (4), respectively. In columns (1) and (3), we control for the total number of valid trademarks held by the firm (*Log (1+ Trademark stock)*), as well as year and industry fixed effects. Results show that import competition has a positive and statistically significant effect on firms' new product lines related trademarking activities. The coefficients on *Import penetration* are positive and statistically significant at the 1% level. In columns (2) and (4), we control for more firm characteristics and the coefficients on *Import penetration* remain positive and significant.

Turning to our control variables, we find that larger, younger, and better performing (in terms of ROA) firms and firms with higher M/B, lower leverage file more trademarks in the following years. Firms with high R&D stock, high capital and advertising expenditure and high trademark stock also have more newly filed trademarks.

Overall, the results in Table 2 suggest that firms facing fiercer import competition launch more new trademarks in the subsequent few years. This is consistent with Arrow (1962)'s argument that competitive markets promote innovation. In unreported tests, we follow Autor et al. (2018) and use the number of patents as our dependent variable. We find that the coefficient on import penetration is negative, albeit insignificant. This suggests that trademarks are likely to contain innovation-related information that is not fully captured by the number of patents.

4.2 Robustness Tests

Similar to other empirical studies, our analysis is subject to potential endogeneity concerns. Though firm level product innovation is unlikely to affect import competition, which is measured at the industry level, our results could still be affected by some omitted variables. For example, some macro factors may affect both foreign competition and firms' trademarking activities. To mitigate this concern, we adopt two empirical strategies.

First, we use instrumental variable to capture exogenous variations in import competition. The instrument we use is source-weighted average of industry foreign exchange rates (Revenga, 1992; Bertrand, 2004; Xu, 2012; Hashmi, 2013). Expressed as the amount of foreign currency per US dollar, foreign exchange rates should be positively correlated with import penetration. That is, a higher exchange rate makes the foreign good cheaper in US dollars and thus encourages imports. Moreover, as a freely floating currency, the dollar's exchange rates are primarily determined by macroeconomic factors that affect its aggregate demand and supply. Since none of these macroeconomic factors is likely to be determined by individual firm-level characteristics, our IV is likely to satisfy the exclusion restriction.

To construct the industry-level exchange rate variable, we follow Xu (2012)[11] and Hashmi (2013). Specifically, we first transform the raw exchange rates to real exchange rates using the exchanging countries' consumer price indices.[12] For each three-digit SIC industry, we compute the source-weighted average of exchange rates across all countries exporting to the US that take up 2% or more of US total imports in the base year of 1995. The weights are the share of each exporting country in total US imports in 1995.[13] Finally, we divide the adjusted exchange rates by one thousand to obtain the industry exchange rate index variable expressed in thousands.

Table 3 displays our two-stage-least-square (2SLS) results. In column (1), we present the first-stage regression result. As expected, our instrument, *Real exchange rate*, is positively

[11] Xu (2012) also uses tariff rate to instrument import penetration. However, Hashmi (2013) argues that the validity of tariff rate as an exogenous instrument is questionable: the innovation activities of firms in industry is likely to affect tariff rate. Hence, the tariff rate is likely to be correlated with the error term. Our results are unchanged if we use both tariff rate and real exchange rate as instrument variables.
[12] The raw exchange rate and consumer price index data are collected from the IMF International Financial Statistics data files.
[13] As Xu (2012) argues, using 1995 import shares is reasonable to approximate the relative importance of each country in the industry exchange rate calculation because most industries have relatively stable country distribution in the import share.

and significantly associated with *Import penetration*. The First-stage F-statistics is 80.38, and the Sanderson-Windmeijer F-statistic rejects the null of the weak instrument. In columns (2) and (3), we report the results of the second-stage regressions, with *Log (1+Trademark_3y)* and *Log (1+Trademark_5y)* as the dependent variable, respectively. The independent variable of interest in the second stage is the predicted values of *Import penetration* from the first-stage regression. We find that, after instrumentation, the coefficients on *Import penetration* are still positive and statistically significant at the 1% level. The impact is also economically significant. All else being equal, a one standard deviation increase in *Import penetration* is associated with a 16.6% and 17.3% increase in the future three and five-year flow of product development related trademarks.

--Insert Tables 3 about here--

Second, we follow Pierce and Schott (2016) and use the United States granting Permanent Normal Trade Relations (PNTR) to China as an exogenous shock to foreign competition to further pin down the causal impact of import competition on product innovation.[14] US imports from China were subject to relatively high tariff rates originally set under the Smoot-Hawley Tariff Act of 1930, known as “non-NTR” rate. Starting in 1980, the President of the United States granted an annual waiver to China after obtaining Congress approval. In October 2000, PNTR was passed by US Congress, which became effective in December 2001 upon China’s accession to the WTO. Prior literature shows that the passage of PNTR played a key role in the elimination of uncertainty for US firms, leading to a substantial reduction in expected US import tariffs on Chinese goods and thus a significant increase in Chinese import penetration (i.e., Pierce and Schott, 2016).[15]

[14] The PNTR was passed by Congress in October 2000 following the November 1999 agreement between the United States and China governing China’s eventual entry into WTO and became effective upon China’s accession to the World Trade Organization (WTO) at the end of 2001 and was implemented on January 1, 2002.
[15] China takes up less than 2% of US total imports in 1989 and this weight moves up to over 20% after 2008.

Since the NTR tariff rate varies across industries, it allows us to examine the link between PNTR and product innovation using a difference-in-differences (DID) specification. Specifically, we examine whether firms in industries facing a larger drop in expected tariffs have significantly more new trademarks after the imposition of PNTR. Following Pierce and Schott (2016), we treat years from 2001 forward as "post-PNTR" period and measure the effect of PNTR on each three-digit SIC industry using the *NTR gap*, defined as the difference between the non-NTR rate to which tariffs would have risen if annual renewal had failed and the NTR tariff rate.[16]

--Insert Tables 4 about here--

Table 4 reports the DID estimations of new product trademark filings from before to after the U.S. granting China PNTR. The dependent variable is *Log (1+Trademark_3y)* in columns (1) and (2) and *Log (1+Trademark_5y)* in columns (3) and (4). In addition to the same set of control variables as in Table 2, we also include the industry NTR tariff rates following Pierce and Schott (2016). The explanatory variable of interest is the interaction term between the *Post_PNTR* dummy and *NTR gap*. In columns (1) and (3), we estimate the DID regressions over the whole sample period. In columns (2) and (4), we follow Pierce and Schott (2016) and Hombert and Matray (2018) and estimate the regressions over the shorter period of 1990 to 2005.We find that in all regressions the estimated coefficient on *NTR gap* is insignificant. This suggests that there is no significant difference in trademark filings between the two groups of firms before the passage of NTR, which helps validate our difference-in-differences analysis. Turning to the interaction term, we find that the estimated coefficients are positive and significant in three out of four regressions, indicating that the imposition of PNTR coincides with more newly launched product trademarks.

[16] Following Pierce and Schott (2016), we use the NTR gaps at the year before the passage of PNTR in our regression (i.e., year 1999).

Taken together, our 2SLS and DID results are consistent with our OLS results. These tests help mitigate the endogeneity concern and provide us with greater confidence in our causal interpretation of the impact of import competition on product innovation.

4.3 Competition and Characteristics of New Product Trademarks

4.3.1 Competition and Trademark Survival Rate

In this section, we investigate the relation between competition and the eventual success rate of these new products. Firms facing fierce product market competition may have a higher cost of bank debt (Valta, 2012), lower profitability (Esposito and Esposito, 1971; Turner, 1980) and thus are expected to have lower product line successful rate. Therefore, we conjecture that product market competition would decrease the survival rate of newly filed product trademarks.

To examine the relationship between competition and the eventual success rate of product innovation, we construct the survival rate of newly launched product trademarks following prior literature (Hsu, Li and Nozawa, 2018; Bereskin, Hsu, Na and Rotenberg, 2018). We define a new trademark's success based on whether it survives the first 10 years, and measure the survival rate of new product trademarks using the percentage of new product trademarks that will survive for 10 years or longer in the total number of new product trademarks filed by the firm from year *t*+1 to *t*+3 (*Survival_rate_3y*) and from year *t*+1 to *t*+5 (*Survival_rate_5y*). Specifically, the two survival rates of newly launched product trademarks for a firm *i* from *i*+1 to *t*+3 and from *i*+1 to *t*+5 are constructed as follows:

$$Survival\_rate\_3y_{i,t+1,t+3} = \sum_{j=1}^{J} \frac{I\left(renewed_{j,t+1,t+3}\right)}{J}$$

$$Survival\_rate\_5y_{i,t+1,t+5} = \sum_{j=1}^{J} \frac{I\left(renewed_{j,t+1,t+5}\right)}{J}$$

where *J* denotes the total number of product trademarks that were filed by firm *i* from *t*+1 to *t*+3 or from *t*+1 to *t*+5, $I\left(renewed_{j,t+1,t+3}\right)$and $I\left(renewed_{j,t+1,t+5}\right)$ are indicator variables showing whether product trademark *j* filed by firm *i* from *t*+1 to *t*+3 or from *t*+1 to *t*+5 is later renewed in its tenth year.

Then, we examine the impact of competition on new product trademarks' survival rate by running the following OLS regressions:

$$Survival\ rate_{i,j,t+1\text{ to }t+3} = \alpha + \beta\ \text{Competition}_{j,t} + \gamma\ \text{Controls}_{i,t} + \delta_j + \varphi_t + \varepsilon_{i,t+1\text{ to }t+3}$$

where the dependent variable is *Survival_rate_3y* or *Survival_rate_5y*. Since the 10 -year renewal status of trademarks filed after 2007 is unknown in our dataset, we estimate the regression for a shorter sample period ending in 2004 for *Survival_rate_3y* and in 2002 for *Survival_rate_5y*. The same set of control variables as in Table 2 are included.

The OLS results are reported in Table 5 columns (1) and (3). The dependent variable is *Survival_rate_3y* and *Survival_rate_5y*, respectively. The independent variable of interest is again *Import penetration.* We find that the coefficients on the competition measure are both negative and statistically significant, consistent with our conjecture that competition decreases the success rate of newly launched product lines.

We also conduct 2SLS analysis to further examine the relation between competition and the survival rate of new product trademarks by using real exchange rate as the instrumental variable for *Import penetration*. The second-stage regression results are reported in Table 5 columns (2) and (4). The estimated coefficients of the predicted *Import penetration* remain negative and statistically significant. The effect is also economically significant. For example, the coefficient on the predicted *Import penetration* in column (2) suggests that a one standard deviation increase in *Import penetration* is associated with an 18.1% decrease in the survival rate of new product trademarks launched in the following three years.

In summary, the above results suggest that firms in highly competitive environment tend to launch more new products, but these product lines are more likely to fail in the future.

--Insert Tables 5 about here--

4.3.2 Competition and Product Trademarking Strategy

In this section, we further explore how the level of competition affects the nature of new product innovation. In particular, we examine the strategies of a firm's trademarking activities.

We first examine whether firms facing greater competition launch a greater variety of product trademarks or ones that are similar with each other. We construct a trademark diversity measure following Hsu, Li and Nozawa (2018):

$$Diversity\_HHI = 1 - \sum_{k=1}^{K} \left(\frac{n_k}{\sum_{k=1}^{K} n_k} \right)^2$$

where *K* is the total number of unique new product trademark classes filed by a firm from year *t*+1 to *t*+3 and n_k denotes the number of new product trademarks filed in the k^{th} trademark class over the three years. [17]

The results are reported in Table 6 column (1), where the dependent variable is *Diversity_HHI*. We find that the coefficient of *Import penetration* is negative and statistically significant. These findings indicate that firms facing greater import competition tend to have less diversified portfolios of new trademarks.

To further investigate the trademarking strategies in response to product market competition, we classify newly launched trademarks into explorative trademarks and exploitative trademarks. A trademark is defined as an explorative trademark if the firm has

[17] All trademarks registered in the USPTO need to be classified into one or multiple product/service classes. Prior to September 1, 1973, the United States used its own classification system, which include 52 goods classes and 8 services classes. Since September 1, 1973, the USPTO has classified goods and services according to the International Classification of Goods and Services under the Nice Agreement (the so-called "Nice Classification"). There are currently 45 classes, including 34 goods classes and 11 services classes.

not registered any other trademarks in this trademark's class (assigned by the USPTO) over the last 10 years. Otherwise, the trademark is defined as an exploitative trademark. *Exploration_3y* (*Exploitation_3y)* are the total numbers of new exploration (exploitation) product trademarks filed by the firm and its subsidiaries from year *t*+1 to *t*+3. To account for skewness in the data, we use the natural logarithm of one plus *Exploration_3y* (*Exploitation_3y)* in the regressions.

Table 6 columns (2) and (3) report the results. The dependent variable is *Log (1+Exploration_3y)* in column (2) and *Log (1+Exploitation_3y)* in column (3). The coefficient of *Import penetration* is negative for explorative trademarks but positively significant for exploitative trademarks. These results imply that firms facing higher import competition tend to file fewer new explorative trademarks but more exploitative trademarks. Overall, our results in Table 6 suggest that firms tend to launch new products in their old and familiar areas in response to intensified product market competition.

--Insert Tables 6 about here--

4.4 Competition, Product Innovation and Firm Performance

In this section, we investigate the relation among competition, product innovation and firm performance by estimating the following OLS regressions:

$$\overline{Performance}_{i,j,t+1,t+3} = \alpha + \beta_1 \text{ Import penetration}_{j,t} + \beta_2 \text{ Log}(1 + \text{Trademark})_{i,j,t+1,t+3}$$
$$+ \beta_3 \text{ Import penetration}_{j,t} * \text{ Log}(1 + \text{Trademark})_{i,j,t+1,t+3} + \gamma \text{ Controls}_{i,t}$$
$$+ \delta_j + \varphi_t + \varepsilon_{i,t}$$

The dependent variable is the average *ROA* and *sales growth* from year *t*+1 to *t*+3. Our main independent variables are *Import penetration, Log (1+Trademark)* and their interaction term.

The results are reported in Table 7. Similar to prior literature (Esposito and Esposito, 1971; Turner, 1980), we find that product market competition lowers firms' future profitability and sales growth. Moreover, consistent with Faurel et al (2017), we find that product trademark is positively associated with firm performance. More importantly, the coefficients of the interaction term in columns (3) and (6) are both positively significant. This result indicates that the launch of new product trademarks significantly mitigates the negative impact of import penetration on firms' long-run performance. The impact is also economically meaningful. Take sales growth (column 6) as an example, a one standard deviation increase in import penetration is associated with a 1.83% decrease in sales growth if a firm does not file any new product trademark in the following three years. The impact is indiscernible if a firm has one new product trademark and positive if it files more than one.

Overall, our results in Table 7 suggest that import penetration could hamper firm performance, but firms could offset this negative impact by undertaking more product innovation.

--Insert Tables 7 about here--

4.5 Domestic Competition and Innovation

Thus far, our analysis has focused on manufacturing firms. The results suggest that import competition affects these firms' production innovation. If the effect of competition on product innovation is universal, we should observe a similar relationship when using domestic competition. Therefore, in this section, we examine the effect of competition on new product trademarks using measures of domestic competition.

In Table 8 columns (1) and (3), we use *Competition dummy* as the alternative competition measure, which is equal to one if the Compustat HHI of the firm's industry is in the lowest quartile of the yearly sample distribution, and zero otherwise. The dependent variable is *Log (1+Trademark_3y)* in column (1) and *Log (1+Trademark_5y)* in column (3). We find that the estimated coefficients of our domestic competition measure are significantly positive in both columns, suggesting that domestic competition is positively associated with the number of newly launched product trademarks.

To further examine the causal effect of domestic product market competition on new product trademark filings, we employ a DID approach by relying on industry deregulations.[18] Since deregulation lessens barriers to entry into an industry and increases industry competition, it is a significant shock that considerably affects the competitive environment of domestic firms. We follow Ovtchinnikov (2010) and select deregulations in the following five industries: entertainment, petroleum and natural gas, utilities, telecommunications, and transportation.

The DID estimations of new trademarking filings from before to after industry deregulation are reported in Table 8 columns (2) and (4). The explanatory variable of interest is *Post_deregulation*Deregulation*. *Deregulation* is an indicator variable equal to one for firms in deregulated industries, defined based on four-digit SIC code. *Post_deregulation* is an indicator variable equal to one for firm years after industry deregulation. Specifically, it equals one for firms in entertainment industry after 1980, 1978-2017 for firms in petroleum and natural gas industry, 1988-2017 for utilities firms, 1979-2017 for telecommunication firms, and 1976-2017 for transportation firms, and zero otherwise. In addition to the baseline controls from Table 2, we further include firm fixed effects to the regressions to account for unobserved time-invariant firm heterogeneity.

We find that the coefficients of *Post_deregulation*Deregulation* in columns (2) and (4) are both positive and statistically significant, indicating that firms in deregulated industries launch more new product lines after deregulation (i.e., when firms face more product market

[18] As mentioned in Ovtchinnikov (2010), Economic deregulation is defined as deregulation of entry, exit, price, and quantity. Deregulation of entry allows entry into an industry by new firms or by existing regulated firms and increases industry competition. Deregulation of exit allows existing firms to exit unprofitable lines of business and shed excess capacity. Deregulation of price and quantity allows firms to set prices and production quantities at competitive levels.

competition). We also replicate our analysis using Fama-French 48-industry classifications to define industry deregulation. Unreported tests show similar results.

Overall, our analysis shows that both foreign import competition and domestic competition increase firms' innovation outputs in the product market and this positive effect is unlikely to be entirely induced by potential endogenous problems.

--Insert Tables 8 about here--

4.6 Additional Analysis

4.6.1 Alternative Product Innovation Measure: New Product Announcement

In this section, we use alternative proxies for product innovation to further confirm the relation between competition and product innovation. The two alternative proxies are the total number of new product announcements and the number of major new product announcements reported by a firm from year t+1 to t+3. The former is obtained from the RavenPack News Analytics database (RavenPack), which collects news and press from all major real-time newswires. Due to data availability, we obtain news announcements made by publicly traded U.S. corporations between 2004 and 2017.[19] We follow Warren and Sorescu (2017) and restrict our sample news announcements coded as "product releases" that have a "relevance score" of 100, which ensures that the firm making the announcement is the focal entity in the press release, and a novelty score of 100, as these represent the first mention of the product to appear in any news outlet within a 24-hour window. Data on major new product announcements is shared by Mukherjee, Singh, and Zaldokas (2017), who count the number of new product announcements that are associated with cumulative abnormal returns above the 75th percentile in the respective calendar year.

[19] We collect new product announcements data from RavenPack Dow Jones and PR Edition. We aggregate the number of new product announcements collected from the two editions. Dow Jones Edition analyzes relevant information from Dow Jones Newswires, regional editions of the Wall Street Journal, Barron's and MarketWatch. PR Edition analyzes news and information from the leading global media organizations (source including: Press releases, regulatory, corporate and news services).

Regression results are reported in Table 9. The dependent variable in columns (1) and (2) is the natural logarithm of one plus the total number of product announcements by firm *i* from year *t*+1 to *t*+3. In columns (3) and (4) we focus on major product announcements. We find that both *Import penetration* and *Competition dummy* are positively and significantly related with the number of new product announcements. Overall, the results are consistent with our baseline regressions and provide more evidence that competition could motivate firms' future product innovation.

--Insert Tables 9 about here--

4.6.2 Subsample Analyses: Non-R&D-intensive Subsample

As mentioned in Hall, Helmers, Rogers, and Sena (2014), trademarking is probably the most widely used form of IP protection as it is applicable to essentially any firm selling a good or service. On the other hand, the existing literature on IP mainly focuses on R&D and patents, which neglects non-R&D and non-patent assets like trademarks held by a much broader set of participants in the economy. In our sample, 72.9% of firms have zero patents during the sample period. The ratio is 56.6% among firms with trademarks. Additionally, 55.3% of firms (44.5% of firms with trademarks) do not report any R&D expense during the sample period. To show that the implications of our studies are broader than those of prior studies based on R&D and patent, we divide our sample into R&D intensive and non-R&D intensive firms, and patent and non-patent firms following Hsu, Li and Nozawa (2018)'s classification. Specifically, a firm is classified as a R&D-intensive firm if it is in the following five industries: pharmaceuticals (3-digit SIC code 283), industrial machinery and equipment (2-digit SIC code 35), electronic and other electric equipment (36), transportation equipment (37), and instruments and related products (38); otherwise, it is classified as non-R&D intensive firm. A firm is classified as a non-patent firm if it has no patent applications in the USPTO patent database. Since most manufacturing firms belong to the R&D intensive subsample, in the analysis, we include all firms and use *Competition dummy* as the main competition measure.

We then repeat the analysis in Table 2 for the non-R&D intensive and non-patent subsamples. The results in Table 10 show that the effect of competition also holds for firms in non-R&D intensive and for non-patent firms.[20] This supports the notion that trademarks are important for non-technological innovations, where patents are not applicable as a means of IP protection.

--Insert Tables 10 about here--

5. Conclusion

In this paper, we use newly launched product trademarks to measure a firm's product development innovation and explore the relationship between competition and product innovation. By studying a sample of manufacturing firms during the period 1972-2005, we find that greater import competition spurs corporate product innovation, though these new product lines are more likely to be abandoned in the future. We further examine the diversity of a firm's new trademarks using the number of unique product/service classes covered by its trademark portfolio. We find that firms tend to launch new brands in familiar areas in response to intensified import competition. Moreover, we study the relation among competition, trademark and firm performance and find that product innovation could mitigate the negative impact of competition on firms' long-run performance.

We then use alternative measures of competition and product innovation and find consistent results. Specifically, using Compustat HHI, we again find that product market competition increases product innovation. The results are also supported by DID regressions based on industry deregulation. Additionally, using the number of new product

[20] We exclude import penetration as our proxy for competition in this subsample test because import penetration data are only available for manufacturing firms and most of them are R&D intensive and patent firms.

announcements as an alternative proxy for new products innovation, we find consistent results. Overall, our results suggest that competitive markets can promote product innovation.

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Appendix

Table A1. Sample Selection Criteria

Sample Selection Step	No. Firms	No. Firm-Years
Total number of Compustat firms (1950-2017)	38,217	497,443
Less: Firms outside USA (Current ISO Country Code!=USA)	(7,327)	(80,242)
Less: Firms with missing or negative sales	(3,736)	(57,493)
Less: Firms with missing SIC code	(2,321)	(51,331)
Subtotal:	24,833	308,377
Less: Observation lacking values for the control variables (age, capex, KL, ROA, Leverage, MB, kz index)	(6,184)	(114,285)
Final Sample	18,649	194,092

Table A2. Variable Definitions

Variable	Explanation	Data Source(s)
Log (1+Trademark_3y)	The natural logarithm of one plus the total number of new product trademarks filed by firm i including all subsidiaries) from year t+1 to t+3. Product trademark is defined as marks that have text of fewer than 4 words, and the text is the first time to appear in a trademark class as product trademarks (i.e., product names). Any subsequent marks with the same text in the same class are marketing trademarks (i.e., updating logos).	USPTO Trademark
Log (1+Trademark_5y)	The natural logarithm of one plus the total number of new product trademarks filed by firm i including all subsidiaries) from year t+1 to t+5.	USPTO Trademark
Log (1+Trademark stock)	The natural logarithm of one plus valid product trademark held by firm i (including all subsidiaries) in year t.	USPTO Trademark
Survival_rate_3y	The survival rate of new product trademarks filed from year t+1 to t+3, defined as the percentage of new product trademarks that will survive for 10 (or 20) years or longer in the total number of new product trademarks filed from year t+1 to t+3	USPTO Trademark
Survival_rate_5y	The survival rate of new product trademarks filed from year t+1 to t+5, defined as the percentage of new product trademarks that will survive for 10 (or 20) years or longer in the total number of new product trademarks filed from year t+1 to t+5	USPTO Trademark
Diversity_HHI	One minus the Herfindahl index based on new product trademarks filed by a firm from year t+1 to t+3 across the product trademark classes	USPTO Trademark
Log (1+Exploration_3y)	The natural logarithm of one plus the explorative trademarks filed by firm i (including all subsidiaries) from year t+1 to t+3. We define a trademark as an explorative trademark if the firm has not registered any product trademarks in this trademark's class (assigned by the USPTO) over the last 10 years.	USPTO Trademark
Log (1+Exploitation_3y)	The natural logarithm of one plus the exploitative trademarks filed by firm i including all subsidiaries) from year t+1 to t+3. We define a trademark as an exploitative trademark if the firm has already registered any product trademarks in this trademark's class (assigned by the USPTO) over the last 10 years.	USPTO Trademark
Log (1+ Annoucements_3y)	The natural logarithm of one plus the total number of major new product announcements by firm i from year t+1 to t+3. A major new product announcement refers to the case in which a company press release in the LexisNexis News database contains new product keywords (e.g., "Launch," "Product," "Introduce," "Begin," "Unveil") and is associated with cumulative abnormal returns above the 75th percentile in the respective calendar year.	Mukherjee Websites
Log (1+ Annoucements_RP_3y)	The natural logarithm of one plus the total number of new product announcements by firm i from year t+1 to t+3. The new product announcement data is download from the RavenPack News Analytics database (Dow Jones and PR Edition).	RavenPack

Import penetration	The ratio of imports over imports plus domestic production in a given 3-digit SIC industry and given year. (Xu 2012; Bertrand 2004)	Peter Schott's website
Competition dummy	Dummy variable equal to one if the Compustat HHI is in the lowest quartile of the yearly sample distribution, and zero otherwise. Compustat HHI is the Herfindahl-Hirschman Index based on 3-digit SIC code computed using Compustat firms. It is defined as the sum of squared market shares. Market shares are computed using firms' sales.	Compustat
Log (Sale)	The natural logarithm of sale in year t, the sale is inflation adjusted (in millions of 2010 dollars)	Compustat
Log (Age)	The natural logarithm of firm age, which is calculated as the number of years that the firm has existed in Compustat.	Compustat
M/B	Market value of assets over book value of assets: (at−ceq+mv)/at. mv: stock price times share outstanding at the end of fiscal year t (csho×prcc_f).	Compustat
Log (K/L)	The natural logarithm of capital-labor ratio in year t, which is the ratio of net stock of property, plant, and equipment to the number of employees (ppent/emp).	Compustat
R&D stock	The R&D stock is scaled by Sale. R&D stock is the 5-year cumulative R&D expenses from year t−4 to t, assuming an annual depreciation rate of 20% ($R\&D_{i,t}$ + 0.8×$R\&D_{i,t-1}$ + 0.6×$R\&D_{i,t-2}$ + 0.4×$R\&D_{i,t-3}$ + 0.2×$R\&D_{i,t-4}$).	Compustat
Adv	The advertising expense is scaled by Sale. Advertising expense is the sum of advertising expenses over two years (ADi,t + ADi,t−1).	Compustat
Capex	The capital expenditures, scaled by Sale.	Compustat
ROA	Return on assets, oibdp/at.	Compustat
Leverage	Total debt divided by total assets, (dltt+dlc)/at.	Compustat
KZ Index	-1.002 × cash flow + 0.283 × Tobin's Q + 3.139 ×leverage − 39.368 × dividends − 1.315 × cash holdings, based on Kaplan and Zingales (1997).	Compustat
Real exchange rate	The source-weighted average of real exchange rates across all countries exporting to the US that take up 2% or more of US total imports in the base year of 1995 (Xu, 2012)	IMF and Peter Schott's website
Post_PNTR	An indicator variable equals to one if year is from 2001 forward, elsewise equals to zero.	Compustat
NTR_gap	the difference between the non-NTR rate and the NTR tariff rate	Peter Schott's website
Post_deregulation	An indicator variable equals to one if firm is in post deregulation period, elsewise equals to zero. Post deregulation period is 1980-2017 for entertainment, 1978-2017 for petroleum and natural gas, 1988-2017 for utilities, 1979-2017 for telecommunications, and 1976-2017 for transportation firms, and zero otherwise.	Compustat
Deregulation	An indicator variable equals to one if firm is in deregulation industry, elsewise equals to zero.	Compustat
Sales growth	The growth rate of sales.	Compustat

Table 1 Descriptive Statistics

This table reports descriptive statistics of variables used in regression analyses. The sample comprises all US public firms in Compustat from 1962 to 2017. All continuous variables are winsorized at 1% and 99% levels. Detailed variable definitions are provided in Appendix A2.

Variable	Observations	Mean	Std	P25	Median	P75
Trademark_3y	194,092	1.76	5.79	0.00	0.00	0.00
Trademark_5y	194,092	2.84	9.17	0.00	0.00	1.00
Trademark stock	194,092	9.24	32.37	0.00	0.00	2.00
Survival_rate_3y	33,243	0.36	0.35	0.00	0.30	0.59
Survival_rate_5y	36,003	0.35	0.33	0.00	0.31	0.56
Diversity HHI	43,108	0.31	0.30	0.00	0.33	0.58
Exploration_3y	194,092	0.22	0.65	0.00	0.00	0.00
Exploitation_3y	194,092	1.54	5.48	0.00	0.00	0.00
Annoucements_3y	15,082	1.53	2.99	0.00	1.00	2.00
Annoucements_RP_3y	25,645	8.06	17.56	0.00	2.00	7.00
Import penetration	70,161	0.153	0.126	0.058	0.116	0.218
Competition dummy	194,092	0.25	0.43	0.00	0.00	0.00
Log (Sales)	194,092	5.04	2.40	3.55	5.15	6.67
Log (Age)	194,092	2.47	0.79	1.95	2.48	3.09
M/B	194,092	2.08	2.53	1.00	1.31	2.07
Log (K/L)	194,092	3.26	1.54	2.23	3.07	4.05
R&D stock	194,092	0.45	2.31	0.00	0.00	0.09
Adv	194,092	0.02	0.06	0.00	0.00	0.02
Capex	194,092	0.13	0.34	0.02	0.04	0.09
ROA	194,092	0.03	0.36	0.02	0.11	0.17
Leverage	194,092	0.26	0.27	0.06	0.22	0.38
KZ index	194,092	-8.54	37.02	-5.01	-0.67	1.10
Real exchange rate	88,511	0.05	0.09	0.00	0.00	0.08
NTR gap	96,950	0.31	0.13	0.25	0.35	0.41

Table 2 Foreign Competition and Product Innovation

This table examine the impact of foreign import competition on new trademark filings. The dependent variable is *Log (1+Trademark_3y)* in columns (1) to (2) and *Log (1+Trademark_5y)* in columns (3) to (4). The independent variable of interest is *Import penetration*. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Log (1+Trademark_3y)		Log (1+Trademark_5y)	
Variable	(1)	(2)	(3)	(4)
Import penetration	0.201***	0.115*	0.235***	0.131*
	(0.069)	(0.064)	(0.082)	(0.76)
Log (Sale)		0.059***		0.065***
		(0.004)		(0.004)
Log (Age)		-0.112***		-0.150***
		(0.007)		(0.009)
ROA		0.038***		0.069***
		(0.012)		(0.015)
M/B		0.022***		0.027***
		(0.002)		(0.002)
Leverage		-0.072***		-0.122***
		(0.015)		(0.019)
Log (K/L)		-0.003		0.000
		(0.006)		(0.007)
R&D stock		0.006***		0.008***
		(0.001)		(0.002)
Capex		0.033***		0.024**
		(0.009)		(0.012)
Adv		0.442***		0.361***
		(0.093)		(0.099)
KZ index		-0.000		-0.000
		(0.000)		(0.000)
Log (1+Trademark stock)	0.495***	0.482***	0.592***	0.582***
	(0.007)	(0.006)	(0.007)	(0.006)
Year fixed Effect	Yes	Yes	Yes	Yes
Industry fixed Effect	Yes	Yes	Yes	Yes
Sample Period	1972-2005	1972-2005	1972-2005	1972-2005
Observations	70,161	70,161	70,161	70,161
R-squared	0.639	0.654	0.659	0.675

Table 3 Robustness Tests for Foreign Competition and Product Innovation (2SLS)

This table reports the regression results of the 2SLS analysis. Column (1) reports the first-stage regression results, with *Import penetration* as the dependent variable. The instrumental variable is *Real exchange rate*. Results from the second-stage regressions are reported in columns (2) and (3), with *Log (1+Trademark_3y)* and *Log (1+Trademark_5y)* as the dependent variables, respectively. The independent variable of interest in second stage is the predicted values of *Import penetration* from the first-stage regression. All baseline controls from Table 2 are included in regressions, whose coefficients are not reported for brevity. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	First Stage	Second Stage	
	Import penetration	Log (1+Trademark_3y)	Log (1+Trademark_5y)
	(1)	(2)	(3)
Real_Exchange rate	0.197***		
	(0.022)		
Import penetration		1.319***	1.372***
		(0.414)	(0.464)
Baseline Controls	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes
F-Statistics	80.38		
Prob>F	0.000		
Sample Period	1972-2005	1972-2005	1972-2005
Observations	68,834	68,834	68,834
R-squared	0.585	0.642	0.665

Table 4 Robustness Tests for Foreign Competition and Product Innovation (DID)

This table reports the results of the difference-in-differences estimations of new product trademarking filings from before to after U.S. granting China PNTR for different time windows. The dependent variable is *Log (1+Trademark_3y)* in columns (1) to (2) and *Log (1+Trademark_5y)* in columns (3) to (4). The explanatory variable of interest is the interaction term between *Post_PNTR* and *NTR gap*. Columns (1) and (3) present the results for the whole sample period from 1974 to 2005 and columns (2) and (4) present the results for the short period from 1990 to 2005. All baseline controls from Table 2 and NTR tariff rate are included in the regressions, whose coefficients are not reported for brevity. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Log (1+Trademark_3y)		Log (1+Trademark_5y)	
	(1) whole period	(2) short window	(3) whole period	(4) short window
Post_PNTR*NTR gap	0.160	0.202**	0.200*	0.234**
	(0.099)	(0.098)	(0.121)	(0.119)
NTR gap	0.112	0.044	0.113	0.035
	(0.099)	(0.135)	(0.116)	(0.169)
Baseline Controls	Yes	Yes	Yes	Yes
Control NTR Tariff rate	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Sample Period	1974-2005	1990-2005	1974-2005	1990-2005
Observations	68,121	39,204	68,121	39,204
R-squared	0.648	0.573	0.668	0.577

Table 5 Foreign Competition and New Trademark Survival Rate

This table examine the relation between foreign competition and new product trademark survival rate using OLS and 2SLS analysis. The instrumental variable for the 2SLS regressions is the same as in Table 2. The OLS regressions results are reported in columns (1) and (3), and 2SLS second-stage regressions results are reported in columns (2) and (4). The dependent variable is *Survival_rate_3y* in column (1) and (2) and *Survival_rate_5y* in columns (3) and (4). The independent variable of interest is (predicted) *Import penetration*. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Survival rate 3y		Survival rate 5y	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS
Import penetration	-0.177***	-1.435***	-0.149***	-1.293**
	(0.054)	(0.521)	(0.058)	(0.515)
Log (Sale)	-0.020***	-0.015***	-0.018***	-0.013**
	(0.004)	(0.005)	(0.004)	(0.006)
Log (Age)	0.017**	0.004	0.020**	0.008
	(0.008)	(0.011)	(0.008)	(0.011)
ROA	0.146***	0.105**	0.132***	0.107***
	(0.034)	(0.042)	(0.033)	(0.037)
M/B	-0.003	-0.002	-0.002	-0.002
	(0.002)	(0.003)	(0.002)	(0.002)
Leverage	0.013	-0.038	0.010	-0.032
	(0.027)	(0.037)	(0.028)	(0.036)
Log (K/L)	0.028***	0.031***	0.026***	0.027***
	(0.008)	(0.009)	(0.008)	(0.009)
R&D stock	-0.003	-0.001	-0.002	-0.000
	(0.004)	(0.004)	(0.004)	(0.004)
Capex	-0.037	-0.043	-0.016	-0.021
	(0.030)	(0.029)	(0.028)	(0.028)
Adv	-0.239***	-0.163*	-0.196**	-0.128
	(0.077)	(0.093)	(0.079)	(0.094)
KZ index	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Log (1+Trademark stock)	0.016***	0.014**	0.014***	0.012**
	(0.005)	(0.006)	(0.005)	(0.006)
Year Fixed Effect	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Sample Period	1972-2004	1972-2004	1972-2002	1972-2002
Observations	19,007	18,642	20,332	19,932

Table 6 Foreign Competition and Trademarking Strategy

This table examines the relation between foreign competition and firm's product trademarking strategy. The dependent variable is *Diversity HHI* in column (1), *Log (1+Exploration_3y)* in column (2) and *Log (1+Exploitation_3y)* in column (2). The independent variable of interest is I*mport penetration*. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Diversity_HHI	Log(1+Exploration_3y)	Log(1+Exploitation_3y)
	(1)	(2)	(3)
Import penetration	-0.097**	-0.014	0.141**
	(0.046)	(0.026)	(0.066)
Log (Sale)	0.042***	0.018***	0.059***
	(0.003)	(0.001)	(0.004)
Log (Age)	-0.014**	-0.038***	-0.098***
	(0.007)	(0.003)	(0.007)
ROA	-0.046**	0.012**	0.021*
	(0.021)	(0.006)	(0.012)
M/B	0.008***	0.007***	0.020***
	(0.002)	(0.001)	(0.002)
Leverage	0.018	-0.024***	-0.056***
	(0.020)	(0.007)	(0.015)
Log (K/L)	-0.001	-0.001	-0.005
	(0.007)	(0.002)	(0.006)
R&D stock	0.002	0.002***	0.006***
	(0.002)	(0.001)	(0.001)
Capex	0.034*	0.008*	0.039***
	(0.018)	(0.004)	(0.008)
Adv	0.138*	0.066	0.507***
	(0.070)	(0.042)	(0.098)
Kz_index	-0.000**	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Log (1+Trademark stock)	0.062***	0.113***	0.459***
	(0.004)	(0.002)	(0.006)
Year Fixed Effect	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes
Sample Period	1972-2005	1972-2005	1972-2005
Observations	19,613	70,161	70,161
R-squared	0.311	0.265	0.652

Table 7 Competition, Trademark and Firm performance

This table examines the relation between competition, trademark and firm performance. The dependent variable is the three-year average ROA from columns (1) to (3) and the three-year average sales growth from column (4) to (6). The independent variable of interest is import penetration, product trademark and their interaction term. All baseline controls from Table 2 are included in the regressions, whose coefficients are not reported for brevity. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	ROA			Sales growth		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Import Penetration	-0.069***	-0.069***	-0.093***	-0.126***	-0.130***	-0.145***
	(0.014)	(0.014)	(0.016)	(0.028)	(0.028)	(0.032)
Import Penetration*Log (1+Trademark_3y)			0.037***			0.023*
			(0.007)			(0.012)
Log (1+Trademark_3y)		0.004***	-0.002		0.026***	0.022***
		(0.001)	(0.002)		(0.003)	(0.003)
Baseline Controls	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Sample Period	1972-2005	1972-2005	1972-2005	1972-2005	1972-2005	1972-2005
Observations	65,003	65,003	65,003	64,667	64,667	64,667
R-squared	0.650	0.650	0.650	0.287	0.288	0.288

Table 8 Domestic Competition and Product Innovation

This table examines the impact of domestic product market competition on new product trademark filings. The dependent variable is *Log (1+Trademark_3y)* in columns (1) and (2) and *Log (1+Trademark_5y)* in columns (3) and (4). Columns (1) and (3) report the OLS regression results with *Competition dummy* as the main independent variable. Columns (2) and (4) report the DID estimation results of new product trademarking filings from before to after industry deregulation. The explanatory variable of interest is the interaction term between *Post_deregulation* and *Deregulation*. All baseline controls from Table 2 are included in the regressions, whose coefficients are not reported for brevity. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Log (1+Trademark_3y)		Log (1+Trademark_5y)	
	(1)	(2)	(3)	(4)
Competition dummy	0.018***		0.029***	
	(0.007)		(0.008)	
Post_deregulation*Deregulation		0.038**		0.068***
		(0.019)		(0.024)
Baseline Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	No	Yes	No
Firm Fixed Effect	No	Yes	No	Yes
Sample Period	1962-2014	1962-2014	1962-2012	1962-2012
Observations	194,092	194,092	186,406	186,406
R-squared	0.594	0.027	0.622	0.028

Table 9 Alternative Proxy for Product Innovation: New Product Announcements

This table examines the relation between competition and new product announcements. The dependent variable is *Log (1+Annoucements_3y)* in columns (1) and (2) and *Log (1+Annoucements_RP_3y)* in columns (3) and (4). The independent variable of interest is *Import penetration* in columns (1) and (3) and *Competition dummy* in columns (2) and (4). All baseline controls from Table 2 are included in the regressions, whose coefficients are not reported for brevity. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Log (1+Annoucements_3y)		Log(1+Annoucements_RP_3y)	
	(1)	(2)	(3)	(4)
Import penetration	1.040***		0.455***	
	(0.421)		(0.174)	
Competition dummy		0.078*		0.082***
		(0.046)		(0.026)
Baseline Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Sample Period	2003-2005	2003-2014	1989-2003	1989-2003
Observations	2,112	21,284	7,412	12,967
R-squared	0.304	0.312	0.167	0.184

Table 10 Non-R&D and Non-Patent Intensive Subsample Test

This table examines the relation between competition and innovation on non-R&D intensive and non-Patent subsamples. The dependent variable is *Log (1+Trademark_3y)* in columns (1) and (2) and *Log (1+Trademark_5y)* in columns (3) and (4). The independent variable of interest is *Competition dummy*. Columns (1) and (3) present the regression results on the non-R&D intensive subsample and columns (2) and (4) show regression results on the non-patent subsample. All baseline controls from Table 2 are included in the regressions, whose coefficients are not reported for brevity. All continuous variables are winsorized at 1% and 99% level. Detailed variable definitions are provided in Appendix A2. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	Log (1+Trademark_3y)		Log (1+Trademark_5y)	
	(1) No R&D	(2) No patent	(3) No R&D	(4) No patent
Competition dummy	0.017**	0.019***	0.028***	0.027***
	(0.007)	(0.006)	(0.009)	(0.008)
Baseline Controls	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Sample Period	1962-2014	1962-2014	1962-2012	1962-2012
Observations	139,839	112,161	134,258	106,500
R-squared	0.592	0.432	0.618	0.454