# ENVIRONMENTAL CHALLENGES TO ORGANIZATIONAL AMBIDEXTERITY: THE EFFECT OF INTERNATIONAL COMPETITION

**Abstract:**

This paper uses a panel dataset of manufacturing U.S. firms to study how changes in international competition affect ambidexterity in organizations. Do firms respond to tougher international competition by searching for completely new solutions (exploration) or do they defend their position by improving current solutions (exploitation)? To obtain exogenous variation in international competition and estimate its causal effect on ambidexterity, we exploit changes in import penetration, which we instrument using exchange rates and scheduled tariffs. We find that tougher international competition causes an increase in technological exploitation and a decrease in technological exploration. Consistently, firms lower their investment in innovation activities and generate patents that are more incremental and therefore receive fewer citations. Our findings suggest that managers should take into account the extent of competitive pressure in the environment when designing an organizational structure to achieve ambidexterity.

**Keywords:** International Competition, Ambidexterity, Exploration, Exploitation.

## INTRODUCTION

The search for new knowledge and the refinement of existing technical skills are the two fundamental parts of the organizational adaptive systems that ensure a firm's short-term performance and long-term survival. A sizable literature has highlighted the benefits obtained by balancing the two activities (He and Wong 2004, Katila and Ahuja 2002, Tushman and O'Reilly 1996).

Due to its nature, exploration is the vulnerable part of the equation that leads to organizational ambidexterity. Its higher risk, higher cost, and the longer time horizon of expected returns generate a tendency toward neglecting the activity in favor of exploitation (Levinthal and March 1993, March 1991). Both articles from the popular press (The Economist, 2007) and academic research (Arora et al. 2017, Bhaskarabhatla and Hegde 2014, Coombs and Georghiou 2002) provide evidence indicative that this tendency is becoming stronger in recent years. For example, Arora and colleagues (2017) show that starting from the 1980s large corporations have consistently decreased their rate of investment in scientific research to focus on the development of commercial knowledge (i.e. patents). In a way, firms' engagement in basic research can be considered the purest form of exploration. Returns from developing scientific knowledge are typically very distant as the potential for commercial application of any discovery is unknown. Therefore, a decrease in the production of scientific research already constitutes a shift in the exploration-exploitation balance.

We contend that the trend exposed by Arora et al. (2017) is part of a change in the way firms approach innovation that it is not limited to basic research. Figure 1 contains a simple analysis of citations in patent applications over the period 1989-2006. Following Katila and Ahuja (2002), we classify a firm's use of a citation as exploitative if the firm has already used the same citation in patent applications made in previous years, vice-versa the citation is classified as explorative. The tendency that emerges is clear; firms are increasingly reusing familiar knowledge in the development of innovations.

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In this paper we focus on the increase in foreign competitive pressure as a factor that can possibly account for the observed shift toward exploitation. The increased exposure to international competition is probably the single most important environmental change faced by all firms in past fifty years (Krugman et al. 1995). In the years between 1970 and 2015 the average worldwide ratio of imports to GDP more than doubled, passing from 13.5% to 28.7% (World Bank Data). Understanding how this trend affects a firm's ability to achieve ambidexterity is therefore relevant in order to give managers recommendations about a phenomenon with which they have to deal in their everyday activities.

Competitive environments have typically been associated with increases in the rate of failure, tighter profit margins, lower prices and a strong pressure toward efficiency (Matusik and Hill 1998, Trefler 2004, Zahra 1996). We argue that there are two potential reasons for which environmental changes of the sort might lead firms to emphasize exploitation at the expenses of exploration. The first is an organization's tendency to react rigidly to the presence of threats in the environment (Staw et al. 1981). According to the threat rigidity hypothesis firms experiencing threats in their operating environment respond by reducing information processing, increasing the centralization of decision making, and increasing the attention to resource conservation (Audia and Greve 2006, Iyer and Miller 2008, Staw et al. 1981). Exploration instead constitutes the search for alternative solutions, which is fostered by decentralized decision-making (Jansen et al. 2006) and by the availability of resources for experimentation (Nohria and Gulati 1996). The second reason is that competition might incentivize opportunistic myopic behavior on the side of managers. Competition makes the performance target for the firm harder to achieve, and a failure to meet the targets generates career concerns on the side of managers (Easterwood and Nutt 1999, Puffer and Weintrop 1991). In such condition, extant theory and existing empirical evidence suggest that managers are incentivized to behave myopically (Graham et al. 2005, Stein 1988).

We investigate the relationship by forming a panel sample of U.S. manufacturing firms, which spans the years between 1991 and 2006. Following prior literature we use changes in import penetration to proxy for changes in the intensity of international competition experienced by U.S.

firms (e.g. Bowen and Wiersema 2005), and correct for potential endogeneity biases by using tariffs and exchange rates as instrumental variables (Cuñat and Guadalupe 2009, Xu 2012). We use five different dependent variables in our estimations to understand the broader picture of how international competition affects innovation strategies: R&D Expenses, Exploration, Exploitation, Patent Applications, and the Number of Citations Received by the patents filed by the focal company

The results from the empirical analyses return a coherent story about the effect of international competition on exploration and exploitation. In our sample period an increase of 5 percentage points in import penetration, from 0.15 to 0.20, produces 9.4% decrease in the use of new citations in patent applications (exploration) and a 17.6% increase in the repeated usage of citations with which the organization is familiar (exploitation). Consistently, firms' investment in R&D decreases by 5.6% and the number of citations received by the patents for which firms apply decreases by 36.1%.

In separate analyses we further test whether we find support for Threat Rigidity and for Opportunistic Myopia as the two potential mechanisms influencing the relationship between competition and exploration. We find evidence for the first but not for the latter. Further our results also suggest that managers try to compensate for the decline in internal exploration by accessing external markets for technology (Arora et al. 2001).

We argue that our findings make a twofold contribution to extant literature. First, consistent with the trend exposed by Arora and colleagues (2017) we show that exploration is declining in corporate R&D, and we identify the increase in international competitive pressure as a key driver explaining this trend. Our additional analyses further suggest that the effect of international competition is at least partially due to a threat rigidity response, and that firms try to compensate for the decline in internal exploration by accessing external markets for technology.

Second, our findings make an important contribution to the organizational ambidexterity literature (He and Wong 2004, Tushman and O'Reilly 1996). While it is generally accepted that combining exploration and exploitation yield positive effects on firm performance (He and Wong 2004, Katila and Ahuja 2002), Cao and colleagues (2009) find that the balance dimension of ambidexterity (i.e. the close matching of exploration and exploitation in their relative magnitude) is especially beneficial for organizations operating in less munificent environments. In contrast, we find that in our context firms react to international competition by decreasing the level of investment in R&D, but instead of correspondingly decreasing patent production to maintain a balance between exploration and exploitation, they choose to do less of the former and more of the latter. We therefore submit that managers should be aware of the incentives provided by international competition when implementing architectural and contextual mechanisms aimed at achieving ambidexterity (Andriopoulos and Lewis 2009, Fang et al. 2010, Gibson and Birkinshaw 2004, Gupta et al. 2006).

## COMPETITION, EXPLORATION AND EXPLOITATION

Exploration and exploitation are the two key components of organizational adaptive systems; long-term survival depends on the periodical acquisition of new knowledge and on the refinement of the knowledge acquired for its application in production processes. Too much focus on either of the two activities is problematic, as March (1991) puts it: *"Adaptive systems that engage in exploration to the exclusion of exploitation are likely to find that they suffer the costs of experimentation without gaining many of its benefits… Conversely, systems that engage in exploitation to the exclusion of exploration are likely to find themselves trapped in suboptimal stable equilibria".* The empirical evidence supports this statement as its shows that balancing exploration and exploitation is leads to improved firm performance and long-term survival (Cao et al. 2009, He and Wong 2004, Hill and Birkinshaw 2014, Katila and Ahuja 2002).

The main challenge in achieving ambidexterity has usually been that of sustaining exploration in the face of a generalized organizational tendency to focus on exploitation (March 1991). For example, Tushman and O'Reilly (1996) describe the struggle of semiconductor companies when faced with successive waves of disruptive innovation that substantially changed the technological paradigm of their industry. Their account of the industry evolution shows how incumbent firms were unable to prepare for the change in paradigm due the fear of losing their dominant position in legacy technology market. Levinthal and March (Levinthal and March 1993) attribute this shortsightedness to the very characteristics of the learning process, which happens through simplification of experience and progressive specialization of responses. These same mechanisms in their view are responsible for different forms of myopia that, among other things, lead firms to focus on the short run at the expenses of long-term considerations.

We argue that an organization's tendency to focus on the short-term (and thus on exploitation) is likely to be enhanced in a context characterized by intense international competition. In the past decades, global markets have become increasingly interconnected due to factors like trade agreements (e.g. Trefler 2004) and developments in information and communication technology (e.g. Freund and Weinhold 2004). Consistently, the empirical evidence suggests that firms have substantially decreased their involvement in exploration by downsizing corporate labs and by diminishing their rate of contributions to basic science (Arora et al. 2017, Bhaskarabhatla and Hegde 2014, Coombs and Georghiou 2002).

Competitive intensity refers to the degree of rivalry between the firms operating in an industry (Matusik and Hill 1998, Porter 1981). Competitive environments have typically been associated with tighter profit margins, lower prices and a strong pressure toward efficiency (Matusik and Hill 1998, Zahra 1996). Furthermore, international competitive shocks of the sort that substantially increase the exposure of domestic players to foreign competition, are associated with an increase in the rate of failure (Bernard et al. 2006, Trefler 2004) and with a tendency toward worldwide industry consolidation (Helpman and Krugman 1985).

There are two potential reasons for which increased international competition may lead firms to emphasize exploration at the expenses of exploitation. The first has to do with the expected reaction of individuals and organizations under threat; the second has to do with the fact that competition might incentivize opportunistic myopic behavior on the side of managers.

Threat Rigidity Theory (Staw et al. 1981) postulates that organizations facing environmental threats, such as an increase in competitive pressure, will follow a predictable pattern of behavior. At the individual level, the response to environmental threats is linked to the psychology of stress, anxiety and arousal. Evidence shows that subjects experiencing these conditions exhibit an increased propensity toward emitting familiar, well-learned and habitual responses (Palermo 1957, Zajonc

1965), a reduction in information processing with a tendency to emphasize prior expectations (Eysenck et al. 2007, Smock 1955), and an increased (decreased) focus on the central (peripheral) cues in the environment (Eysenck 1976, Wine 1971). At the organizational level, the threat rigidity response results in a restriction in information processing, a constriction of control, and an increased attention toward the conservation of resources. All these tendencies are potentially linked to a decrease in firms' exploratory effort. Exploration requires organizations to consider alternative sources of knowledge. Instead, threats to security result in a restriction of the number of alternatives considered by strategy makers (Gladstein and Reilly 1985, Smart and Vertinsky 1977). Exploration is fostered in environments with relatively high decentralization of authority (Jansen et al. 2006). By contrast Pfeffer and Leblebici (1973) found that firms operating in environments characterized by high degrees of competition exhibit a higher centralization in decision making. Exploration requires resources for experimentation (Nohria and Gulati 1996). Instead, perceived threats are usually accompanied by tightening budgets and an increased attention toward efficiency (D'aveni 1989, Irene Rubin 1977).

Threat rigidity constitutes a natural response to a tougher competitive environment. Furthermore, competition also provides incentives for managers to engage in opportunistic behavior. A manager's performance is typically evaluated based on the performance of the firm to which he/she belongs. Evidence shows that market analysts fail to revise downwards the performance targets as a consequence of new negative information being released (Easterwood and Nutt 1999). In turn, a firm's failure to meet the relevant performance targets  results in large drops in the share price (Brown 2001, Matsumoto 2002, Skinner 1994) and in significant concerns for a manager's career prospects (Puffer and Weintrop 1991). Stein (1988, 1989) formally analyze the situation in which low current earnings cause the firm's stock to be undervalued and significantly increase the risk of takeover. He concludes that, under such contingencies, managers are incentivized to sacrifice the long-term interest of the firm to boost current profits. Campbell and Marino (1994) examine managers optimal self-interested behavior when they have control over an unobservable variable that affects the time distribution of returns on a firm's investment (the equivalent of controlling the choice between exploration and exploitation). They shows that when managers' ability is evaluated based on firm performance in a relatively short timeframe, and labor markets for managers are competitive and frictionless, then managers have an incentive to select myopic investments. In general, there is abundant evidence that shows how managers choose to sacrifice valuable investments opportunity in order to meet current profits target (e.g. Cohen et al. 2008, Cohen and Zarowin 2010, Graham et al. 2005, Roychowdhury 2006). For example, in a survey of 400 executives, Graham et al. (2005) report that 78% of the sample admits sacrificing long-term value to smooth earnings.

To conclude, we note that a change in balance between exploration and exploitation has implications for the entire innovation strategy of the firm. If international competition leads to more exploitation and less exploration, we also expect international competition to be associated with innovations that are less influential. Exploitative innovations in fact are, by definition, more likely to contain incremental knowledge and less likely to contain technological breakthrough. At the same time, innovations that exploit the current knowledge base of the firm are less costly to produce than innovations that require the acquisition of new knowledge. If international competition leads to more exploitation, we also expect international competition to either decrease R&D expenses or to increase the production of innovations. Due to lower unitary cost of exploitative innovations in fact, firms can maintain the production of innovations (patents) more or less at the same level while cutting the R&D budget. Alternatively, they can keep the R&D budget fixed and achieve a higher innovative output (sheer number of patents).

## EMPIRICS

The purpose of this paper is to investigate the effect of changes in the intensity of international competition on the balance between exploration and exploitation. To accomplish this aim we assemble a panel dataset of U.S. companies by combining data from different sources. We use the Standard & Poor's Compustat database to obtain information about firms' financials, firms' operating segments, and firms' expenditures in R&D activities. We use the NBER Patent Database (Hall et al. 2001) to obtain information about firms' patent applications and about the citations made and received by firms' patents. We use data coming from different NBER datasets (Becker et al. 2013, Feenstra 1996, Feenstra et al. 2002, Schott 2010) to calculate our measure of international competition: import penetration. Finally, we also use data on tariffs coming from the UNCTAD TRAINS dataset of the World Bank, and data on exchange rates and Consumer Price Indexes (CPIs) coming from the International Financial Statistics of the IMF for the calculation of our instrumental variables.

The resulting dataset effectively covers the period between 1991 and 2006 and it is limited to firms having their primary operations in manufacturing SICs (SIC 2000-3999), as trade information is available only for these sectors. The choice of the timespan is imposed by the limited availability of tariff data and patent data. The UNCTAD TRAINS database in fact starts in 1989 and we require two years of lagged observations for our analyses, while the NBER Patent Database ends in 2006. We eliminate from this data firms below 10 million dollars in sales. We use two samples for the analyses. The first sample contains all the firm-years for which there is information available in Compustat. This sample has a total of 16,894 observations belonging to 2,193 different firms. The second sample instead is a subsample of the first and it contains the firm-years in which firms filed at least one patent application. The second sample has a total of 8,429 observations belonging to 1,317 different firms. The two samples will be used for testing the effect of international competition on separate aspects of the firms' innovation strategy. When discussing our dependent variables in the next session we will delve more deeply into the issue.

The general form of our regression models is the following:

$$\ln\left(Y_{f,t}\right) = \alpha_t + \gamma_f + \beta_1 ImportPen_{f,t-1} + \beta X_{f,t}^{\prime} + \epsilon_{f,t}$$

Where $Y_{f,t}$ is one of our five dependent variables: R&D Expenses, Patent Applications, Citations Received, Exploitation, and Exploration, which we explain in detail below; $\alpha_t$ and $\gamma_f$ are respectively year and firm fixed-effects; $ImportPen_{f,t-1}$ is our measure of import penetration lagged by one year; $X_{f,t}^{\prime}$ is a vector of control variables, which depending on the regression includes the logarithm of sales, firm's ROA, R&D Expenses, Patent Applications, Patent Stock, and the total number of Citations Made by the patents for which the firm applied; $\epsilon_{f,t}$ is the error term. We cluster standard errors in all regressions at the firm level to allow for autocorrelation of the error term within firms and across years. Moreover, to reduce the influence of outliers we take the natural logarithm of all our dependent variables and controls except for ROA that we winsorize at the 1% level.

**Dependent variables:**

We use five dependent variables in our analyses: R&D Expenses, Patent Applications, Citations Received, Exploitation, and Exploration.

Our proxy for a firm's investment in R&D is the natural logarithm of total R&D expenses coming from the Compustat Annual data file. The rest of our measures are calculated using data obtained from the NBER Patent-Assignee data file and the NBER citations data file.

Patent Applications is the total number of patents for which a firm applied in a given year and that were eventually granted. We account for whether a patent application is filed by multiple companies by dividing the weight of the patent equally between the owners.

Citation Received is the total number of citations received in the future by the patents filed by a firm in a given year. We correct for citation truncation due to the fact that the patent database ends in 2006 by multiplying the citations received by each patent for a correction factor estimated by Hall et al. (2001). The correction factor takes into account the technological field and the year of patent granting to estimate a grossing up factor that accounts for the citations received by a patent after 2006.

Consistent with prior research, we use the citation contained in patent applications to capture the constructs of technological Exploration and Exploitation (e.g. Choi et al. 2016, Sorensen and Stuart 2000). In particular, we base ourselves on the seminal work of Katila and Ahuja (2002). Exploitation captures the extent to which the firm, in its patent applications, reuses a knowledge base with which is already familiar. We define the variable as the total number of times that citations in the focal year were repeatedly used in patent applications filed between t-1 and t-5. To avoid overinflating the measure we only count repeated usage of the same citation across the different years. As a result, each citation can take a value between zero and five depending on whether the citation has never been used in the five years prior to the focal year, or whether it has been used at least once in each of the five years prior to the focal year. Exploration instead captures the extent to which the firm searches for new knowledge to develop innovations. Consistently, the measure is defined as the total number of new citations contained in the patent applications. Again, a citation is defined as new if it was never used in patent applications filed by the firm between t-1 and t-5.

We transform all our dependent variables by taking the natural logarithm in order to reduce the influence of outliers on the estimates obtained from our regression models.

Note that we use separate measures to capture Exploration and Exploitation. While in general we agree with Lavie et al. (2010) in that single measures capturing the degree of exploration vs. exploitation are more appropriate in most cases (e.g. Lavie and Rosenkopf 2006, Lin et al. 2007, Uotila et al. 2009), the use of separate measures in our study is justified by the fact that competition can induce firms to change their level of investment in R&D. An increase in R&D expenses would be consistent with increased levels of exploration but it wouldn't necessarily imply decreased levels of exploitation. Firms could even increase their level of engagement in the two activities proportionally in order to maintain balance. A similar argument applies in the case in which firms decrease their investment in R&D.

**Import penetration and instruments**

Our identification strategy for international competition is based on the prior work of Cuñat and Guadalupe (2009) and Xu (2012). Consistently, our proxy for international competition is Import Penetration. We start by calculating the level of import penetration, for every year and for every four-digits manufacturing SIC (SICs 2000-3999), as the ratio between the value of imports divided by the total value of internal production plus imports. All the data necessary for this calculation comes from the NBER website. Data on imports were compiled by Feenstra (Feenstra 1996), Feenstra, Romalis and Schott (Feenstra et al. 2002), and Schott (2010), data on the value of shipments at the four-digits SIC level comes from the NBER-CES Manufacturing Industry Database (Becker et al. 2013).

Import Penetration arguably is a good depiction of the extent to which foreign competitors are present in the U.S. domestic markets. Figure 2 shows that the trend over the sample period is generally upward. The average level of import penetration went from 13% in 1990, to 18% in 1998, to 25% in 2006. However, this tendency was not uniform across industries. As Figure 2 shows, some sectors start with a comparatively higher level of import penetration and experience a decline in the presence of foreign competitors while for other industries the trend is opposite. As a result, for every year in the sample period, our dataset contains a rich combination of changes in Import Penetration.

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For the purpose of our analysis, we refine our measure of import penetration by taking two further steps. First, we take the deviation in import penetration by subtracting the industry mean calculated between all sample years. This ensures that our measure does not capture unobserved differences across industries that are correlated with import penetration. Finally, we take into account whether the firm operates in different manufacturing industries by computing a weighted average (by segment sales) of the level of import penetration experienced by the firm in each of its industries. Taking into account whether the firm operates in multiple industries, instead of considering just the firm's main operating sector, ensures that our measure is a better reflection of the actual level of import penetration faced by the firm. However, it also presents further challenges, as the measure becomes dependent on endogenous production decision. To address this concern we keep the weights of the segments fixed and equal to the proportions of sales that the segments represent in 1998. For many firms the product offering changed radically in the years between 1990 and 2006, 1998 is halfway through the sample period and therefore it minimizes this problem. We have also repeated our analyses by changing the weight of the segments based on the proportion of total firm sales that the segments represent in each year. Results do not change.

Our empirical strategy fully exploits the panel nature of our datasets to include firm and year fixed-effects that control for unobserved heterogeneity. Notwithstanding this advantage, results obtained from regressions on import penetration can still be subject to a number of criticisms in terms of endogeneity. For example, reverse causality issues may arise if changes in the level of exploration and exploitation of U.S. firms drive the behavior of foreign executives and therefore influence their presence in the U.S. market (e.g. Cornaggia et al. 2015). Further, if firms anticipate changes in the level of imports the estimated effect will depend on the strategy adjustment that takes places after the intensity of international competition is manifest. Finally, our proxy for import penetration might be measured with error therefore causing attenuation bias. The presence of any of these problems would entail that the estimates obtained from our regression models are biased. To deal with these endogeneity concerns, we use current and lagged exchange rates as well as lagged tariffs to instrument for import penetration (Cuñat and Guadalupe 2009, Xu 2012).

We start by calculating measures of exchange rate and tariff at the sector level. Data on scheduled tariffs come from the World Bank UNCTAD TRAINS dataset and are available at the six-digits HS (Harmonized System) product level starting from 1989. Scheduled tariffs are superior in comparison to calculated average tariffs because they prevent the instrument from being mechanically correlated with imports.[1] From the TRAINS dataset we download data on the tariffs scheduled by the U.S. for each combination of trade partner and HS6 product category. Then, we use the NBER import data to calculate the weight of each trade partner on the imports of every four-digits SIC in 1998, our baseline year. We keep this weight fixed, and we use it to compute a weighted average tariff for each combination of SIC4 and HS6 product category. To assign HS6 product categories to SIC4 industries we use a mapping developed by the US Census Bureau and available through the NBER website. Finally, we calculate the average scheduled tariff for each industry-year as the simple average of the tariffs calculated for all the products assigned to that industry.

Our proxy for exchange rate is also calculated at the four-digits SIC sector level. Following Bertrand (2004), we define the measure as the weighted average of the log real exchange rate of importing countries expressed in amount of foreign currency per dollar. We transform nominal

[1] Average tariffs are available through the NBER website. The problem with using average tariffs lies in the fact that these are calculated as the ratio between duties collected and value of imports, and the value of imports also enters in the calculation of the import penetration variable. As a result, any error in measuring imports would generate variation that mechanically improves the fit on the instrumented variable. Our goal is instead to isolate the variation due to changes in tariffs.

exchange rates into real exchange rates using the trading partners Consumer Price Index (CPI). Data on CPIs and nominal exchange rates are obtained from the International Financial Statistics of the IMF. Again, we keep the weight of each trading partner constant throughout the sample period and equal to the share of imports that the country represents for each four-digits SIC in 1998. Following the procedure used for the calculation of our import penetration measure, exchange rates and tariffs are also demeaned and weighted to obtain firm-specific measure.

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For our instruments to be valid they have to be exogenous and satisfy the exclusion restriction. Being the dollar a freely floating currency, its exchange rate with other currencies is primarily determined by macroeconomic factors that affect its aggregate demand and supply. Examples are interest rates, inflation and the balance of payments between the U.S. and its trading partners. None of these factors is likely to be significantly affected by individual firm-level characteristics. Tariff rates instead are the result of international trade agreements and federal policy decisions and therefore are likely uncorrelated with firm-level innovation strategies. Nevertheless, one can still argue that executives might lobby to obtain increases in import tariff after experiencing an increase in competitive pressure. Figure 3 should mitigate this concern. The graph shows that the trend in tariff rate in the years of the sample period is consistently downwards. In particular, most of the decline in tariffs is concentrated in the years around 1995 when the results of the Uruguay round of the General Agreement on Tariffs and Trade (GATT) start being implemented. As an example between 1994 and 1995 the average tariff rate applied in the operating industries of the firms in our sample declined by 21%.

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## DESCRIPTIVE AND RESULTS

Table I contains the descriptive statistics. For each variable relevant for the analyses, we report both the raw value and the value of the transformation used in the regression models. As it is possible to see the distribution of many of the dependent variables is quite skewed, thereby justifying the use of logarithmic transformations. For example, the mean value for R&D Expenses in the full sample is 147 millions USD while the median is 11 millions USD. We mean-center Import Penetration and its instruments to prevent the variables from capturing cross-sector differences that are correlated with Import Penetration and that would prevent causal inference from our regression analyses. Furthermore, as described above, we use static segment weights to calculate Import Penetration for diversified firms. This helps in addressing the exclusion restriction since it increases the explanatory power of exchange rates and tariffs for imports and decreases the explanatory power for endogenous production decisions. The mean value of the raw import penetration measure is 0.2 over the sample period with a standard deviation of 0.14. For what concerns the average import tariff rate instead the mean value is 2.56 and the standard deviation is 2.46.

Table II reports the pairwise correlations. Many of the variables exhibit very high level of correlation but this is to be expected. For example, the total number of Patent Applications naturally is highly correlated with the total number of Citations Received (0.80), Exploitation (0.79), and Exploration (0.91). A high level of correlation in our case does not constitute a problem because potential multicollinearity issues only affect variables that will be used jointly as controls. For what concerns our independent variable, Import Penetration exhibits a highly negative correlation with tariffs (-0.61) and a low negative correlation with exchange rates (-0.07). The correlation of Import Penetration with Exploitation is positive and small (0.10), while the correlation of Import Penetration with Exploration is negative and small (-0.03).

Table III reports the results from first stage regressions for both the full sample and for the subsample of firm-years with a positive number of patent applications. The results are almost identical. In particular, columns 1 and 4 show that a real dollar appreciation significantly decreases Import Penetration in the same year while it significantly increases Import Penetration with a one-year lag. These results are consistent with the J-curve hypothesized in the literature of monetary economics (Bahmani-Oskooee and Ratha 2004, Magee 1973) and they are in line with the findings of recent studies (e.g. Cuñat and Guadalupe 2009). Columns 2 and 5 instead replace exchange rates with tariffs and show that higher tariffs are associated with lower Import Penetration. Finally, columns 3 and 6 test the instruments jointly. The results show that the effect of both tariffs and exchange rates remains significant.

Conclusions about the validity of our instruments are further reinforced by the statistics reported in Table IV together with the results from second stage regressions. We report statistics that are robust to violations of the i.i.d. assumption and that test for under-identification, weak identification, and for the over-identification restriction. The Kleibergen-Paap LM statistics test the null that the model is under-identified (i.e. the instruments are not correlated with the endogenous regressors). The null is rejected for all the models. The modified Kleibergen-Paap F statistics test for whether the model is identified but the instruments are only weakly correlated with the endogenous regressors. Weak instruments generate problems to the extent that they produce inconsistent instrumental variable estimators. Inconsistent estimators can be biased if the asymptotic distribution of the estimated parameters deviates substantially from the normal distribution (Stock et al. 2002). Stock and Yogo (2005) provide a table with the critical value of the F statistics for the weak instrument test at the 5 percent confidence level. In our case, the critical value is 13.5, while the Kleibergen-Paap F statistic of our models ranges between 84.6 and 48.7. Finally, we report the p-value from the Hansen-Sargan test of the over-identifying restriction (Hansen J). This is a test of the joint null that the excluded instruments are not correlated with the error term from the second stage regressions. The p-value associated with the Hansen J is never significant in any of the models. In particular, it ranges between from minimum of 0.45 in Model 4 to a maximum of 0.58 in Model 3. Therefore, the null cannot be rejected.

In our theoretical discussion we have argued that the increased exposure to foreign competitors is likely to be one of the determinants of the decline in Exploration observed by recent studies (Arora et al. 2017, Bhaskarabhatla and Hegde 2014, Coombs and Georghiou 2002). International competition is in fact susceptible of generating both a threat rigidity response and incentives for opportunistic myopic behavior on the side of managers. Models 1 to 5 in Table IV contain the results of our test. In particular, our dependent variables are five: R&D Expenses, Patent Applications, Citations Received, Exploitation, and Exploration. All regressions include firm and year fixed-effects and control for firm size and profitability. Depending on the specification, when necessary, we also control for R&D Expenses, number of Patent Applications, the size of the Patent Stock, and the number of Citations Made in the patent applications. We cluster standard errors by firm in all specifications to allow for autocorrelation of the error term within firm across years.

Model 1 tests the effect of Import Penetration on firms' expenditure in R&D activities. The effect is negative and significant (-1.11; p-value<0.05). Model 2 tests the effect of Import Penetration on the number of Patent Applications made by the firms. We find no effect. Model 3 tests the effect of Import Penetration on the number of Citations Received by the patents for which the firm applied. Here the effect is negative and highly significant (-7.24; p-value<0.01). Model 4 tests the effect of Import Penetration on Exploitation. The effect is positive and highly significant (3.53; p-value<0.01). Finally, Model 5 tests the effect of Import Penetration on Exploration. The effect is negative and highly significant (-1.88; p-value<0.01).

As it is possible to see, these results return quite a coherent picture supporting the idea that firms react to international competition by cutting exploration and increasing exploitation. Therefore, considering that the exploitation is relatively less costly, firms are able to save in terms of R&D expenses. However, while these savings do not affect the production of innovations in terms of number of patent applications, the innovations produced are less influential. In fact, international competition decreases the total number of citations received in the future by the patents for which the firm applies.

The magnitude of these effects is also highly significant. To put things into perspective, these coefficients imply that if Import Penetration increases by 5 percentage points, going for example from 0.15 to 0.20, this generates a 5.6% reduction of firms' investment in R&D, a 17.6% increase in exploitation, a 9.4% decrease in exploration, and in turn the citations received by the patents for which the firms apply decrease by 36.2%.

### COMPLEMENTARY ANALYSES

In the theory section, we outlined two possible mechanisms that could link an increase in international competition to a decrease in exploration. In this section, we engage in a series of complementary analyses with the aim of testing them. It is worthwhile noticing that the proposed explanations are not mutually exclusive.

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Insert Table V About Here

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The first mechanism conjectured the existence of a threat rigid response (Staw et al. 1981) of incumbent domestic firms when faced with an increase in pressure from foreign competitors. Threat rigidity is the results of psychological and sociological mechanisms connected to the perception of existential threats in the firm's environment. It follows that organizational characteristics that influence the likelihood of failure should also influence the extent to which firms decrease their level of exploration as a result of international competition. Here we take into consideration two of these characteristics: The degree of product-market diversification and the extent to which the cost structure of the firm is fixed rather than variable. By lowering the variability of performance, product-market diversification is a well-known factor that decreases the likelihood of bankruptcy (e.g. Amit and Livnat 1988). Therefore, we expect comparatively more diversified firms to reduce to a lesser extent their exploration efforts after an increase in international competition. Vice-versa the degree of operating leverage (the relative importance of fixed costs in the cost structure of the firm) influences the extent to which changes in sales affect firm profits. Firms with a higher degree of operating leverage are more likely to fail as a result of a decline in market share and therefore we expect them to engage in a comparatively higher reduction of exploration after an increase in competition. We measure Product-Market Diversification with the Entropy measure (Palepu 1985). We measure

Operating Leverage through the ratio between selling, general and administrative expenses over sales, consistent with research showing that this important cost item is relatively insensitive to declines in sales (Anderson et al. 2003). The results from the analyses are contained in Model 1 and 2 of Table V and support the idea that threat rigidity is at least partly responsible for the decline in exploration that follows an increase in international competition. The coefficient of the interaction between the Entropy measure of diversification and Import Penetration in fact is positive and significant in Model 1 (coeff. = 1.886; $p<0.05$), while the coefficient of the interaction between the Operating Leverage and Import Penetration is negative and significant in Model 2 (coeff. = -9.826; $p<0.01$)[2].

The second explanation that we have advanced deals with opportunistic myopic behavior on the side of managers. By increasing the difficulty of achieving the performance targets, international competition generates career concerns and incentives for foregoing valuable long-term investment opportunities. We test this explanation using both compensation and governance measures. If opportunism is responsible for the decline in exploration, we expect forward-looking incentive compensation to correct at least in part the problem. We take the logarithm of the total value of the unexercisable stock options held by the CEO as a measure of forward-looking incentive compensation. For what concerns our governance measure instead we use the Governance Index developed by Gompers et al. (2003), and available through Andrew Metrick website, to capture the extent a firm internal balance of power is tilted toward its management or toward its shareholders. We expect that the higher the level of the index and therefore the more the management is entrenched in the firm, the less the management will need to give up valuable long-term investment opportunities to boost current profits. The results from the analysis are reported in Model 3 and Model 4 in Table V. Neither of the interactions between international competition and our measures of forward-looking compensation and governance is significant.

[2] For the sake of brevity, we report only the results of the tests on Exploration, nevertheless we also estimate the effect of these interactions on the rest of our proxies for innovation. In particular, the interaction between Diversification and Import Penetration is negative and significant on the number of Patent Applications and positive and significant on the number of Citations Received. The interaction between Operating Leverage and Import Penetration instead, is negative and significant on the number of Citations Received. These results are consistent with the main results on Exploration. They are available from the authors upon request.

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Insert Figure 4 About Here

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Figure 4 graphically depicts the effect of a 5 percentage point increase in import penetration for firms that are in the 25th, 50th, and 75th percentiles of Diversification and Operating Leverage. The values of the percentiles for the Entropy Measure of diversification are calculated only among diversified firms. As it is possible to see for both Diversification and Operating leverage the difference between the 25th and the 75th percentile of the distribution is of about 10%. Firms that are in the in the 75th percentile of the distribution for Diversification will do approximately 10% more exploration than firms in the 25th percentile of the distribution, the opposite occurs for Operating Leverage.

Finally, we investigate whether firms simply cut their investment in exploration or whether they try to substitute for its decline by finding cheaper sources of innovations. We expect the second option to be more likely as managers might find it easier to justify cutting internal R&D to stakeholders if there is a sizable supply of technology available to be either bought or licensed (Arora et al. 2001). To test whether this is the case we follow Arora and Nandkumar (2012) and develop a measure of technological supply for each four-digits SIC sector by considering the one-year lagged stock of utility patents granted to universities and governmental agencies[3]. We expect that the higher the technology supply available for a sector the less firms will engage in exploration after an increase in competition because they can resort to market-based technology transactions. The result from the analysis is contained in Model 5 in Table V. As it is possible to see, the empirical evidence is consistent with international competition leading firms to outsource the production of exploratory innovations. Indeed,

[3] We use a five years rolling window in the calculation of the stock of patents. The procedure for the calculation of the measure involves four steps. First, we calculate the technological intensity of each sector by computing the total number of patents granted to the companies operating in that sector. Second, we calculate a "technological supply ratio" for every technological class by dividing the total number of patents granted to universities and governmental institutions by the total number of patents granted to firms. The technological supply ratio captures how many patents concerning a technology are potentially available for licensing for every patent that is owned by a firm. Third, we calculate the weight of each technology in what we call "technological mix" of each sector. The technological mix captures which technologies are used by the firms operating in an industry and in what proportion. We calculate the weight of technology "c" in the technological mix of industry "I" by dividing the total number of patents granted to firms operating in industry "I" concerning technology "c", by the total number of patents granted to firms operating in industry "I". Finally, we calculate our measure of supply of technology for an industry in the following way:

$$Tech.Supply_I = \sum_{c=1}^{N} Tech.Intensity_I \times Supply\ Ratio_{I,c} \times Weight\ in\ Tech.Mix_{I,c}$$

The underlying assumption is that university and governmental agency will tend to either license or sell the technology that they produce considering that they lack the downstream capabilities that are necessary for the commercialization.

the coefficient of the interaction between Technological Supply and Import Penetration is negative and significant on exploration (coeff = -0.461, $p<0.05$).

## DISCUSSION AND CONCLUSIONS

This study addresses the effect of international competitive pressure on exploration and exploitation in the domain of technological innovation. Our results show how international competition produces an increase in technological exploitation and a decrease in technological exploration. To give an idea of the effect size, in our sample period an increase of 5 percentage points in Import Penetration produces a 17.6% increase in Exploitation and a 9.4% decrease in Exploration. Consistently, firms lower their investment in R&D by 5.6% and the number of Citations Received by the patents for which firms apply decreases by 36.1%.

We advance two theoretical mechanisms that might account for the observed relationship: Threat Rigidity and Opportunistic Myopia. According to Threat Rigidity (Staw et al. 1981) organizations facing environmental threats, such as an increase in competitive pressure, will follow a predictable pattern of behavior that involves a restriction in information processing, a constriction of control, and an increased attention toward the conservation of resources. All these tendencies are potentially linked to a decrease in firms' exploratory effort. The Opportunistic Myopia explanation instead points toward managerial self-interest as the driver causing firms to forego valuable long-term investment opportunities in favor of investments with a shorter time horizon of expected returns. According to this account, competition increases the difficulty of achieving the firm's performance target (Easterwood and Nutt 1999). This in turn threatens managerial employment security and provides incentive for opportunistic behavior (Campbell and Marino 1994, Stein 1988, 1989).

In separate analyses, we test each of the two theoretical mechanisms. We use firms' characteristics that affect the likelihood of failure as a result of competition (Product-Market Diversification and Operating Leverage) to test for Threat Rigidity. We use compensation and governance measure that influence the alignment of interests between managers and firms' shareholders (Value of Unexercisable Stock Options and the Governance Index) to test for Opportunistic Myopia. Our analyses provide support for Threat Rigidity but not for Opportunistic Myopia. We note however that the two mechanisms are not mutually exclusive and therefore they could potentially coexist. Further, our lack of support for the Opportunistic Myopia explanation might be partly due to the fact that the sample size of the analyses testing this mechanism is about half of that of the analyses testing for Threat Rigidity. Both our compensation and governance proxies in fact have a lot of missing values in our sample period.

We also provide evidence indicative that firms try to compensate for the decline in internal exploration by finding cheaper sources of innovation. The decline in exploration in fact is particularly strong in sectors in which there is a sizable supply of technology available to be either bought or licensed. We argue that this substitution is unlikely to lead to long-term competitive advantage, as external markets for technology are available to all sector incumbents. If these markets are at least to some extent efficient, then the rents generated by a valuable new technology will be appropriated by the seller. Furthermore, even if we assume that sector incumbents differ in their ability to identify valuable technology, firms that are not actively involved in exploration are unlikely to have an edge. The literature on absorptive capacity (Cohen and Levinthal 1990) in fact teaches us that a firm's ability to recognize and exploit new technologies depends on the firm's experience with prior related knowledge.

Our findings make several contributions to the extant literature. First, our evidence is consistent with the results of academic studies that document the downsizing of large corporate R&D labs and the decline in the rate of firms' contribution to basic science (Arora et al. 2017, Bhaskarabhatla and Hegde 2014, Coombs and Georghiou 2002). This literature suggests that firms are increasingly focusing on a narrower and more applied knowledge base; nevertheless these studies also show that firms' patenting activity (in terms of quantity) has either remained unaffected or has increased over time. We contribute to the debate by first showing that the nature of corporate patents has change over time in a way consistent with increasing technological specialization. Then, we identify the increase in international competition as a key driver responsible for this change in behavior. This finding also has implications for the debate on the relationship between competition and innovation (Aghion et al. 2005, Bloom et al. 2016). While we are not concerned with the total amount of innovation produced in an economy, our findings do call for an increased attention to the quality of the innovation that is produced after an increase in competition. The relationship between competition and innovation quality (degree of exploitation and citations received) in our sample is negative.

Second, our results make an important contribution to the organizational ambidexterity literature (He and Wong 2004, Katila and Ahuja 2002, Tushman and O'Reilly 1996). Recent findings in the literature suggest that balancing exploration and exploitation in their relative magnitude is particularly beneficial for firms that operate in environments characterized by low munificence (Cao et al. 2009). In contrast, we find that in our context firms react to international competition by decreasing the level of investment in R&D, but instead of correspondingly decreasing patent production to maintain a balance between exploration and exploitation, they choose to do less of the former and more of the latter.

The only scenario in which this reaction is efficient is if prior to the increase in competition firms were in general doing more exploration than exploitation. While we have no means of testing for whether this is the case, we argue that this scenario is unlikely as adaptive systems naturally tend to overemphasize exploitation at the expenses of exploration (Levinthal and March 1993, March 1991, Miller 2002). Therefore we submit that developing both architectural and contextual mechanisms for achieving ambidexterity is fundamental in a context characterized by intense competition (Fang et al. 2010, Gibson and Birkinshaw 2004, Gupta et al. 2006).

On the methodological side the results obtained from our analyses are particularly robust. We test our hypotheses on a large panel dataset of U.S. manufacturing firms (SICs 20-39) that spans the period 1991-2006. The panel nature of the dataset allows for the inclusion of both firm and year fixed effects that control for unobserved heterogeneity at the firm level and unobserved trends. Further, we follow prior literature and instrument our independent variable, Import Penetration, using both exchange rate and tariffs (Cuñat and Guadalupe 2009, Xu 2012) to reduce endogeneity concerns and permit a causal interpretation of the results. Finally, to increase the confidence in the results, we estimate regressions also on other proxies for innovation such as R&D Expenses, the number of Patent Applications, and the number of Citations Received by the patents for which the firm applies. The results obtained from these analyses serve as a crosscheck for the consistency of the story about the effect of international competition on Exploration and Exploitation.

To conclude, we also acknowledge that our study suffers from some limitation. First of all, we test the effect of international competition on exploration and exploitation only in the domain of R&D. In recent years the literature has applied the concepts of exploration and exploitation to other functional domains such as marketing (e.g. Lavie et al. 2011), and also to structural domains such as the formation of alliances (e.g. Lavie and Rosenkopf 2006). There is no guarantee that the findings of this study will be generalizable to domains other than the one of technology. In explicitly acknowledging this limitation we join the call of other prominent scholars (Lavie et al. 2010) and try to avoid the problems related to the overgeneralization of the findings that are plaguing the literature on exploration and exploitation. Second, our sample is composed entirely by U.S. firms. While we believe that our results should be generalizable to other national contexts we are not able to control for whether the idiosyncratic characteristics of the U.S. economy are influencing the relationship between competition, exploration and exploitation.

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FIGURE 1: PERCENTAGE OF EXPLORING AND EXPLOITING CITATIONS IN PATENTS (5-YEARS WINDOW)

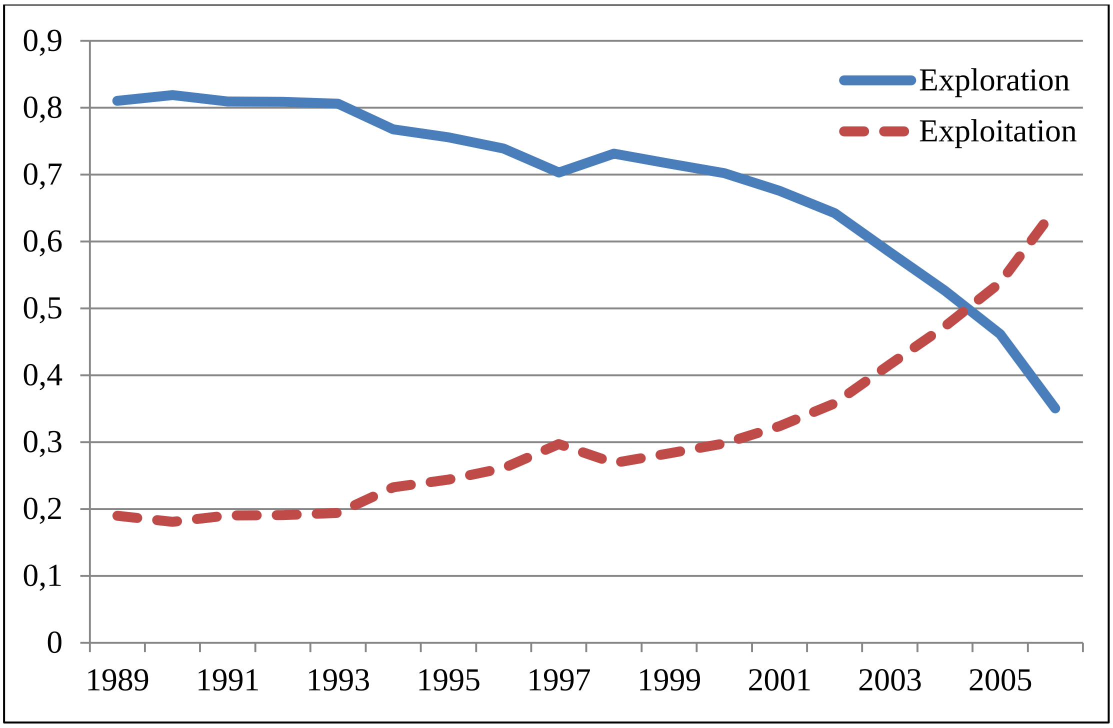



FIGURE 2: TREND IN IMPORT PENETRATION – AVERAGE AND BY SECTOR

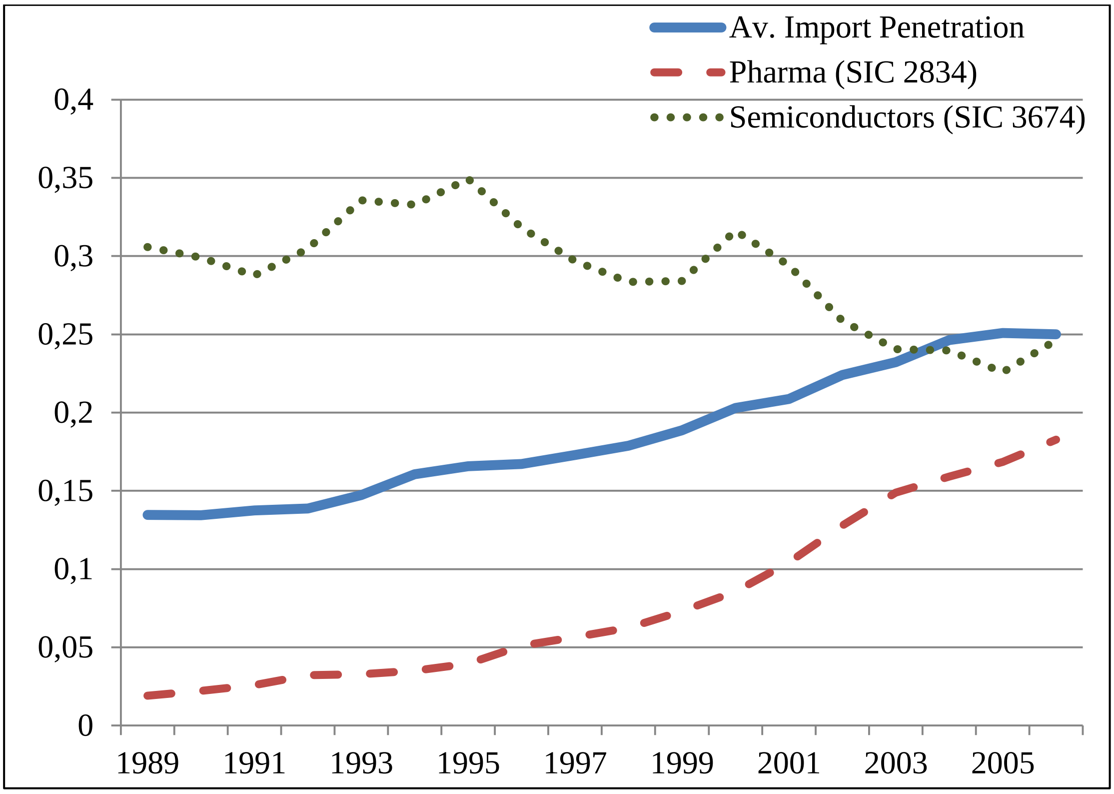


FIGURE 3: AVERAGE SCHEDULED TARIFF BY YEAR

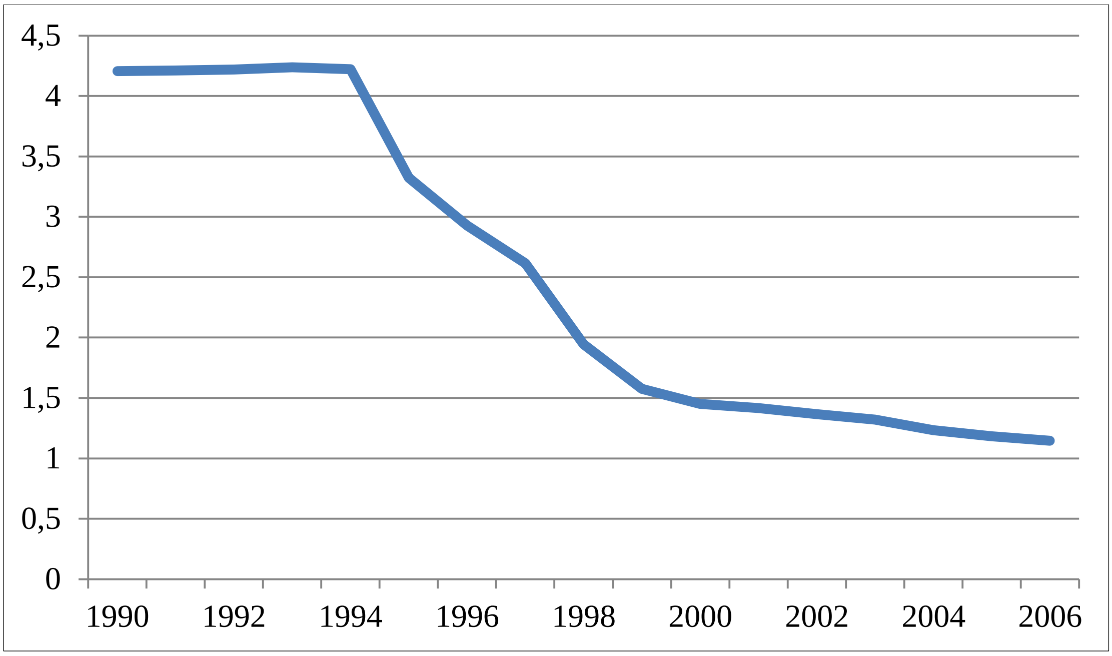
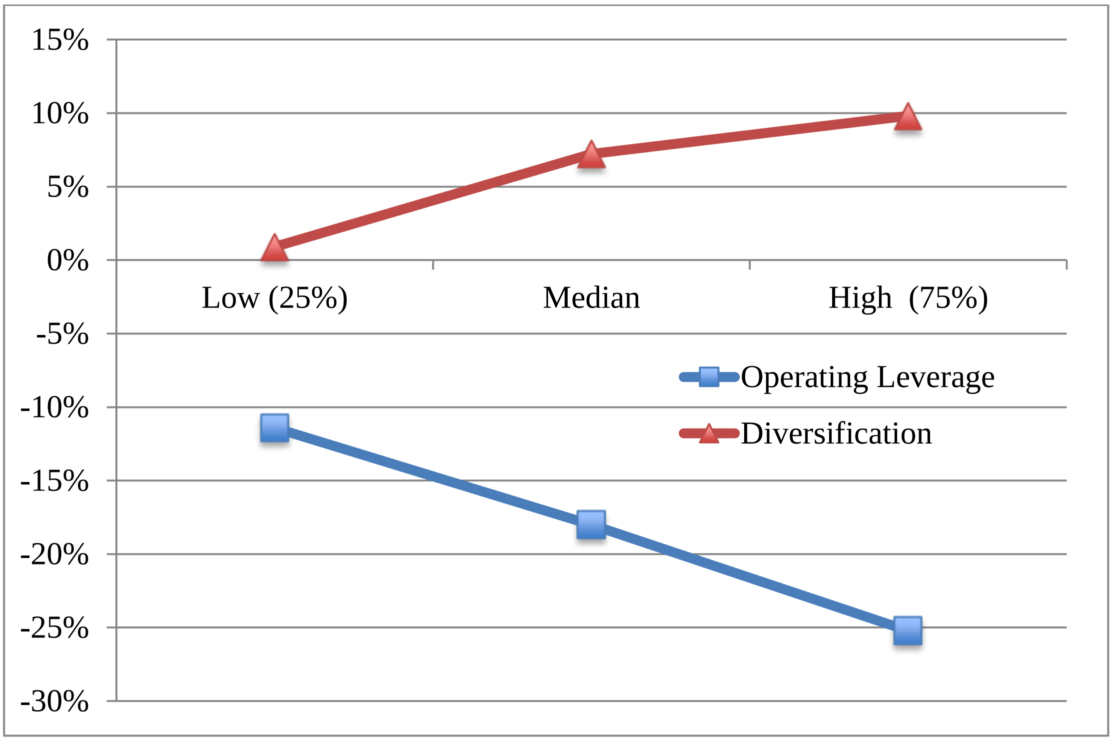



FIGURE 4: INTERACTION EFFECTS ON EXPLORATION FOR A 5 PERCENTAGE POINTS INCREASE IN IMPORT PENETRATION.




Note: The graph depicts the interaction effects of Diversification and Operating Leverage for a 5 percentage points increase in Import Penetration. For the Diversification interaction the value of the 25th, 50th and 75th percentiles are calculated only among diversified firms.

TABLE I: DESCRIPTIVE STATISTICS

| | Obs. | Mean | SD | p25 | p50 | p75 |
|---|---|---|---|---|---|---|
| *Dependent Variables* | | | | | | |
| R&D (raw) | 16894 | 147.31 | 600.48 | 3.08 | 11.17 | 45.45 |
| R&D (ln) | 16894 | 2.81 | 1.84 | 1.41 | 2.50 | 3.84 |
| Patents app. (raw) | 16894 | 24.32 | 119.00 | 0 | 1.00 | 6.00 |
| Patents app. (ln) | 16894 | 1.17 | 1.57 | 0 | 0.69 | 1.95 |
| Citations Received (raw) | 8429 | 696.51 | 2703.56 | 12.30 | 59.07 | 266.32 |
| Citations Received (ln) | 8429 | 4.00 | 2.42 | 2.59 | 4.10 | 5.59 |
| Exploiting Cit. (raw) | 8429 | 560.36 | 3263.31 | 2.00 | 25.00 | 186.00 |
| Exploiting Cit. (ln) | 8429 | 3.34 | 2.55 | 1.10 | 3.26 | 5.23 |
| Exploring Cit. (raw) | 8429 | 301.92 | 948.47 | 13.00 | 43.00 | 169.00 |
| Exploring Cit. (ln) | 8429 | 3.95 | 1.82 | 2.64 | 3.78 | 5.14 |
| *Import Penetration & Instruments* | | | | | | |
| Import Penetration (raw) | 16894 | 0.20 | 0.14 | 0.10 | 0.17 | 0.26 |
| Import Penetration (mean c.) | 16894 | 0.00 | 0.06 | -0.03 | -0.01 | 0.03 |
| Exchange Rate (raw) | 16894 | 2.53 | 0.73 | 2.06 | 2.53 | 3.05 |
| Exchange Rate (mean c.) | 16894 | 0.00 | 0.26 | -0.13 | 0.03 | 0.15 |
| Tariff Rate (raw) | 16894 | 2.56 | 2.46 | 0.63 | 2.09 | 4.11 |
| Tariff Rate (mean c.) | 16894 | 0.07 | 1.48 | -1.17 | -0.03 | 1.19 |
| *Independent Variables & Controls* | | | | | | |
| Diversification | 8429 | 0.20 | 0.36 | 0 | 0 | 0.36 |
| Operating Leverage | 7979 | 0.33 | 0.22 | 0.19 | 0.30 | 0.42 |
| Unexercisable Stock Options (ln) | 3705 | 5.28 | 3.58 | 0 | 6.37 | 8.10 |
| Governance Index | 3070 | 9.11 | 2.82 | 7 | 9 | 11 |
| Technology Supply (ln) | 8429 | 4.41 | 1.68 | 3.27 | 4.57 | 5.48 |
| Sales (ln) | 16894 | 5.57 | 2.05 | 3.97 | 5.19 | 6.81 |
| ROA | 16894 | 0.09 | 0.15 | 0.05 | 0.11 | 0.18 |
| Citations Made (ln) | 8429 | 4.38 | 1.88 | 3.00 | 4.20 | 5.64 |

TABLE II: CORRELATIONS

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | R&D | 1.00 | | | | | | | | | | | | | | | | |
| 2 | Patents App. | 0.64 | 1.00 | | | | | | | | | | | | | | | |
| 3 | Cit. Received | 0.42 | 0.80 | 1.00 | | | | | | | | | | | | | | |
| 4 | Exploiting Cit. | 0.57 | 0.79 | 0.58 | 1.00 | | | | | | | | | | | | | |
| 5 | Exploring Cit. | 0.62 | 0.91 | 0.78 | 0.70 | 1.00 | | | | | | | | | | | | |
| 6 | Self-Citations | 0.62 | 0.88 | 0.67 | 0.89 | 0.79 | 1.00 | | | | | | | | | | | |
| 7 | Imp. Penetration | 0.09 | -0.09 | -0.28 | 0.10 | -0.03 | 0.03 | 1.00 | | | | | | | | | | |
| 8 | Exchange Rate | -0.04 | 0.06 | 0.11 | 0.00 | 0.06 | 0.02 | -0.09 | 1.00 | | | | | | | | | |
| 9 | Tariff Rate | -0.11 | 0.06 | 0.30 | -0.15 | 0.00 | -0.07 | -0.61 | 0.08 | 1.00 | | | | | | | | |
| 10 | Diversification | 0.21 | 0.17 | 0.12 | 0.09 | 0.18 | 0.16 | -0.01 | 0.02 | 0.00 | 1.00 | | | | | | | |
| 11 | Op. Lev | 0.01 | -0.08 | -0.11 | 0.00 | -0.14 | -0.08 | 0.09 | -0.02 | -0.14 | -0.20 | 1.00 | | | | | | |
| 12 | Stock Opt. | 0.25 | 0.18 | 0.11 | 0.17 | 0.14 | 0.17 | 0.03 | -0.01 | -0.05 | -0.02 | 0.05 | 1.00 | | | | | |
| 13 | Governance | 0.09 | 0.06 | 0.01 | 0.06 | 0.06 | 0.09 | 0.01 | -0.04 | 0.01 | 0.16 | -0.12 | 0.02 | 1.00 | | | | |
| 14 | Tech. Supply | 0.29 | 0.15 | 0.03 | 0.19 | 0.11 | 0.14 | 0.15 | -0.08 | -0.19 | -0.12 | 0.32 | 0.16 | -0.12 | 1.00 | | | |
| 15 | Sales | 0.80 | 0.54 | 0.38 | 0.46 | 0.57 | 0.54 | 0.05 | -0.01 | -0.05 | 0.35 | -0.39 | 0.14 | 0.24 | -0.01 | 1.00 | | |
| 16 | ROA | 0.10 | 0.14 | 0.18 | 0.08 | 0.18 | 0.13 | -0.07 | 0.00 | 0.14 | 0.07 | -0.55 | 0.21 | 0.09 | -0.13 | 0.34 | 1.00 | |
| 17 | Citations Made | 0.65 | 0.92 | 0.73 | 0.88 | 0.93 | 0.88 | 0.04 | 0.03 | -0.08 | 0.14 | -0.07 | 0.17 | 0.05 | 0.18 | 0.55 | 0.13 | 1.00 |

TABLE III: FIRST STAGE REGRESSIONS

| | Import Pen. (1) | Import Pen. (2) | Import Pen. (3) | Import Pen. (4) | Import Pen. (5) | Import Pen. (6) |
|---|---|---|---|---|---|---|
| | *Full Sample* | | | *Subsample with Pat. Applications* | | |
| Exchange rate | -0.016** | | -0.012** | -0.014** | | -0.009* |
| | (0.000) | | (0.000) | (0.002) | | (0.040) |
| Lag Exch. Rate | 0.028** | | 0.024** | 0.020** | | 0.015** |
| | (0.000) | | (0.000) | (0.000) | | (0.000) |
| Lag Tariff | | -0.014** | -0.014** | | -0.014** | -0.014** |
| | | (0.000) | (0.000) | | (0.000) | (0.000) |
| Controls | YES | YES | YES | YES | YES | YES |
| Firm FE | YES | YES | YES | YES | YES | YES |
| Year FE | YES | YES | YES | YES | YES | YES |
| N | 16,894 | 16,894 | 16,894 | 8,429 | 8,429 | 8,429 |
| R-squared | 0.398 | 0.442 | 0.445 | 0.345 | 0.408 | 0.409 |

Note: The regressions of on the *Full Sample* include as controls Firm sales (log), Firm ROA, and R&D Expenses (log). Aside from these three control variables the regressions on the *Subsample with Patent Applications* include as controls the number of Patent Application in the year (log), The Patent Stock of the firm (log); and the total Number of Citations contained in the patent applications made by the firm in the year (log).
Note: P-values in parentheses. Two-tailed tests for all the variables in the models (+ p < .10; * p < .05; ** p < .01)

TABLE IV: SECOND STAGE

| | R&D (1) | Pat. Appl. (2) | Cit. Received (3) | Exploitation (4) | Exploration (5) |
|---|---|---|---|---|---|
| Lag Import Penetration | -1.114* | 0.225 | -7.235** | 3.528** | -1.883** |
| | (0.020) | (0.835) | (0.000) | (0.010) | (0.006) |
| Sales | 0.750** | 0.136** | -0.025 | 0.038 | -0.031 |
| | (0.000) | (0.000) | (0.628) | (0.492) | (0.300) |
| ROA | -1.241** | -0.266** | 0.104 | -0.179 | 0.142 |
| | (0.000) | (0.002) | (0.495) | (0.314) | (0.175) |
| R&D | | 0.187** | -0.149** | -0.044 | -0.001 |
| | | (0.000) | (0.001) | (0.361) | (0.981) |
| Patent Applications | | | 1.288** | -0.053 | 0.460** |
| | | | (0.000) | (0.208) | (0.000) |
| Patent Stock | | | | 0.802** | -0.291** |
| | | | | (0.000) | (0.000) |
| Citations Made | | | | 0.926** | 0.693** |
| | | | | (0.000) | (0.000) |
| Observations | 16,894 | 16,894 | 8,429 | 8,429 | 8,429 |
| KP LM | 232.78** | 234.32** | 139.38** | 141.60** | 141.60** |
| KP F | 84.585 | 84.859 | 48.744 | 49.749 | 49.749 |
| Hansen J (p-v.) | 0.454 | 0.460 | 0.584 | 0.447 | 0.508 |

Note: P-values in parentheses. Two-tailed tests for all the variables in the models (+ p < .10; * p < .05; ** p < .01)

TABLE V: COMPLEMENTARY ANALYSES

| Dependent Variable: Exploration | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|---|---|---|---|---|---|
| Lag Import Penetration | -1.917** (0.005) | 2.001 (0.130) | -1.387 (0.169) | 0.776 (0.650) | 0.322 (0.756) |
| Diversification X Imp. Pen. | 1.886* (0.017) | | | | |
| Op. Leverage X Imp. Pen. | | -9.826** (0.001) | | | |
| Stock option X Imp. Pen. | | | -0.060 (0.587) | | |
| Governance X Imp. Pen. | | | | -0.155 (0.357) | |
| Tech Supply X Imp. Pen. | | | | | -0.461* (0.019) |
| Diversification | 0.042 (0.194) | | | | |
| Operating Leverage | | -0.109 (0.397) | | | |
| Unexercisable Stock Options | | | 0.004 (0.143) | | |
| Governance Index | | | | -0.002 (0.862) | |
| Technology Supply | | | | | -0.000 (0.993) |
| Controls | YES | YES | YES | YES | YES |
| Firm Fixed-Effects | YES | YES | YES | YES | YES |
| Year Fixed-Effects | YES | YES | YES | YES | YES |
| N | 8,429 | 7,979 | 3,705 | 3,070 | 8,429 |
| KP LM | 141.156 | 130.685 | 63.371 | 58.238 | 134.947 |
| KP F | 26.266 | 19.858 | 12.587 | 9.526 | 22.618 |
| Hansen J (p-value) | 0.445 | 0.300 | 0.590 | 0.778 | 0.899 |

Note: All the regressions include as controls: Firm sales (log), Firm ROA, R&D Expenses (log), the number of Patent Application in the year (log), the Patent Stock of the firm (log), and the total Number of Citations contained in the patent applications made by the firm in the year (log).
P-values in parentheses. Two-tailed tests for all the variables in the models (+ p < .10; * p < .05; ** p < .01)