IMPORTED INTERMEDIATE INPUTS AND DOMESTIC PRODUCT GROWTH: EVIDENCE FROM INDIA[1]

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Abstract

New goods play a central role in many trade and growth models. We use detailed trade and firm-level data from India to investigate the relationship between declines in trade costs, imports of intermediate inputs and domestic firm product scope. We estimate substantial gains from trade through access to new imported inputs. Moreover, we find that lower input tariffs account on average for 31 percent of the new products introduced by domestic firms. This effect is driven to a large extent by increased firm access to new input varieties that were unavailable prior to the trade liberalization.

Keywords: Intermediate Inputs, Firm Scope, Multi-product Firms, Product Growth, Gains from Variety, Endogenous Growth, Trade Liberalization, India

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1. Introduction

New intermediate inputs play a central role in many trade and growth models. These models predict that firms benefit from international trade through their increased access to previously unavailable inputs, and this process generates static gains from trade. Access to these new imported inputs in turn enables firms to expand their domestic product scope through the introduction of new varieties, which generates dynamic gains from trade. Despite the prominence of these models, we have surprisingly little evidence to date on the relevance of the underlying microeconomic mechanisms.

In this paper we take a step towards bridging the gap between theory and evidence by examining the relationship between new imported inputs and the introduction of new products by domestic firms in a large and fast growing developing economy: India. During the 1990s, India experienced an explosion in the number of products manufactured by Indian firms, and these new products accounted for a quarter of India's manufacturing output growth (Goldberg, Khandelwal, Pavcnik and Topalova, henceforth GKPT, *forthcoming*). During the same period, India also experienced a surge in imported inputs, with more than two-thirds of the intermediate import growth occurring in new varieties. The goal of this paper is to determine if the increase in Indian firms' access to new imported inputs can explain the introduction of new products in the domestic economy by these firms.

One of the challenges in addressing this question is the potential reverse causality between imports of inputs and new domestic products. For instance, firms may decide to introduce new products for reasons unrelated to international trade. Once the manufacturing of such products begins, the demand for imported inputs, both existing and new varieties, may increase. This would lead to a classic reverse causality problem: the growth of domestic products could lead to the import of new varieties and not vice versa. To identify the relationship between changes in imports of intermediates and introduction of new products by domestic firms, we exploit the particular nature of India's trade reform. The reform reduced input tariffs differentially across sectors and was not subject to the usual political economy pressures because the reform was unanticipated by Indian firms.

Our analysis proceeds in two steps. We first offer strong reduced-form evidence that declines in input tariffs resulted in an expansion of firms' product scope: industries that experienced the largest declines in input tariffs contributed relatively more to the introduction of new products by domestic firms.[2] The relationship is also economically significant: lower input tariffs account on average for 31 percent of the observed increase in firms' product scope over this period. Moreover, the relationship is robust to specifications that control for pre-existing industry- and firm-specific trends. We also find that lower input tariffs improved the performance of firms in other dimensions including output, TFP and research and development (R&D) activity that are consistent with the link between trade and growth.

In order to investigate the channels through which input tariff liberalization affected domestic product growth in India, we then impose additional structure guided by the methods of Feenstra (1994) and Broda and Weinstein (2006) and use India's Input-Output (IO) Table to construct exact input price indices for each sector. The exact input price index is composed of two parts: a part that captures changes in prices of existing inputs and a part that quantifies the impact of new imported varieties on the exact price index. Thus, we can separate the changes in the exact input price indices faced by firms into a "price" and "variety" channel. This methodology reveals substantial gains from trade through access to new imported input varieties: accounting for new imported varieties lowers the import price index for intermediate goods on average by an additional 4.7 percent per year relative to conventional gains through lower prices of existing imports.

We relate the two components of the input price indices to changes in firm product scope. The results suggest an important role for the extensive margin of imported inputs. Greater access to imported varieties increases firm scope. This relationship is robust to an instrumental variable strategy that accounts for the potential endogeneity of input price indices using input tariffs and proximity of India's trading partners as instruments. Hence, we conclude that input tariff liberalization contributed to domestic product growth not simply by making available imported

[2] Recent theoretical work by Bernard, Redding and Schott (2006), Eckel and Neary (*forthcoming*) and Nocke and Yeaple (2006) shows that trade liberalizations should lead firms to rationalize their product scope. These theoretical models focus on the role of final goods and tariffs on output, while the analysis of this paper focuses on input tariffs and the role of intermediates.

inputs cheaper, but, more importantly, by relaxing technological constraints facing such producers via access to new imported input varieties that were unavailable prior to the liberalization.[3]

These findings relate to two distinct, yet related, literatures. First, endogenous growth models, such as the ones developed by Romer (1987, 1990) and Rivera-Batiz and Romer (1991), emphasize the static and dynamic gains arising from the import of new varieties. Not only do such varieties lead to productivity gains in the short and medium run, the resulting growth fosters the creation of new domestic varieties that further contribute to growth. The first source (static) of gains has been addressed in the empirical literature before. Existing studies document a large expansion in new imported varieties (Feenstra [1994], Broda and Weinstein [2006], Arkolakis, Demidova, Klenow and Rodriguez-Clare [2008], Klenow and Rodriguez-Clare [1997]), which, depending on the overall importance of new imported varieties in the total volume of trade, can generate substantial gains from trade (see, for example, Feenstra [1994] and Broda and Weinstein [2006]).[4] Our evidence points to large static gains from trade because of increased access to imported inputs.

The second source (dynamic) of gains from trade has been empirically elusive, partly because data on the introduction of *domestic* varieties produced in each country have been difficult to obtain.[5] The two studies that are closest to ours (Broda, Greenfield and Weinstein [2006] and Feenstra, Madani, Yang, and Liang [1999]) resort to export data to overcome this difficulty. They use the fraction of the economy devoted to exports and industry-specific measures of export varieties as proxies for domestic R&D and domestic variety creation, respectively. The advantage of our data is that we directly observe the creation of new varieties by domestic firms. This enables us to link the creation of new domestic varieties to changes in imported inputs. In our framework, trade encourages creation of new domestic varieties because Indian trade liberalization significantly reduces tariffs on imported inputs. This leads to imports of new varieties of intermediate products,

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[3] The importance of increased access to imported inputs has been noted by Indian policy makers. In a recent speech, Rakesh Mohan, the managing director of the Indian Reserve Bank, argued that "trade liberalization and tariff reforms have provided increased access to Indian companies to the best inputs available globally at almost world prices" (Mohan 2008).

[4] Klenow and Rodriguez-Clare (1997) and Arkolakis, Demidova, Klenow and Rodriguez-Clare (2008) find small variety gains following the Costa Rican trade liberalization, which they attribute to the fact that the new varieties were imported in small quantities, thus contributing little to welfare.

[5] Brambilla (2006) is an exception.

which in turn enables the creation of new domestic varieties. Hence, new imported varieties of intermediate products go hand-in-hand in our context with new varieties of domestic products.

Our study also relates to the literature on the effects of trade liberalization on total factor productivity. Several theoretical papers have emphasized the importance of intermediate inputs for productivity growth (e.g., Ethier [1979, 1982], Markusen [1989], Romer [1987, 1990], Grossman and Helpman [1991]). Empirically, most recent studies have found imports of intermediates or declines in input tariffs to be associated with sizeable productivity gains (see Kasahara and Rodrigue [2008], Amiti and Konings [2007], Halpern, Koren and Szeidl [2006]), with Muendler (2004) being an exception. Our findings are in line with the majority of the empirical literature on this subject, as we too document positive effects of *input* trade liberalization and imported intermediates. However, in contrast to earlier work, our main focus is not on TFP, but rather on the domestic product margin.[6] As noted by Erdem and Tybout (2003) and De Loecker (2007), a potential problem with the interpretation of the TFP findings is that the use of revenue data to calculate TFP implies that it is not possible to identify the effects of trade liberalization on physical efficiency separately from its effects on firm markups, product quality, and, in the case of multi-product firms, the range of products produced by the firm. In light of this argument, one can interpret our findings as speaking to the effects of trade reform on one particular component of TFP which is clearly identified in our data: the range of products manufactured by the firm.[7]

The remainder of the paper is organized as follows. In Section 2 we provide a brief overview of the data we use in our analysis and the Indian trade liberalization of the 1990s. We next discuss the reduced-form evidence. Section 3 organizes our results in two subsections. In Section 3.1, we provide descriptive evidence linking the expansion of the intermediate import extensive margin to tariff declines. In Section 3.2, we provide reduced-form evidence that lower input tariffs caused firms to expand product scope and we conduct a series of robustness checks. While these

[6] Nevertheless, we also provide evidence that conventionally measured TFP increases with input trade liberalization in our context. See also Topalova (2007).

[7] Exploring the relationship between the number of new products and TFP is beyond the scope of this analysis. The theoretical literature offers arguments for both a positive (Bernard, Redding and Schott [2006]) and a negative (Nocke and Yeaple [2007]) relationship between these two variables. We note however, that while the effect of new products on firm-level TFP may depend on the particular theoretical model one adopts, there is substantial empirical evidence that new product additions by domestic firms account for a sizable share of sales growth in several countries (Bernard, Redding and Schott [*forthcoming*], Navarro [2008], GKPT (*forthcoming*)).

regressions establish our main empirical findings, they are unable to inform our understanding of the particular channels that are at work. In Section 4, we therefore impose more structure and develop a framework that allows us to interpret the reduced form results and identify the relevant mechanisms. Subsections 4.1 and 4.2 present the framework and our identification assumptions; subsections 4.3 and 4.4 discuss the empirical implementation of the structural approach and our results, respectively. Section 5 concludes.

2. Data and Policy Background

2.1 Data Description

The firm-level data used in the analysis are constructed from the Prowess database which is collected by the Centre for Monitoring the Indian Economy (CMIE). Prowess has important advantages over the Annual Survey of Industries (ASI), India's manufacturing census, for our study. First, unlike the repeated cross section in the ASI, the Prowess data is a panel of firms, which enables us to track firm performance over time. Second, Prowess records detailed product-level information at the firm level and can track changes in firm scope over the sample. Finally, the data span the period of India's trade liberalization from 1989-2003. Prowess is therefore particularly well suited for understanding how firms adjust their product lines over time in response to increased access to intermediate inputs.[8]

Prowess enables us to track firms' product mix over time because Indian firms are required by the 1956 Companies Act to disclose product-level information on capacities, production and sales in their annual reports. As discussed extensively in GKPT *(forthcoming)*, several features of the database give us confidence in its quality. Product-level information is available for 85 percent of the manufacturing firms, who collectively account for more than 90 percent of Prowess'

[8] Prowess accounts for 60 to 70 percent of the economic activity in the organized industrial sector and comprises 75 percent of corporate taxes and 95 percent of excise duty collected by the Government of India (CMIE). The Prowess is not well suited for understanding firm entry and exit because firms are under no legal obligation to report to the data collecting agency. However, since Prowess contains only relatively large Indian firms, entry and exit is not necessarily an important margin for understanding the process of adjustment to increased openness within this subset of the manufacturing sector. Very few firms exit from our sample during this period (7%), and we observe no statistical difference in initial firm scope, output, TFP and R&D activity between continuing and exiting firms. Using a nationally representative data covering Indian plants, Sivadasan (2008) finds that reallocation across firms played a minor role in aggregate TFP gains following India's reforms. Our analysis below relies on within-firm variation in firm outcomes, rather than across-firm variation.

manufacturing output and exports. More importantly, product-level sales comprise 99 percent of the (independently) reported manufacturing sales. We refer the reader to GKTP (*forthcoming*) for a detailed summary statistics. Our database contains 2,927 manufacturing firms that report product-level information and span the period from 1989-1997.

We complement the product-level data with disaggregated information on India's imports and tariffs. The tariff data, reported at the six-digit HS (HS6) level, are available from 1987 to 2001 and they are obtained from Topalova (2007). We use a concordance by Debroy and Santhanam (1993) to aggregate tariffs to the National Industrial Classification (NIC) level.

Input tariffs, the key policy variable in this paper, are computed by running the industry-level tariffs through India's input-output matrix for 1993-94. For each industry, we create an input tariff for that industry as the weighted average of tariffs on inputs used in the production of the final output of that industry. The weights are constructed as the input industry's share of the output industry's total output value. Formally, input tariffs are defined as $\tau_{qt}^{\text{inp}} = \sum_i \alpha_{iq}\tau_{it}$, where α_{iq} is the value share of input *i* in industry q. For example, if a final good uses two intermediates with tariffs of 10 and 20 percent and value shares of .25 and .75, respectively, the input tariff for this good is 17.5 percent.[9] The weights in the IO table are also used to construct the components of the input exact price index.

Official Indian import data are obtained from Tips Software Services. The data classify products at the eight-digit HS (HS8) level and record transactions for approximately 10,000 manufacturing products imported from 160 countries between 1987 and 2000. For the purposes of descriptive analysis in Section 3.1, we assign products according to their end use into two classifications: intermediate goods (basic, capital, intermediates) and final goods (consumer durables and non-durables).[10] This classification is adopted from Nouroz's (2001) classification of India's IO matrix. The codes from the IO matrix are then matched to the four-digit HS (HS4) level

[9] The IO table includes weights for manufacturing and non-tradeables (e.g., labor, electricity, utilities, labor, etc.), but tariffs, of course, only exist for manufacturing. Therefore, the calculation of input tariffs implicitly assumes a zero tariff for non-tradeables. All of our regressions rely on changes in tariffs over time and not cross-sectional comparisons.

[10] What constitutes an input for one industry may be an output for another industry, though there are many products for which their most common use justifies this distinction (e.g., jewelry and clothing are usually considered final goods, whereas steel is considered an intermediate product).

following Nouroz (2001), which enables us to classify imports broadly into final and intermediate goods.

2.2 India's Trade Liberalization

India's post-independence development strategy was one of national self-sufficiency and heavy government regulation of the economy. India's trade regime was among the most restrictive in Asia, with high nominal tariffs and non-tariff barriers. The emphasis on import substitution resulted in relatively rapid industrialization, the creation of domestic heavy industry and an economy that was highly diversified for its level of development (Kochhar et al. [2006]).

In August 1991, in the aftermath of a balance-of-payments crisis, India launched a dramatic liberalization of the economy as part of an IMF adjustment program. An important part of this reform was to abandon the extremely restrictive trade policies.[11] The average tariffs fell from more than 80 percent in 1990 to 39 percent by 1996. Non-tariff barriers (NTBs) were reduced from 87 percent in 1987 to 45 percent in 1994 (Topalova [2007]). There were some differences in the magnitude of tariff changes (and especially NTBs) according to final and intermediate industries with NTBs declining at a later stage for consumer goods. Overall, the structure of industrial protection changed, as tariffs across sectors were brought to a more uniform level reflecting the guidelines of the tariff reform spelled out in the IMF conditions (Chopra et al. [1995]).

Several features of the trade reform are crucial to our study. First, the external crisis of 1991, which came as a surprise, opened the way for market oriented reforms (Hasan et al. [2007]).[12] The liberalization of the trade policy was therefore unanticipated by firms in India. Moreover, reforms were passed quickly as sort of a "shock therapy" with little debate or analysis to avoid the inevitable political opposition (Goyal [1996]). Industries with the highest tariffs received the largest tariff cuts implying that both the average and standard deviation of tariffs fell across industries. Consequently, while there was significant variation in the tariff changes across industries, Topalova (2007) has shown that output and input tariff changes were uncorrelated with pre-reform firm and industry characteristics such as productivity, size, output growth during the

[11] The structural reforms of the early 1990s also included a stepped-up dismantling of the "license raj," the extensive system of licensing requirements for establishing and expanding capacity in the manufacturing sector, which had been the cornerstone of India's regulatory regime. See GKPT *(forthcoming)*.

[12] This crisis was in part triggered by the sudden increase in the oil prices due to the Gulf War in 1990, the drop in remittances from Indian workers in the Middle East, and the political uncertainty surrounding the fall of a coalition government and assassination of Rajiv Gandhi, which undermined investors' confidence.

1980s and capital intensity.[13] The tariff liberalization does not appear to have been targeted towards specific industries and appears free of usual political economy pressures.

India remained committed to further trade liberalization beyond the Eighth Plan (1992-97). However, following an election in 1997, Topalova (2007) finds evidence that tariffs under the Ninth Plan (1997-2002) changed in ways that were correlated with firm and industry performance in the previous years. This indicates that unlike the initial tariff changes following the reform, after 1997, tariff changes were subject to political influence. This concern leads us to restrict our analysis in this paper to the sample period that spans 1989-1997.

We extend Topalova's (2007) analysis by providing additional evidence that the input tariff changes from 1992-1997 were uncorrelated with pre-reform changes in the firm performance measures that we consider in this paper. Column 1 of Table I regresses the *pre-reform* (1989-1991) growth in firm scope on the subsequent input tariff changes between 1992 and 1997. If the tariff changes were influenced by lobbying pressures, or targeted towards specific industries based on pre-reform performance, we would expect a statistically significant correlation. However, the correlation is statistically insignificant, suggesting that the government did not take into account pre-reform trends in firm scope while cutting tariffs. Columns 2-4 of Table I report the correlations of the input tariff changes with the pre-reform growth in firm output, TFP and R&D. As before, there is no statistically significant correlation between changes in these firm outcomes and input tariff changes. This table provides additional assurance that the tariff liberalization was unanticipated by firms.

3. Reduced-Form Results

This section presents some descriptive and reduced-form evidence on the relationship between tariff liberalization and product scope. Before we review the evidence, it is instructive to briefly explain the reasons we expect tariffs to affect the development of new products in the domestic market. Section 4 provides a more formal analysis of specific channels.

Suppose that the production technology of a product q in the final goods sector of the economy has the general form:

[13] This finding is consistent with Gang and Pandey (1996) who argue that political and economic factors cannot explain tariff levels at the time of the reform.

$$Y_q = f(A, L, S, \{X_i\}_{i=1}^{I}) \tag{1}$$

where *Y* denotes output, A is the product-specific productivity, and *L* and *S* are labor and non-tradeable inputs (e.g., electricity, water, warehousing, etc). The input vectors $X_i = \{X_{iD}, X_{iF}\}$ are comprised of domestic (X_{iD}) and imported inputs(X_{iF}), respectively. This production technology is general and for now does not commit us to any particular functional form. Suppose further that production of *q* requires a fixed cost F_q. The firm will choose inputs optimally so as to maximize profits and will produce product *q* as long as the variable profits are greater than or equal to the fixed cost.

Even without making any particular assumptions about market structure or functional forms, it is easy to see how a reduction in input tariffs would affect a firm's decision to introduce a new product. First, input tariff reductions lower the prices of *existing* imported inputs. The increase in variable profits resulting from lower input tariffs raises the likelihood that a firm can manufacture previously unprofitable products. Second, liberalization may lead to the import of new varieties (e.g., see Klenow and Rodriguez-Clare [1997]), therefore expanding the set of intermediate inputs available to the firm.[14] The significance of this second effect will depend on the particular form of the production technology, and in particular on the substitutability between domestic and imported inputs, as well as the substitutability between different varieties of imported intermediates.

Suppose, for example, that at one extreme, some of the intermediate inputs included in $\{X_{iF}\}_{i=1}^{I}$ are essential, so that if one of these inputs falls to zero, product *q* cannot be produced. Then the effect of trade liberalization on the introduction of new products is expected to be large, as it will relax technological constraints facing domestic firms. On the other extreme, if the new imported varieties were perfect substitutes to domestic, or previously imported, varieties there would be no effect through the extensive margin of imports. The importance of the extensive margin relative to the pure price effects of trade liberalization is therefore an empirical question.

The reduced-form evidence we present in this section does not allow us to distinguish between these two channels. That is, even if we find that tariff liberalization led to an increase in domestically produced varieties, this increase could have resulted solely from a decline in prices of existing imported inputs; the reform would then have operated only through price effects on

[14] The fixed costs of production may also decline with input tariff liberalization, which would also increase the likelihood that firms manufacture new products.

existing imports. Nevertheless, the descriptive evidence we present here indicates an enormous contribution of the extensive margin to import growth, which suggests that the reform is unlikely to have operated solely through the price channel. In section 4, we place additional structure on the firm's production function in order to quantify the specific channels generating the reduced-form findings.

3.1 Descriptive Evidence: Trade Liberalization and Import Data

Before analyzing the relationship between input tariff declines and firm scope, we first examine India's import data. We show that imports increased following the trade liberalization, and decompose the margins of aggregate import adjustment during the 1990s. Next, we examine the impact of trade liberalization on key trade variables in our empirical framework: total imports, imports of intermediates, unit values and the number of imported varieties. The goal of this analysis is to show that the extensive product margin was an important component of import growth (especially for intermediates) and that trade liberalization affected the variables relevant in our framework in expected ways.

3.1.1 Import Decomposition

We begin by examining the growth of imports into India during the 1990s. Total import growth reflects the contribution of two margins: growth in HS6 products that existed in the previous period (intensive margin) and growth in products that did not exist in the previous period (extensive margin).

There are two striking features that emerge from this decomposition reported in Table II. The first observation is that India experienced a surge in overall imports; column 1 indicates that real imports (inclusive of tariffs) rose by 130 percent between 1987 and 2000.[15] More interestingly, intermediate imports increased by 227 percent while final goods increased by 90 percent. In other words, the overall import growth was dominated by an increase in *intermediate* imported products.[16]

[15] Nominal imports, inclusive of tariffs, grew 516 percent over this period. Excluding tariffs, real and nominal import growth was 228 and 781 percent, respectively. The reason the growth numbers excluding tariffs are higher is because tariffs were very high prior to the reform.

[16] As discussed above, we rely on the Nourez (2001) classification of products to final and intermediate goods in this section only. The results in Section 4 rely on input-output matrices to construct the input price indices.

The second fact that emerges from Table II is that the relative contribution of the extensive margin to overall growth was substantially larger in the intermediate imports. Intermediate products unavailable prior to the reform accounted for about 66 percent of the overall intermediate import growth while the intensive margin accounted for the remaining third. Moreover, the net contribution of the extensive margin is driven entirely by gross product entry. There are very few products that cease to be imported over this period. In contrast, the relative importance of each margin in the final goods sectors is reversed; the extensive margin accounted only for 37 percent of the growth in imports, while the intensive margin contributed 63 percent of the growth. In GKPT (2009), we provide evidence that the majority of the growth in the extensive margin is driven by imports from OECD countries, which presumably are relatively high quality imports. Table II therefore suggests that imports increased substantially during our sample period and that this increase was largely driven by the growth in the number of intermediate products that were imported.

3.1.2 Import Values, Prices and Varieties

We next examine whether the expansion in trade noted in Table II was systematically related to the tariff reductions induced by India's trade liberalization. To summarize our findings, we find that: (a) lower tariffs led to an overall increase in import values, (b) lower tariffs resulted in lower unit values of existing product lines and (c) lower tariffs led to an increase in the imports of new varieties. Moreover, this expansion of varieties in response to tariff declines was particularly pronounced for intermediate products.

We begin by examining the responsiveness of import values to tariffs by regressing the (log) import value (exclusive of tariffs) of an HS6 product on the HS6-level tariff,[17] a HS6-level fixed effect and year fixed effects, and restrict the analysis to 1987-1997 (see Section 2.2). We should emphasize that we interpret these regressions strictly as reduced-form regressions. In particular, unlike Klenow and Rodriguez-Clare (1997), we are not assuming complete tariff pass-through on import prices, so that the tariff coefficients in our regressions cannot be used to back out structural parameters.[18] Table IIIa reports the coefficient estimates on tariffs for all sectors (column 1),

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[17] We lag the tariff measure one period in all specifications because the trade reform was implemented towards the end of 1991 (initiated in August 1991).

[18] Incomplete pass-through can arise even with a CES utility function if the market structure is oligopolistic and/or non-traded local costs are present.

intermediate sectors (column 2) and final goods sectors (column 3). In all cases, declines in tariffs are associated with higher import values. This analysis therefore confirms that the trade reform played an important role in the expansion of imports documented in Table II.

Traditional trade theory usually emphasizes the benefits from trade that occur through increased imports of *existing* products/varieties at lower prices. This channel also plays a role in our context. We explore the impact of tariff declines on the tariff-inclusive unit values of HS8-country varieties by regressing the variety's unit value on the tariff, a year fixed effect and a variety (HS8-country) fixed effect. Note that by including the variety fixed effect, we implicitly investigate how tariffs affected the prices of continuing varieties. The results are reported in Table IIIb. Overall, lower tariffs are associated with declines in the unit values of existing varieties (column 1). Columns 2 and 3 report the coefficients for the intermediate and final goods sectors, respectively. While the coefficient is positive and significant for both sectors, the magnitude of the coefficient is larger for the intermediate sectors. This suggests that to the extent imported inputs are used in the production process by domestic firms, the observed declines in unit values of existing products will lower the marginal cost of production for Indian firms.

The aggregate decomposition in Table II suggests that new imported varieties played an important role in the expansion of overall imports, particularly for the intermediate sectors. This is consistent with Romer (1994), who shows that if there are fixed cost of importing a product, a country will import the product only if the profits from importing exceed the fixed costs. This means that high tariffs not only limit the quantity but also the range of goods imported. To provide direct evidence of the effect of tariffs on the extensive margin of imports we estimate the following specification:

$$\ln(v_{ht}) = \alpha_h + \alpha_t + \beta\tau_{ht} + \varepsilon_{ht} \tag{2}$$

where v_{ht} is the number of varieties within a HS6 product *h* at time *t*, τ_{ht} is the HS6 tariff, α_h is a HS6 fixed effect and α_t is year fixed effect. The results are reported in Table IIIc. To show that our results are not sensitive to the definition of a variety, the table reports equation (2) with different definitions of a "variety" as the dependent variable: HS6 -country (panel A), HS8 codes (panel B), and HS8 category-country (panel C). Since our results are robust to alternative definitions of a variety, we focus our discussion on the results in Panel A.[19] Column 1 estimates equation (7) for all products and shows that tariff declines were associated with an increased number of imported varieties. This result confirms the importance of the new variety margin during a trade reform, as emphasized in Romer (1994).

We re-run regression (2) for the intermediate and final products in columns 2 and 3 of each panel, respectively. Consistent with the evidence in Table II, the relationship between tariff declines and the extensive margin is particularly pronounced for intermediate products. The coefficient on tariffs for the intermediate products in column 2 is more than twice as large as the tariff coefficient for the final goods. Moreover, the results for intermediate products are robust to the alternative definitions of a variety in panels B and C, while the results for final products are more sensitive to the definition of varieties.[20]

Our results are generally consistent with the evidence in Klenow and Rodriguez-Clare (1997) and Arkolakis et al. (2008), who also find that the range of imported varieties expands as a result of the tariff declines in Costa Rica. However, there is one important difference. In India, Table II indicates that new imported intermediate varieties accounted for a sizable share of total imports. In contrast, in Costa Rica, newly imported varieties accounted for a small share of total imports and thus generate relatively small gains from trade (Arkolakis et al. [2008]). Thus, the evidence so far suggests that gains from new import varieties, particularly from the intermediate sectors, may be potentially large in the context of the Indian trade liberalization.

In sum, a first look at the import data demonstrates that tariff declines led to increases in import values, reductions in the import prices of existing products and expansion of new varieties. These responses were particularly pronounced for imports of intermediate products. Thus, Indian firms may have benefited from the trade reform not only via cheaper imports of existing intermediate inputs, but also by having access to new intermediate inputs. In the next section, we quantify the overall impact of input tariff reductions on firm-level outcomes.

3.2 Reduced-Form Evidence

3.2.1 Input Tariffs and Domestic Varieties

[19] We obtain qualitatively similar results using a Poisson regression, and when balancing the data to account for HS6 codes with no initial imports. Results are available upon request.

[20] One explanation for the lack of robust findings for final goods is the fact that NTBs still existed in these HS lines.

In this section, we relate input tariffs to the number of new products introduced in the market by domestic Indian firms. We then examine the relationship between input tariff reductions and other variables that are relevant in endogenous growth models, such as firm sales, total factor productivity, and R&D.

To explore the impact of input tariffs on the extensive product margin, we estimate the following equation:

$$\ln\left(n_{it}^{q}\right) = \alpha_i + \alpha_t + \beta\tau_{qt}^{\text{inp}} + \varepsilon_{it} \tag{3}$$

where n_{it}^{q} is the number of products manufactured by firm *i* operating in industry *q* at time *t*, and τ_{qt}^{inp} is the input tariff that corresponds to the main industry in which firm *i* operates. This regression also includes firm fixed effects to control for time-invariant firm characteristics, and year fixed effects to capture unobserved aggregate shocks. The coefficient of interest is β which captures the semi-elasticity of firm scope with respect to tariffs on intermediate inputs. Standard errors are clustered at the industry level.

In GKPT (*forthcoming*), we found virtually no evidence that firms dropped product lines during this period; 53 percent of firms report product additions during the 1990s, and very few firms dropped any product lines. Thus, the net changes in firm scope during this period can effectively be interpreted as gross product additions.

Table IVa presents the main results in column 1. The coefficient on the input tariff is negative and statistically significant: declines in input tariffs are associated with an increase in the scope of production by domestic firms. The point estimate implies that a 10 percentage point fall in tariffs results in a 3.2% expansion of a firm's product scope. During the period of our analysis, input tariffs declined on average by 24 percentage points implying that within-firm product scope expanded 7.7 percent. Firms increased their product scope on average by 25 percent between 1989 and 1997, so our estimates therefore imply that declines in input tariffs accounted for 31 percent of the observed expansion in firms' product scope.

In GKPT (*forthcoming*), we find that the (net) product extensive margin accounted for 25 percent of India's manufacturing output growth during our sample. If India's trade liberalization impacted growth only through the increase in product scope, our estimates imply that the lower input tariffs contributed 7.8 percent (.25*.31) to the overall manufacturing growth. This back-of-the-envelope calculation suggests a sizeable effect of increased access to imported inputs for manufacturing output growth.

As discussed in Section 2.2, the trade liberalization coincided with additional market reforms. In the remaining columns of Table IVa, we control for these additional policy variables. Column 2 introduces output tariffs to control for pro-competitive effects associated with the tariff reduction. The coefficient on output tariffs is not statistically significant, while the input tariff coefficient hardly changes and remains negative and statistically significant. While it may appear puzzling that the output tariff declines did not result in, for instance, a rationalization of firm scope, we refer the reader to GKPT (*forthcoming*) for explanations of this finding. In column 3, we include a dummy variable for industries delicensed (obtained from Aghion et al. [2008]) during our sample, and the input tariff coefficient remains robust. Finally, column 4 includes a measure of FDI liberalization taken from Topalova (2007). The coefficient implies that firms in industries with FDI liberalization increased scope, but the coefficient is not statistically significant. The input tariff remains negative and significant, indicating that even after conditioning on other market reforms during this period, input tariff declines led to an expansion of firm product scope.

In Table IVb, we run a number of robustness checks to examine the sensitivity of our main results to alternative specifications of the main estimating equation, most importantly to controlling for pre-existing sector and firm trends. Specifications 1 and 2 of Table IVb introduce NIC2-year and NIC3-year pair fixed effects, respectively, to control for pre-existing, sector-specific trends. These controls capture several factors, such as sector-specific technological progress, that may be correlated with input tariff changes. Not only do the input tariff coefficients in each column remain statistically significant, the magnitude of the point estimates hardly changes. This is further evidence that input tariffs are not correlated with potentially omitted variables. Specifications 3-6 control for industry-specific trends by interacting year fixed effects with the pre-reform (1989-1991) growth in the number of products by industry (3), output growth (4), and TFP growth (5). Specifications 6-10 control for a number of pre-existing *firm* trends. Specification 6 reports the coefficient on input tariffs by augmenting equation (3) with year fixed effects interacted with a dummy that indicates whether the firm manufactured multiple products in its initial year. Specification 7 presents more flexible controls by interacting year fixed effects with the number of initial products manufactured by the firm. Specifications 8 and 9 place firms into output and TFP deciles, based on their initial year, and interacts the deciles with year dummies. This specification controls for shocks to firms of similar sizes over time. Specification 10 interacts a dummy indicating whether the firm had initial-period positive R&D expenditures with year dummies. The input tariff coefficient is robust to including all these flexible industry and firm controls. More importantly, the magnitude of the input tariff coefficient is remarkably stable across specifications, which provides further reassurance that the baseline results are not driven by omitted variable bias or pre-existing trends. Specification 11 reports the input tariff coefficient using a Poisson specification which uses the number of products as the dependent variable. Finally, specification 12 addresses potential concerns about entry and exit by re-running specification (3) on a set of constant firms that appear in each year of the sample period from 1989 to 1997. As before, the input tariff coefficient remains stable and statistically significant.

The bottom panel of Table IVb reports robustness checks using long differences. The first check (specification 13) regresses changes in firm scope on changes in input tariffs between 1989 and 1997. The standard error is now larger (p-value: 19%), but the coefficient is remarkably close to the annual regression results in Table IVa and the previous regressions in Table IVb. Specification 14 reports a double-difference specification by regressing $\left(\Delta \ln n_{i,97-91}^{q} - \Delta\ln\ n_{i,91-89}^{q}\right)$ on $\left(\Delta\tau_{q,97-91}^{\text{inp}} - \Delta\tau_{q,91-89}^{\text{inp}}\right)$. This double-difference specification removes firm-specific trends throughout the sample period. While not statistically significant, the input tariff coefficient is again very close to the previous regressions. The finding that the long-difference specifications do not substantially attenuate the input tariff coefficient suggests that omitted variables are not biasing our main results in Table IVa.

3.2.2. Input Tariffs and Other Firm Outcomes

In Table IVc, we estimate variants of equation (3) that use other firm outcome variables as dependent variables. These variable—firm sales, productivity, and R&D—were chosen based on their relevance to the mechanisms emphasized in endogenous growth models. We find that declines in input tariffs were associated with increased firm sales (column 2) and higher firm productivity (column 3).[21] This evidence is consistent with predictions of theoretical papers that

[21]We obtain TFP for our sample of firms from Topalova (2007). We should emphasize that the interpretation of the TFP findings is difficult in our setting for reasons discussed in Erdem and Tybout (2003). The presence of multiproduct firms further complicates the interpretation of TFP obtained from Olley and Pakes (1996)

have emphasized the importance of intermediate inputs for productivity growth (e.g., Ethier [1979, 1982], Markusen [1989], Romer [1987, 1990], Rivera-Batiz and Romer [1991], and Grossman and Helpman [1991]). It is also in line with recent empirical studies that find imports of intermediates or declines in input tariffs to be associated with sizeable measured productivity gains (see Kasahara and Rodrigue [2008], Amiti and Konings [2007], Topalova [2007], Halpern, Koren and Szeidl [2009]). Finally, we find that lower input tariffs are associated with increased R&D expenditures (column 3), although the coefficient is imprecisely estimated. The imprecision might in part reflect heterogeneity in the R&D response across firms. In column 4, we allow the effect of input tariffs to differ across firms that are above and below the median value of initial sales. The coefficient on the interaction between input tariffs and the size indicator is negative and statistically significant. Thus, lower input tariffs are associated with increased R&D participation, but only in initially larger firms. Overall, the above results provide further support for the effects emphasized in the endogenous growth literature.

Our earlier findings in GKPT *(forthcoming)* indicate no systematic relationship between India's liberalization of output tariffs and domestic product scope. In sharp contrast, here we find strong and robust evidence that the reductions of input tariffs were associated with an increase in the range of products manufactured by Indian firms. Moreover, we also observe that lower input tariffs are associated with an increase in firm output, total factor productivity and R&D expenditure among (initially) larger firms.

4 Mechanisms

The results presented in the previous section quantify the overall impact of access to imported inputs on firm scope and other outcomes. A limitation of this analysis is that it cannot uncover the mechanisms through which lower input tariffs influence product scope. In particular, it does not tell us whether the effects operate through lower prices for existing imported intermediate products or through increases in the variety of available inputs. This section explores and quantifies the relative importance of the price and variety channels.

4.1 Theoretical Framework

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methodology (see De Loecker [2007]). We therefore view these results simply as a robustness check that allows us to compare our findings to those of the existing literature.

We first provide the theoretical foundation for understanding the mechanisms through which imported inputs lead to growth in domestic varieties. This necessitates introducing functional form assumptions for the production function of producing product *q* in equation (1). The functional forms we choose are motivated by the nature of our data, and importantly, the model provides a specification that is easy to implement empirically.

We start by specifying a Cobb-Douglas production function:

$$Y_q = AL^{\alpha_{Lq}} S^{\alpha_{Sq}} \prod_{i=1}^{I} X_i^{\alpha_{iq}}, \tag{4}$$

where $\alpha_{Lq} + \alpha_{Sq} + \sum_{i=1}^{I} \alpha_{iq} = 1$. The production of the final good requires a fixed cost F_q. The minimum cost of manufacturing one unit of output is given by

$$C_q = A^{-1} \left[\prod_{i=1}^{I} P_i^{\alpha_{iq}} \right] \left(P_L^{\alpha_{Lq}} P_S^{\alpha_{Sq}} \right) \left(\alpha_{Lq}^{-\alpha_{Lq}} \alpha_{Sq}^{-\alpha_{Sq}} \right) \prod_{i=1}^{I} \alpha_{iq}^{-\alpha_{iq}}, \tag{5}$$

where P_k denotes the price index associated with input $k = L, S, 1 \ldots i \ldots I$. We assume that each input sector *i* has a domestic and an imported component (e.g., Indian and imported steel) that are combined according to the CES aggregator:[22]

$$X_i = \left(X_{iD}^{\frac{\gamma_i - 1}{\gamma_i}} + X_{iF}^{\frac{\gamma_i - 1}{\gamma_i}} \right)^{\frac{\gamma_i}{\gamma_i - 1}}, \tag{6}$$

where X_{iF} and X_{iD} denote the domestic and foreign inputs, and γ_i is the elasticity of substitution between the two input bundles. The overall price index for input industry *i* is a weighted average of the price index for the domestic and foreign input bundles, Π_{iD} and Π_{iF}:

$$P_i = \Pi_{iD}^{\omega_{iD}} \Pi_{iF}^{\omega_{iF}}. \tag{7}$$

The weights $\{\omega_{iD}, \omega_{iF}\}$ are the Sato-Vartia log-ideal weights:

$$\omega_{iB} = \frac{\frac{s_{iB} - s'_{iB}}{\ln s_{iB} - \ln s'_{iB}}}{\sum_{B=D,F} \frac{s_{iB} - s'_{iB}}{\ln s_{iB} - \ln s'_{iB}}} \text{ and } s_{iB} = \frac{\Pi_{iB} X_{iB}}{\sum_{B=D,F} \Pi_{iB} X_{iB}}, \qquad B = D, F \tag{8}$$

where the notation ‘ denotes the value of a variable in the previous period.

We assume that the imported input industry X_{iF} is itself a CES aggregator of imported varieties (e.g., Japanese and German steel):

[22] Halpern, Koren and Szeidl (2009) use a similar production structure.

$$X_{iF} = \left[\sum_{v\in I_{iF}} a_{iv}^{\sigma_i} x_{iv}^{\frac{\sigma_i - 1}{\sigma_i}}\right]^{\frac{\sigma_i}{\sigma_i - 1}}, \quad \sigma_i > 1, \tag{9}$$

where σ_i is the industry-specific elasticity of substitution, a_{iv} is the quality parameter for variety *v*, and I_{iF} is the set of available foreign varieties in industry *i.* The minimum cost function associated with purchasing the basket of foreign varieties in equation (9) is given by

$$c(p_{iv}, a_{iv}, I_{iF}) = \left[\sum_{v\in I_{iF}} a_{iv} p_{iv}^{\sigma_i - 1}\right]^{\frac{1}{1-\sigma_i}} \tag{10}$$

Following Feenstra (1994) and Broda and Weinstein (2004), the price index over a constant set of imported varieties is the *conventional price index*, P_{iF}^{conv}:

$$P_{iF}^{\text{conv}} = \frac{c(p_{iv}, a_{iv}, \tilde{I}_{iF})}{c(p'_{iv}, a_{iv}, \tilde{I}_{iF})} = \prod_{v\in \tilde{I}_{iF}} \left(\frac{p_{iv}}{p'_{iv}}\right)^{w_{iv}} \tag{11}$$

where $\tilde{I}_{iF} = I_{iF} \cap I'_{iF}$ is the set of common imported varieties between the current and previous period. The weights in equation (11) are again the Sato-Vartia log-ideal weights:

$$w_{iv} = \frac{\frac{s_{iv} - s'_{iv}}{\ln s_{iv} - \ln s'_{iv}}}{\sum_{v\in \tilde{I}_{iF}} \frac{s_{iv} - s'_{iv}}{\ln s_{iv} - \ln s'_{iv}}} \quad \text{and} \quad s_{iv} = \frac{p_{iv} x_{iv}}{\sum_{v\in \tilde{I}_{iF}} p_{iv} x_{iv}}. \tag{12}$$

Feenstra (1994) shows that the price index of these foreign varieties in equation (11) can be modified to account for the role of new imported varieties as long as there is some overlap in the varieties available between periods ($\tilde{I}_{iF} \neq \emptyset$). The exact price index adjusted for new imported varieties is

$$\Pi_{iF} = P_{iF}^{\text{conv}} \Lambda_{iF} \tag{13}$$

Equation (13) states that the exact price index from purchasing the basket of imported varieties in equation (9) is the conventional price index multiplied by a *variety index*, Λ_{iF}, that captures the role of new and disappearing varieties:

$$\Lambda_{iF} = \left(\frac{\lambda_{iF}}{\lambda'_{iF}}\right)^{\frac{1}{\sigma_i - 1}} \tag{14}$$

with

$$\lambda_{iF} = \frac{\sum_{v\in \tilde{I}_{iF}} p_{iv} x_{iv}}{\sum_{v\in I_{iF}} p_{iv} x_{iv}} \quad \text{and} \quad \lambda'_{iF} = \frac{\sum_{v\in \tilde{I}_{iF}} p'_{iv} x'_{iv}}{\sum_{v\in I'_{iF}} p'_{iv} x'_{iv}} \tag{15}$$

As has been noted in the literature, Λ_{iF} has an intuitive interpretation. Suppose there are no disappearing varieties (Table II) so that the denominator of (14) is one, then Λ_{iF} measures the expenditure on the varieties that are available in both periods relative to the expenditure on the set of varieties available in the current period. The more important the new varieties are (i.e., higher expenditure share), the lower will be Λ_{iF} and the smaller the exact price index will be relative to the conventional index. Equation (14) also shows Λ_{iF} depends on the substitutability of the foreign varieties captured by the elasticity of substitution σ_i. The more substitutable the varieties are, the lower is the term $1/(\sigma_i - 1)$ and the lower is the difference between the exact and conventional price indices. In the limit case of an infinite elasticity of substitution, the second term becomes unity, indicating that changes in the available varieties have no effect on the price index.

Substituting equation (13) into equation (7) indicates that the overall input price index for input industry *i* is $P_i = \Pi_{iD}^{\omega_{iD}} (P_{iF}^{\text{conv}} \Lambda_{iF})^{\omega_{iF}}$. Substituting this expression back into the minimum cost function in equation (5) and taking logs yields

$$\ln C_q = \left\{ \sum_{i=1}^{I} \alpha_{iq} \omega_{iF} \ln P_{iF}^{\text{conv}} + \alpha_{Lq} \ln P_L + \alpha_{Sq} \ln P_S \right\} + \left\{ \sum_{i=1}^{I} \alpha_{iq} \omega_{iF} \ln \Lambda_{iF} \right\} + \nu \tag{16}$$

where $\nu \equiv \sum_{i=1}^{I} \alpha_{iq} \omega_{iD} \ln \Pi_{iD} + \ln \left(\alpha_{Lq}^{-\alpha_{Lq}} \alpha_{Sq}^{-\alpha_{Sq}} \prod_{i=1}^{I} \alpha_{iq}^{-\alpha_{iq}} \right) - \ln A.$

The expression in equation (16) illustrates the channels through which changes in the minimum cost of production affect the set of products manufactured by domestic firms. Equation (16) can be expressed in terms of observable data (the terms in the first two brackets) and the unobservable component captured by ν. The first bracket captures the *overall* conventional price index for imported inputs (P_{iF}^{conv}), labor (P_L) and non-tradeables (P_S):

$$\ln P_q^{\text{inp,conv}} \equiv \sum_{i=1}^{I} \alpha_{iq} \omega_{iF} \ln P_{iF}^{\text{conv}} + \alpha_{Lq} \ln P_L + \alpha_{Sq} \ln P_S \tag{17}$$

The second bracket captures the importance of new imported inputs:

$$\ln \Lambda_{qF}^{\text{inp}} \equiv \sum_{i=1}^{I} \alpha_{iq} \omega_{iF} \ln \Lambda_{iF} \tag{18}$$

As discussed above, the term in (18) adjusts the price index to reflect new (or disappearing) imported varieties available to firms; a lower value indicates larger gains from variety.

We use this structure to guide our analysis of the mechanisms driving the link between imported input use and domestic product scope. As we discuss in section 3, lower tariffs on imported inputs will affect product innovation if they lower the variable cost of producing the product below the fixed cost of introducing a product. Our approach relates the change (between 1989 and 1997) in firms' product scope to the observable input price indices [equations (17) and (18)] in the firms' minimum cost function. Although equation (13) suggests that reductions in the price and variety indices should have an equal effect on product scope, there are additional factors, not explicitly modeled above, which may break this equality. For example, the technological complementarity between varieties *within the firm* or *within product lines* of a firm could be much stronger than that implied by the index we estimate at the level of aggregation we use in our empirical analysis. In this case, new varieties would be more important to the firm than suggested by the variety index, which would make the introduction of new domestic products more responsive to the estimated variety index. We therefore allow the impact of the input indices to vary in the following specification:

$$\Delta \ln n_f^q = \alpha + \beta_1 \ln P_q^{\text{inp,conv}} + \beta_2 \ln \Lambda_{qF}^{\text{inp}} + \varepsilon_f. \tag{19}$$

The theoretical framework suggests that coefficients on both input price components should be negative.[23]

4.2 Identification Strategy

The error term in (19) captures unobservable factors that might influence changes in firm scope. These factors include the unobserved components in ν as well as potential demand shocks. Specification (19) clearly illustrates the endogeneity issues that arise in estimating how imported inputs affect firm scope. For instance, suppose firms expand the set of domestic varieties in response to lower price and variety indices for imported inputs. The expansion of domestic varieties will affect the exact price index of domestic inputs (contained in the unobserved ε). This domestic variety expansion will further drive down (depending on parameters) the minimum cost of production, thereby increasing the likelihood of more domestic variety expansion. This feedback between the foreign and domestic price indices creates a correlation between the error term and the observable input price indices in (19); in the absence of a shock to changes in the input indices, it is difficult to separate cause and effect. Alternatively, suppose that firms introduce new domestic varieties due to demand shocks, and manufacturing these new varieties requires more imported inputs. The imports and domestic input indices will both adjust in response to the demand shock,

[23] Note that (19) is a change-on-change regression since both $P_q^{\text{inp,conv}}$ and $\Lambda_{qF}^{\text{inp}}$ are price indices.

further influencing the minimum cost of production. This reverse causality concern is precisely the econometric complication that has limited previous research from identifying the impact between imported inputs and domestic variety growth.

Equation (19) therefore highlights the importance of the policy change (i.e., the tariff liberalization) we exploit. Section 2 established that declines in India's tariffs were plausibly unanticipated and not correlated with firm and industry characteristics prior to the reform, so tariff changes are a natural instrument for identifying the channels. The exogenous reform allows us to establish a casual chain of the following events. A sharp and unanticipated decline in tariffs led to lower prices of existing inputs (as seen in Table IIIb), and hence a lower conventional price index for imports. Tariff declines also resulted in increased imported varieties (Table IIIc); this finding is consistent with models with fixed costs of exporting where lower variable exporting costs increase variable profits and make it more likely that the returns to exporting exceed the fixed cost of entering the foreign market. Thus, changes in tariffs will be correlated with the input price and variety indices in equation (19), satisfying a necessary condition for the IV strategy.

Although the price index of domestic inputs changes as firms introduce new domestic varieties, this phenomenon is an *indirect* effect of the trade reform affecting imported inputs. This point reflects our main identification assumption: input tariffs affect the price index of domestic inputs and TFP *only through* their impact on imported input prices and varieties, which we capture through the right-hand side variables in (19). That is, there is no *direct* effect of changes in input tariffs on the unobserved components of (19). Perhaps the most controversial component of this identification strategy is that the unobservable components in (19) include total factor productivity since there is evidence that trade liberalizations lead to productivity improvements. However, most of this evidence pertains to productivity improvements that result from reallocation effects associated with *output* tariff liberalization (e.g., Pavcnik [2002] and Melitz [2003]); these findings are not pertinent to our analysis since we focus on changes *within firms* over time,[24] which we argue are the result of *input* tariff liberalization. More relevant to our study are findings from recent empirical studies that report within-firm (measured) productivity improvements following trade

[24] Recall that Prowess contains relatively large firms for which entry and exit are not important margins of adjustment. Moreover, Sivadasan (2008) finds very little support for the reallocation mechanism in the context of India's market reforms.

reforms.[25] The three prevailing arguments for why trade reforms affect within-firm measured productivity are a) product rationalization, b) improved access to imported inputs and c) elimination of x-inefficiencies through managerial restructuring. From Table IVa [see also GKPT (*forthcoming*)], there is no evidence that Indian firms dropped relatively unproductive product lines to improve measured TFP; this rules out point (a) in the Indian context. The input channel [argument (b)] is precisely the focus of our analysis: the trade reform affects productivity through the intermediate input channels in (19), which are captured by the observable part of this equation. Elimination of x-inefficiency is a plausible argument, but it is important to note that our policy instruments are input tariffs. One would expect elimination of x-inefficiency to be driven by pro-competitive output tariffs, rather than changes in input tariffs.[26] Hence, our identification assumption is supported by existing theoretical and empirical research.

Since equation (19) contains two endogenous variables, we need a second instrument to identify the coefficients. Our second instrument is motivated by the insights of Helpman, Melitz and Rubinstein (2008) and is based on the idea that the potential for exporting to India following the liberalization may be larger for those countries with “stronger ties” or proximity to India.[27] Tariff declines lower the conventional price index and the variety index, but since India sets a common tariff to all countries, tariff declines alone cannot explain which countries are more likely to start exporting products to India after the reform. In other words, tariffs alone are not sufficient as instruments for the increase in *varieties*, defined as export country/product pairs. Our second instrument, based on common language between India and its potential trading partners in a given industry, attempts to explain, for a given decline in tariffs, which industries experience a larger growth in new countries that begin exporting to India (i.e., new imported varieties).

The instrument is constructed as follow. We first identify the set of countries that speak English (English is an official language of India). These countries plausibly possess a lower fixed cost of exporting to India (Helpman, Melitz and Rubinstein [2008]).[28] Next, we identify the set of

[25] See Topalova (2007), Amiti and Konings (2007), Sividasan (2008) and Halpern et al. (2009). For theoretical evidence, see Bernard, Redding and Schott (2006), Eckel and Neary (*forthcoming*) and Nocke and Yeaple (2006).
[26] We can control for this channel by controlling for changes in output tariffs in equation (19).
[27] We are grateful to a referee for suggesting the idea of this instrumentation strategy.
[28] Other possible fixed cost proxies might include common religion, border and colonial origin. Common religion and border are not very good fixed cost proxies in the Indian context, and a colonial origin dummy is co-linear with

countries with a revealed comparative advantage (RCA) for each HS4 industry. Countries with a RCA are more likely to respond to the trade liberalization than countries that do not have a RCA. We identify countries' RCA using Comtrade data that reports countries' HS4-level exports to the world (*excluding India*) in 1989 (*prior to India's reform*). We then take the intersection of these two sets to identify, for each HS4 industry, the set of English-speaking and RCA countries. Our proximity measure is a GDP-weighted average of these countries with the idea that industries with a higher average are likely to experience a larger increase in the extensive margin following trade liberalization. The proximity measure therefore uses country-specific differences in fixed costs of exporting to India (captured by language), combined with information on RCA, to construct a proxy for fixed costs that varies across industries. We then pass this variable through the input-output matrix and use the concordances described above to obtain an NIC-level measure of language proximity of potential trading partners to India. This industry-specific variable therefore reflects the lower fixed cost of exporting intermediates to India. Finally, we interact this measure of proximity of potential trading partners in a given NIC code with the change in input tariffs. This interaction serves as our second instrument.

4.3 Empirical Implementation

We use the formulas from the theoretical model to guide our empirical implementation. We begin by constructing the import indices, Π_{iF} and Λ_{iF}. We calculate these indices from India's import data according to equations (11) and (14) at the HS4-level of aggregation. We chose this level of aggregation because while the method proposed by Feenstra (1994) and Broda and Weinstein (2006) is designed to quantify the gains from new varieties within existing codes, the method is unable to quantify the introduction of entirely new codes.[29] We obtain estimates for the elasticity of substitution σ_i from Broda, Greenfield and Weinstein (2006) who estimate India's elasticities of substitution at the HS3 level.

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the English language dummy. Distance is not a good proxy because it is more likely to capture variable costs as opposed to fixed costs.

[29]This is because index decomposition relies on a set of overlapping varieties across time periods. Between 1989 and 1997, the Indian import data indicate that the number of imported HS6 codes increased from 2,958 to 4,115, which means that computing indices at the HS6 level would ignore this substantial increase in new products. We therefore chose to compute indices at the HS4 level (although we still are unable to compute indices for the 220 (out of 1145 HS4 codes) that appear between 1989 and 1997).

Table V reports Λ_{iF} computed between 1989 and 1997.[30] Row 1 reports the mean of each component across all HS4 codes. The mean variety index between 1989 and 1997 is .899, implying that the exact import price index adjusted for variety growth fell about 10 percent faster than the conventional import price index. There is a considerable heterogeneity in the impact of variety growth across HS4 price indices (for examples of HS4 codes, see GKPT [2009]). Column 3 aggregates across all HS4 codes to compute the overall import price index. Accounting for the introduction of new varieties lowers the conventional import price index by 31 percent over nine years, or by 3.9 percent per year. This contribution of the extensive margin to the import price index is substantially larger than estimates obtained for Costa Rica (Arkolakis et al. [2008]). It is also larger than the estimates for the United States, where aggregate import prices are on average 1.2 percent lower per year due to new imported varieties (Broda and Weinstein [2004]). This large contribution of the extensive margin in India reaffirms the evidence from the raw data in Section 3 and reflects the restrictive nature of the Indian trade policy prior to the 1991 liberalization.

The second and third rows of Table V report the price index computed separately for the HS4 codes classified by intermediate and final goods, respectively. Consistent with the import decompositions in Table II and the import variety regressions in Table IIIc, we observe that new variety growth was more substantial in the intermediate sectors than in the final goods sectors. The mean variety index for the intermediate sectors was .881 between 1989 and 1997 compared to .904 for final goods sectors. The difference in the overall aggregate price index is even starker. Variety growth deflated the conventional price index by 38 percent for intermediate sectors, compared to 15 percent for final sectors. This figure implies that the import price index for intermediates is on average 4.75 percent lower per year due to new varieties. Table V clearly highlights the gains from new imported varieties, particularly for intermediate inputs.[31]

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[30] For HS4 codes that enter the import data after 1989, we assign a variety index of one. This is a conservative estimate of the gains from variety. For HS4 codes with missing price and variety indices in 1997 (for instance, because there is no overlap in varieties or units for prices are missing), we assign average values of coarser HS codes.

[31] As discussed earlier, Prowess does not contain reliable product-level information on imported inputs used by a firm. We therefore cannot create a reliable measure of the actual number of imported inputs used by a firm. Of course, since the import data used in our analysis are a census of all imported varieties, it is clear from the previous tables that firm access to new inputs expanded during this period. The ASI collects the number of inputs (imported and total) at the plant-level, but this information is only available after the reform period, so we cannot look at changes in firm input use. Moreover, since the ASI is a cross-sectional database, we cannot directly observe changes in inputs at a level more disaggregate than the industry. Nevertheless, we conducted one

Having established that variety growth has a substantial impact on the import price index, and that this effect is particularly pronounced in the intermediate goods sector, we next turn to quantifying the relative importance of the price and variety margins in the expansion of domestic product scope. We construct the two components of price index from (17) and (18) that capture the price and variety channels. This requires several pieces of information in addition to the conventional import price and import variety indices discussed above. We calculate the nominal wage index (P_L) from the ASI by taking the ratio of the total industry wage bill between 1997 and 1989. We use the wholesale price index (WPI) for the non-tradeable price index(P_S).[32] Finally, we need the two sets of weights: the Cobb-Douglas shares, α_{iq}, and the share of foreign imports, ω_{iF}. India's IO matrix provides estimates of α_{iq}. We obtain ω_{iF} using equation (8) from the information on the share of imports in total domestic consumption for each sector in India's IO matrix. We collapse the import indices to the level of aggregation in India's IO matrix and combine it with the additional variables described above, to construct the indices using (17) and (18). We then map these indices to industry-level NIC codes associated with the main product a firm produces prior to reform.

4.4 Results

We begin by reporting the OLS estimates of equation (19) in Table VIa. Table VIa offers a preliminary lens to the mechanisms driving the reduced-form results in Section 3. Columns 1 and 2 estimate equation (19) with the conventional input price and variety index separately. A negative coefficient on the conventional input price index in column 1 suggests that lower prices of existing inputs are associated with higher product scope, although the coefficient is not statistically significant. The coefficient on the input variety index in column 2 is negative and statistically significant suggesting that an increase in input variety (captured by a lower index number) is associated with an expansion of firm scope. This finding continues to hold in column 3, when we

robustness check using the 1999 ASI data and regressed the industry-level average number of inputs per plant on changes in input tariffs between 1989-1997. We observe a statistically significant and negative relationship for both imported and total inputs. This is consistent with the trade reform enabling firms to expand their range of inputs.

[32] A separate price index for electricity is available, so we separate the non-tradeable inputs into electricity and other inputs (e.g., warehousing, communication, water, gas, etc.) for which we do not have detailed price indices (and assign the WPI).

estimate equation (19) with both indices as independent variables. Thus, the OLS results indicate that an increase in input variety is correlated with firm scope expansion.

The theoretical section showed that the import indices may be correlated with the error term of the estimating equation. This would bias the OLS coefficients in Table VIa. We therefore turn to the IV results next.

Columns 1 and 2 of Table VIb report the coefficients from first stage regressions. Column 1 reports first stage results with the conventional input price index as the dependent variable. As expected, a decline in tariffs leads to a decline in the conventional input price index. The coefficient on the interaction of the input tariff with language proximity to India is not significant, indicating no differential decline in the conventional input price index across sectors that vary in their language proximity to India. Column 2 reports first stage results for the input variety price index. Lower input tariffs result in more imported input varieties (i.e., a decline in the variety component) particularly in industries where countries with a RCA share language with India (i.e., a higher value of proximity cost variable). This is consistent with the interpretation that industries with closer language proximity to India experience a larger increase in varieties for a given decline in input tariffs.

The remaining columns of Table VIb report IV estimates of equation (19). The first-stage F statistics on excluded instruments are reported at the bottom of each column. Column 3 reports the results using only the conventional input price index; this is the IV version of column 1 in Table VIa. As with OLS, the result is not significant, but the sign of the coefficient suggests that lower input prices of existing inputs are associated with increases in firm scope. Column 4 presents the IV result for the input variety index. The coefficient on the variety index is negative and significant. Column 5 presents the results when equation (19) is estimated with IV and both indices are included; this equation is just identified with the two instruments and two endogenous regressors. The coefficient on the variety index is not statistically significant at conventional levels (p-value is 20%), which is not surprising given the well known problems associated with efficiency of IV estimators. However, the point estimates are very close to the IV results in column 4 that do not condition on the conventional input price index. The results in columns 4 and 5 suggest that more imported variety (i.e., a lower variety index) is associated with expansion in product scope.

Note that the IV estimates of the variety effect in columns 4 and 5 are lower (larger in magnitude) than the OLS estimates. *A priori*, it is difficult to sign the bias of the OLS estimates. As noted earlier, the error term in equation (19) contains the (unobserved) price index of domestic inputs (Π_{iD}) as well as unobserved demand shocks. If the correlation between the error term and $\Lambda_{qF}^{\text{inp}}$ is positive, the OLS estimates are biased downwards (i.e., too negative). If the correlation is negative, the OLS estimates are biased upwards (i.e., not negative enough). In order to understand why the bias is ambiguous, suppose there is an increase in (unobserved) demand. The demand shock will likely raise the demand for foreign inputs resulting in a lower $\Lambda_{qF}^{\text{inp}}$. The shock may also induce domestic input suppliers to manufacture new varieties which will cause downward pressure on Π_{iD} since more varieties lower the price index. This effect suggests a positive correlation between $\Lambda_{qF}^{\text{inp}}$ and the error term in (19). However, the domestic shock will also induce an increase in the prices of existing domestic inputs, therefore causing Π_{iD} to increase. If the price increase of existing domestic inputs outweighs the downward pressure on Π_{iD} due to new varieties, there will be an overall negative correlation between $\Lambda_{qF}^{\text{inp}}$ and the error term in (19). Thus, the potential bias of the OLS estimates is, *a priori*, ambiguous. The IV coefficients on the variety index are lower than the OLS estimates, suggesting that the negative correlation dominates.

We estimate additional variants of equation (19). Our analysis so far has relied on the 1993-94 IO table for India. This IO table likely reflects India's production technology across industries at the start of the reform period. At that time, industries may not have relied heavily on inputs of machinery that were subject to high tariffs. Such an IO matrix may thus provide a more noisy measure of the potential to benefit from trade in inputs. As a robustness check, we re-constructed the conventional and variety input price indices using India's 1998-99 IO matrix. In column 6 of Table VIb, we report IV results based on these measures. We find that the point estimates are similar to column 5 but are, not surprisingly, more precisely estimated.

The response of the extensive margin to tariffs is likely to be non-linear since India's strongest or weakest trading partners are less likely to be affected by changes in tariffs. In column 7 we therefore use a third-order polynomial expansion of input tariffs and language-proximity as instruments for the conventional and variety input price index and estimate equation (19) with a continuous-updating GMM estimator. This estimator is more efficient than the two stage least squares estimator (TSLS) and also less prone to potential problems with weak instruments when there are multiple instruments (see Baum et al. [2007] and Stock et al. [2002]). We again find that lower input variety is associated with expanded product scope and that the magnitudes of the coefficients are similar to previous columns, and the first-stage F-statistics improve. Finally, we re-estimate equation (19) controlling for changes in output tariffs. This specification directly controls for the possibility that trade liberalization affected TFP of domestic firms through declines in output tariffs. These regressions (available upon request) yield very similar coefficients to those reported in columns 4-7, suggesting that our assumption that input tariffs affect firms' product scope only through the conventional input price and variety index is valid.

Overall, the analysis suggests that the increase in imported variety enabled Indian firms to expand their product scope. The magnitudes of the coefficients on the imported variety index in columns 3-7 are also economically significant, and consistent with the reduced form results in Section 3. Consider the coefficient in column 5. The coefficient implies that a 1% decline in the variety index leads to a 13.4% increase in firm scope. This elasticity is large, but it is important to note that the input variety index has been weighted by import shares (see equation 18) and so the import-share-weighted variety indices are orders of magnitude smaller than the numbers in Table V. During the period of our analysis, input tariffs declined on average by 24 percentage points, and from column 2, the decline in input tariffs led to a .25% decline in input variety index on average. The IV point estimate therefore implies a 3.4% increase in scope for the average firm due to the increased availability of imported varieties.

While our theoretical framework suggests that reductions in the price and variety components should have an equal effect on product scope (see equation 13), our empirical results suggest a much larger elasticity with respect to the variety index. As we noted earlier, one possible explanation for this finding is that the technological complementarity *within product lines* in a firm is much stronger than the one we capture through the variety index we construct at a more aggregate level. Suppose for example that the production of a particular product required the use of particular inputs in fixed proportions. The firm might adjust product lines in response to tariff changes, but there would be no substitution of inputs *within* product lines. This would make the effect of new varieties very strong: the availability of new inputs would enable the firm to produce entirely new products. While we cannot provide direct evidence on this hypothesis given the level of aggregation in available data, the large elasticity of product scope with respect to the variety index is highly suggestive.

To conclude, the results in Tables IVa and IVb provide insight into the mechanisms generating the reduced-form results we presented earlier.[33] Given that new product additions accounted for about 25% of growth in Indian manufacturing output during our sample, the results suggest that the availability of new imported intermediates played an important role in the growth of Indian manufacturing in the 1990s.

5. Conclusion

After decades of import substitution policies, Indian firms responded to the 1991 trade liberalization by increasing their imports of inputs. Importantly, two-thirds of the intermediate import growth occurred in products that had not been imported prior to the reforms. During the same period, India also experienced an explosion in the number of products manufactured by Indian firms. In this paper, we use a unique firm-level database that spans the period of India's trade liberalization to demonstrate that the expansion in domestic product scope can be explained in large part by the increased access of firms to new imported intermediate varieties. Hence, our analysis points to an additional benefit of trade liberalization: Lower tariffs increase the availability of new imported inputs. These in turn enable the production of new outputs. Local consumers gain from an increase in domestic variety (on top of the increased number of imported consumer goods).

Our approach relies on detailed product-level information on all Indian imports to measure the input price and variety changes. Since similar data are readily available for many countries, our approach can in principle be used by other researchers interested in the consequences of trade and imported inputs. Additionally, disaggregate data on the use of imported intermediates at the firm level may be available for some countries. However, we believe that relying on aggregate, product-specific import data rather than firm-level data on input use offers a few advantages. First, because the data on product imports is a census, we can say with confidence that the varieties classified as "new" were not available anywhere in India prior to the reform: their total imports were zero. Second, firms frequently access imported inputs through intermediary channels rather than direct

[33] We estimated equation (19) for output, TFP and R&D activity. The analysis confirms that access to more varieties resulted in higher firm output and R&D activity, but lower TFP (although these results are not statistically significant). The counterintuitive sign on TFP could in part reflect the difficulties associated with measuring TFP noted in the introduction.

imports; hence, it is possible that a firm that reports zero imported intermediates is in fact using imported intermediates that have been purchased through a domestic intermediary. This implies that there are advantages to using products or sectors as the appropriate units of aggregation. Third, the level of aggregation we use in this study allows us to take advantage of the tariff reforms in our identification strategy. Nevertheless, firm-level data with detailed information on imported inputs by firm may strengthen our understanding of the mechanisms that we highlight. More detailed data would enable us, for example, to study the determinants and consequences of differential adoption of imported inputs by Indian firms, although such a study would need to address the endogeneity of this differential adoption of imported inputs by firms – the trade policy changes we exploit as a source of identification do not vary by firm.

Our findings relate to growth models that highlight the importance of access to new imported inputs for economic growth and to recent cross-country evidence that lower tariffs on intermediate inputs are associated with income growth (Estevadeordal and Taylor [2008]). Our firm-level analysis offers insights into the microeconomic mechanisms underlying growth by focusing on one particular channel, access to imported intermediates, and one particular margin of firm adjustment, product scope. While we do not concentrate on aggregate growth, the fact that the creation of new domestic products accounted for nearly 25 percent of total Indian manufacturing output growth during our sample period suggests that the implications of access to new imported intermediate products for growth are potentially important. In future work we plan to further explore the contribution of these new products to TFP by exploiting product-level information on prices and sales available in our data. This will allow us to ultimately provide a direct estimate of the dynamic gains from trade.

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Tables

Table I: Pre-reform Firm Characteristics and Input Tariff Changes

	Products	Output	TFP	R&D
	(1)	(2)	(3)	(4)
1997-1992 Input Tariff Change	0.180	-0.744	0.517	-1.531
	0.308	0.745	0.507	1.341
Observations	713	712	614	667

Notes: The dependent variables in each column are the pre-reform 1989-1991 growth in firm-level outcomes. The variables are regressed on post-reform (between 1992 and 1997) changes in input tariffs. Column 1 is the pre-reform firm-level change in (log) number of products. Columns 2-4 are the pre-reform changes in (log) firm output, TFP and R&D expenditure. The number of observations varies in each column because the coverage of firm outcomes varies. Standard errors clustered at the industry level. Significance levels: * 10 percent; ** 5 percent; *** 1 percent.

Table II: Decomposition of Import Growth, 1987-2000

Product Classification	Import Growth (1)	Extensive Margin: Net (2)	Extensive Margin: Product Entry (3)	Extensive Margin: Product Exit (4)	Intensive Margin: Net (5)	Intensive Margin: Growing (6)	Intensive Margin: Shrinking (7)
All Products	130	84	84	0	45	84	-39
Intermediate Products	227	153	153	0	74	116	-42
Final Products	90	33	33	0	57	86	-29

Notes: The table decomposes real import growth into the extensive and intensive margins between 1987 and 2000. Imports are deflated by the wholesale price index. Column 1 reports overall import growth. Column 2 and column 5 report the contribution of the extensive and intensive margins, respectively. The extensive margin is growth in imports due to new six-digit HS codes not imported in the 1987. The intensive margin measures import growth within products that India had imported in 1987. The gross contributions are reported in columns 3 and 4 for the extensive margin, and columns 7 and 8 for the intensive margin. Rows 2 and 3 decompose import growth in the intermediate (basic, capital and intermediates) and final (consumer durables and non-durables) products. The HS codes have been standardized to remove any issues due to changes in the Indian HS classification system.

Table IIIa: Import Values and Tariffs

	All products		Intermediates		Final Goods	
	(1)		(2)		(3)	
Output Tariff	-0.136	***	-0.117	***	-0.151	**
	0.035		0.044		0.076	
Year FEs	yes		yes		yes	
HS6 FEs	yes		yes		yes	
R-squared	0.82		0.82		0.80	
Observations	35,833		20,140		11,838	

Notes: The table reports coefficients on tariffs from product-level regressions of log (fob) import value on lagged output tariffs, HS6 product fixed effects, and year effects. An observation is HS6-category-year. Column 1 pools across all sectors. Columns 2 and 3 report coefficients for the intermediate and final goods, respectively. Tariffs are at the HS6 level and regressions are run from 1987-1997. Standard errors clustered at the HS6 level. Significance levels: * 10 percent; ** 5 percent; *** 1 percent.

Table IIIb: Import Unit Values and Tariffs

	All Products		Intermediate		Final Goods	
	(1)		(2)		(3)	
Output Tariff	0.273	***	0.304	***	0.245	***
	0.050		0.077		0.079	
Year FEs	yes		yes		yes	
HS8-Country FEs	yes		yes		yes	
R-squared	0.88		0.85		0.93	
Observations	49,109		32,619		11,070	

Notes: This table summarizes regressions of (log) tariff-inclusive unit values on tariffs, HS8-country fixed effects and year fixed effects. Unit values are computed for each HS8-country pair and the tariffs are the HS6 level. The first column uses all products and the second and third column reports coefficients for the intermediates and final goods, respectively. Regressions are run from 1987-1997. Standard errors clustered at the HS6 level. Significance level: * 10 percent; ** 5 percent; *** 1 percent.

Table IIIc: Import Extensive Margin and Tariffs

	All Products (1)		Intermediate (2)		Final Goods (3)	
	Panel A: Variety: HS6-country					
Output Tariff	-0.082	***	-0.106	***	-0.049	*
	0.012		0.014		0.026	
R-squared	0.85		0.84		0.84	
Observations	35,833		20,140		11,838	
	Panel B: Variety: HS8					
Output Tariff	-0.015	**	-0.023	***	-0.005	
	0.007		0.009		0.014	
R-squared	0.88		0.90		0.85	
Observations	35,833		20,140		11,838	
	Panel C: Variety HS8-country					
Output Tariff	-0.095	***	-0.129	***	-0.042	
	0.013		0.016		0.028	
R-squared	0.87		0.86		0.86	
Observations	35,833		20,140		11,838	

All regressions also include year fixed effects and HS6 fixed effects

Notes: The table reports coefficients on tariffs from product-level regressions of (log) number of varieties on output tariffs, HS6 product fixed effects, and year effects. The regressions are run at the HS6-year level and each panel uses at alternative definition of a variety. A variety is defined as an HS6-country pair in panel A, an HS8 code in panel B, and an HS8-country pair in panel C. Within each panel, the first column pools across all sectors while columns 2 and 3 report coefficients for the intermediate and final goods, respectively. As in the previous tables, tariffs are at the HS6 level and the regressions are run from 1987-1997. Standard errors clustered at the HS6 level. Significance levels: * 10 percent; ** 5 percent; *** 1 percent.

Table IVa: Product Scope and Input Tariffs

	(1)		(2)		(3)		(4)	
Input Tariff	-0.323	**	-0.310	**	-0.327	**	-0.281	**
	0.139		0.150		0.150		0.125	
Output Tariff			-0.013		-0.014		-0.010	
			0.043		0.041		0.041	
Delicensed					-0.032		-0.026	
					0.023		0.021	
FDI Liberalized							0.037	
							0.024	
Year Effects	yes		yes		yes		yes	
Firm FEs	yes		yes		yes		yes	
R-squared	0.90		0.90		0.90		0.90	
Observations	14,882		14,864		13,435		11,135	

Notes: The dependent variable in each regression is (log) number of products manufactured by the firm. The delicenced variable is an indicator variable obtained from Aghion et al (2008) which switches to one in the year that the industry becomes delicensed. The FDI variable is a continuous variabled obtained from Topalova (2007) with higher values indicating a more liberal FDI policy. As with the tariffs, the licensed and FDI policy variables are lagged. All regressions include firm and year fixed effects and are run from 1989-1997. Standard errors clustered at the industry level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table IVb: Reduced-Form Robustness Checks

Product scope regressed on input tariffs, firm and year fixed effects, plus controls					
(1) NIC2 X Year FEs	-0.323	*	(7) Initial Products X Year FEs	-0.408	***
	0.191			0.128	
(2) NIC3 X Year FEs	-0.424	**	(8) Initial Output Decile X Year FEs	-0.311	**
	0.204			0.146	
(3) Pre-reform Industry Product Growth X Year FEs	-0.327	**	(9) Initial TFP Decile X Year FEs	-0.321	*
	0.145			0.163	
(4) Pre-reform Industry Output Growth X Year FEs	-0.315	**	(10) Initial R&D Dummy X Year FEs	-0.312	**
	0.141			0.154	
(5) Pre-reform Industry TFP Growth X Year FEs	-0.336	**	(11) Poisson Model	-0.286	*
	0.141			0.162	
(6) Initial MPF Dummy X Year FEs	-0.393	***	(12) Constant Firms	-0.403	*
	0.127			0.206	

Long-Difference Robustness Checks

	Dependent variable: 1997-1989 Change in Log Product Scope	*Dependent variable:* 1997-1991 Change in Log Scope — 1991-1989 Change in Log Scope	
(13) ΔInput $\text{Tariffs}_{1997\text{-}1989}$	-0.315	(14) ΔInput $\text{Tariffs}_{1997\text{-}1991}$ —	-0.234
	0.237	ΔInput $\text{Tariffs}_{1991\text{-}1989}$	0.251
Observations	696	Observations	662

Notes: The dependent variable in each regression is (log) number of products manufactured by the firm. Each row reports the coefficient on the input tariff with the additional controls beyond firm and year fixed effects. Specifications 1-12 have approximately 14,000 observations. Specifications 1-2 include two-digit NIC-year and three-digit NIC-year fixed effects, respectively. Specification 3 interacts the firms' initial multiple-product status with year fixed effects. Specification 4 interacts the firms' initial number of products with year fixed effects. Specifications 5-6 include interactions of year fixed effects with deciles of initial firm output and TFP. Specification 7 includes firms' initial R&D status with year dummies. Specifications 8-10 include interactions of year dummies with pre-reform (1989-1991) industry product, output and TFP growth, respectively. Specification 11 runs equation (3) using a Poisson regression using product scope (rather than log product scope) as the dependent variable. Specification 12 re-runs equation (3) on a constant set of firms. The bottom panel reports long-difference specifications. Specification 13 runs a long difference regression of the change in (log) scope on the change in input tariffs between 1989-1997. Specification 14 runs a long-difference regression which controls for firm-specific trends by running the change in log scope between 1991-1997 and 1989-1991 on the equivalent double-difference in input tariffs. All regressions include firm and year fixed effects. Standard errors clustered at the industry level. Significance: * 10 percent; ** 5 percent; *** 1 percent.

Table IVc: Input Tariffs and Other Firm Outcomes

	Output		TFP		R&D	R&D	
	(1)		(2)		(3)	(4)	
Input Tariff	-1.125	**	-0.454	*	-1.559	-0.077	
	0.436		0.233		1.751	1.124	
Input Tariff X Large Firm						-1.903	*
						1.111	
Year Effects	yes		yes		yes	yes	
Firm FEs	yes		yes		yes	yes	
R-squared	0.92		0.81		0.21	0.21	
Observations	14,874		13,714		14,233	14,233	

Notes: The dependent variable in column 1 is log output. The dependent variable in column 2 is firm TFP obtained from Topalova (2007). Columns 3 and 4 are R&D expenditures. Column 4 includes an interaction with a dummy if the firm is above median size. All regressions include firm and year fixed effects and are run from 1989-1997. Standard errors clustered at the industry level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table V: Import Variety Indices

	Variety Index		
	Mean	Median	Overall
All Sectors	0.899	0.986	0.688
Intermediate Sectors	0.881	0.954	0.624
Final Sectors	0.904	1.000	0.850

Notes: Table reports the variety index computed at the HS4 level using elasticities of substitution from Broda, Greenfield, and Weinstein (2006) for India. The indices use HS6-country pairs as the definition of a variety. Columns 1 and 2 report the median and mean variety index across HS4 groups. Column 3 aggregates the HS4 indices to the overall economy level using equation (13) in Broda and Weinstein (2006). The first row reports the variety index over all imported sectors. The second and third row compute the indices for the intermediate and final sectors. The numbers are computed using data between 1989 and 1997.

Table VIa: Product Scope and Channels: OLS

	(1)	(2)		(3)	
Conventional Price Index	-0.156			-0.124	
	0.121			0.113	
Variety Index		-5.97	**	-5.70	**
		2.55		2.41	
R-squared	0.002	0.009		0.010	
Observations	696	696		696	

Notes: Table reports OLS regressions of firm scope on the imported input price indices. Column 1 includes the conventional index, column 2 includes the variety index and column 3 includes both indices. Regression is run for years 1989 and 1997. Standard errors clustered at the industry level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table IVb: Product Scope and Channels: Instrumental Variables

	1st Stage Regressions		2nd Stage Regressions				
	{Conv. Price Index}$_q$	{Variety Index}$_q$	{ΔFirm Scope}$_f$	{ΔFirm Scope}$_f$	{ΔFirm Scope}$_f$	{ΔFirm Scope}$_f$ — 1998/99 IO Matrix	{ΔFirm Scope}$_f$ — Polynomial Instruments
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
{Δ Input Tariff}$_{q,97\text{-}89}$	1.340 ***	-0.007					
	0.476	0.020					
{Δ Input Tariff}$_{q,97\text{-}89}$ X {Proximity}$_q$	-0.707	0.121 *					
	1.618	0.065					
{Conventional Price Index}$_q$			-0.240		-0.033	-0.047	-0.493 *
			0.211		0.299	0.245	0.271
{Variety Index}$_q$				-14.24 *	-13.40	-14.88 *	-14.80 ***
				7.56	10.46	8.97	5.00
F-test 1st Stage Instruments			[5.3,p=.01]	[3.1,p=.05]	[5.3,p=.01; 3.1,p=.05]	[33.4,p=.00; 5.5,p=.01]	[21.4,p=.00; 12.8,p=.00]
Observations	696	696	696	696	696	696	696

Notes: Table reports IV regressions of firm scope on the imported input price indices. The instruments are changes in input tariffs and changes in input tariffs interacted with the proximity measure described in the text. Columns 1 and 2 report the first stage regressions for the conventional price and variety indices, respectively. Columns 3-7 report the second stage regressions. Column 6 uses the 1998/99 input-output matrix. Column 7 includes third-order polynomials of the instruments and is estimated using a continuously-updated GMM estimator. The regressions are run for years 1989 and 1997. Standard errors clustered at the industry level. Significance: * 10 percent; ** 5 percent; *** 1 percent.