IMPORTED INTERMEDIATE INPUTS AND DOMESTIC PRODUCT GROWTH:
EVIDENCE FROM INDIA

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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 a large developing economy—India—to investigate the relationship between declines in trade costs, the imports of intermediate inputs and domestic firm product scope. We estimate substantial static gains from trade through access to new imported inputs. Accounting for new imported varieties lowers the exact 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. Moreover, we find that lower input tariffs account on average for 31 percent of the new products introduced by domestic firms, which implies potentially large dynamic gains from trade. This expansion in firms' product scope is driven predominately by international trade increasing access of firms to new input varieties rather than by simply making existing imported inputs cheaper. Hence, our findings suggest that an important consequence of the input tariff liberalization was to relax technological constraints through firms' access to new imported inputs that were unavailable prior to the liberalization.

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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 1990's, 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 growth (Goldberg, Khandelwal, Pavcnik and Topalova, henceforth GKPT, 2008). During the same period, India also experienced a surge in intermediate imports, 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 intermediates and new domestic products. In particular, in a fast-growing economy, firms may decide to introduce new products for reasons unrelated to international trade. Once the manufacturing of such products begins, the demand for imported intermediates, both existing ones 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, which reduced input tariffs differentially across sectors. Importantly, these reductions were not the outcome of the usual political economy pressures from Indian firms. We find a strong and robust relationship between declines in input tariffs and the introduction of new, domestically manufactured products: firms in sectors that faced the largest input tariff declines contributed more to the introduction of new products. Lower input tariffs account on average for 31 percent of the observed increase in firms' product scope. Such firms also improved their performance along several other dimensions: they experienced greater sales growth, exhibited larger TFP growth and were more likely to engage in R&D activities.

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To investigate the channels through which input tariff liberalization affected domestic product growth in India, we use the methods developed by Feenstra (1994) and Broda and Weinstein (2006) together with the Indian Input-Output Table to construct input import price indices for each sector and decompose these indices into two parts: a part capturing the conventional price index that is calculated based on the import prices of existing varieties and a second part that captures the effect of new imported product varieties on the exact index. This methodology suggests substantial static gains from trade through access to new imported inputs. Accounting for the introduction of new varieties lowers the exact import price index of intermediate goods by 4.7 percent per year on average relative to the conventional price index.

We find that input tariff reductions had a significant effect on both components of the input price index; the liberalization reduced the conventional import price index by reducing the prices of the imported inputs that were imported prior to the liberalization, but also contributed to a decline in the exact price index through the increase in the extensive margin of imported intermediate inputs.

In the final step of our empirical investigation we relate these components of the intermediate input price indices to the product growth observed in each firm. The results suggest a much bigger role for the extensive margin of imported intermediate inputs than the intensive margin. Hence, it appears that input tariff liberalization contributed to domestic product growth not simply by reducing the production cost facing domestic producers (i.e., making available imported 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.[2]

These findings relate to three 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. While the first source of (static) gains has been addressed in the empirical literature before (see our discussion of studies focusing on total factor productivity below), the second source has been empirically elusive, partly because data on the introduction of *domestic* varieties produced in each country have been difficult to obtain.[3] The two studies that are closest to ours (Broda, Greenfield and Weinstein (2006) and Feenstra, Madani,

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[2] The importance of increased access to imported inputs has been noted by Indian policy makers. In a recent speech, the managing director of the Indian Reserve Bank Rakesh Mohan 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)."

[3] Brambilla (2006) is an exception.

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; moreover, we also observe other firm-level measures that play an important role in endogenous growth models, such as the R&D activity in each firm.

Second, our results are related to the large literature on the gains from variety associated with trade. While existing estimates tend to find that such gains are substantial (see for example Feenstra (1994) and Broda and Weinstein (2006)[4]), these studies have exclusively focused on the role of new *imported* varieties, abstracting from the effect of trade on domestic varieties. But as Arkolakis, Demidova, Klenow, and Rodriguez-Clare (2008) point out, it is possible that the intensified import competition following a trade liberalization, especially a unilateral episode like India's, results in a decline in domestic variety. In fact, Melitz (2003) and Eaton, Kortum and Kramarz (2007) predict that that domestic variety falls with a decline in trade costs while empirical evidence has found that trade liberalizations lead to exit by domestic firms (Tybout (2003)). Recent multiple-product firm models (e.g., Bernard, Redding and Schott (2006a and 2006b), Eckel and Neary (2006), Nocke and Yeaple (2007), Baldwin and Gu (forthcoming)) also predict that a trade liberalization will induce firms to focus on their "core competence" by shedding relatively less profitable products. Given these predictions, it is unclear if total variety in an economy (domestic plus imported) will increase, decrease or remain constant following a trade liberalization. Baldwin and Forslid (2008) develop a model where total variety falls with a decline in trade costs, an effect that the authors label the "anti-variety" effect of a trade liberalization.

To our knowledge, our study is the first to empirically examine the response of *domestic* variety to trade liberalization. Not only do we not find an "anti-variety" effect of trade, our findings document an explosion in the domestic varieties available in India that we (partly) attribute to the trade reform. The key in understanding the source of our findings lies in the distinction between tariffs on final goods and tariffs on inputs; the "variety-creation" effect of trade liberalization documented in our study arises because the Indian trade liberalization significantly reduced tariffs on imported inputs, which led to imports of new varieties of intermediate products, which in turn

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[4]Klenow and Rodriguez-Clare (1997) and Arkolakis, Demidova, Klenow and Rodriguez-Clare (2008) however 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.

enabled 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.

Finally, our work is also related to the work 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 the domestic product margin.[5] 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 – 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 offered by the firm. Recent empirical work suggests that in fact, new product additions by local firms account for a sizable share of sales growth in several countries (Bernard, Redding and Schott (2006a), GKPT (2008), Navarro (2008)), trumping the contribution of firm entry and exit.

The remainder of the paper is organized as follows. In Section 2 we describe our empirical framework and lay out the steps of our empirical analysis. Section 3 offers a brief overview of the data we use in our analysis and the Indian trade liberalization of the 1990s; for more details we refer the reader to an earlier paper of ours that uses the same data (GKPT (2008)). Section 4 organizes our results in three subsections. In Section 4.1, we provide descriptive evidence linking the expansion of the intermediate import extensive margin to tariff declines. Next, we provide reduced-form evidence that lower input tariffs caused firms to expand product scope. While these regressions establish our main empirical findings, they are unable to inform our understanding of the particular channels that are at work. In Section 4.3, we therefore present results based on the framework laid out in Section 2

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

that allow us to interpret the reduced form results and identify the relevant mechanisms. Section 5 concludes.

2. Empirical Framework

Input tariff liberalization can affect the development of new products in the domestic market through two channels. First, the reduction of tariffs is expected to reduce the prices of imported intermediate products, thus decreasing the variable cost of production for domestic producers making use of such inputs. Second, the reduction of tariffs may lead to the import of new input varieties that enable domestic firms to produce new goods.

More formally, suppose that the production technology of a product j in sector s of the economy at time t has the following general form:

$$Y_{jt}^s = f(\Omega_{jt}, K_{jt}, L_{jt}, D_{jt}^s, M_{jt}^s)$$

where Y denotes output, Ω stands for product-specific productivity, K and L are capital and labor respectively, and the vectors D_j^s and M_j^s denote a set of domestic and imported intermediates, respectively. This production technology is general in the sense that it does not commit us to a particular functional form. Suppose further that the production of j requires a fixed cost F_j. The firm will choose inputs optimally so as to maximize profits and will produce product j 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. By decreasing the price of imported inputs and thus increasing variable profits, input tariff reductions raise the likelihood that a firm can manufacture previously unprofitable products. Furthermore, liberalization may lead to the import of new varieties, thus expanding the set of intermediate inputs available to the firm. 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 some of the intermediate inputs included in the vector M_j^s are essential, in the sense that if the use of one of them falls to zero, product j 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. Quantifying the contributions of these two channels to new product creation is the main goal of our analysis.

To this end, we adapt the approach developed by Feenstra (1994) and its extension by Broda and Weinstein (2006) in order to provide some structure in our setting. Let each of the m imported intermediate inputs included in the vector M_t (for notational convenience we drop the super- and subscript s and j for now) be the composite of a set of imported intermediate varieties v, which are combined according to the non-symmetric CES function:

$$M_{mt} = \left(\sum_{v \in I_{mt}} d_{mvt} M_{mvt}^{\frac{\sigma_m}{\sigma_m - 1}} \right)^{\frac{\sigma_m}{\sigma_m - 1}} \tag{1}$$

where $\sigma_m > 1$ denotes the elasticity of substitution among varieties of good m, d_{mvt} is a quality taste parameter specific to variety v, and I_{mt} being the subset of varieties of good m with positive imports at time t. As is common in the literature, the definition of "variety" is based on the country of origin for each import; the premise that imports are differentiated across originating countries is consistent with the Armington assumption. Let $I_m = I_{mt} \cap I_{mt-1}$ be the set of varieties of import good m that is available both in periods t and $t-1$. The minimum unit-cost function corresponding to (1) is:

$$c_{mt}^C(I_{mt}, d_{mt}) = \left(\sum_{v \in I_{mt}} d_{mvt} (p_{mvt})^{1-\sigma_m} \right)^{\frac{1}{1-\sigma_m}}$$

where p_{mvt} denotes the price of variety v of import good m at time t and d_{mt} is the vector of taste parameters. Then the exact price index for m over a *constant* set of varieties, P_m^C, corresponding to the non-symmetric CES is:

$$P_m^c(p_{mt}, p_{mt-1}, M_{mt}, M_{mt-1}, I_m) = \frac{c_{mt}^C(I_m, d_m)}{c_{mt-1}^C(I_m, d_m)} = \prod_{v \in I_m} \left(\frac{p_{mvt}}{p_{mvt-1}} \right)^{w_{mvt}} \tag{2}$$

where the weights w_{mvt} given by:

$$w_{mvt} = \frac{(s_{mvt} - s_{mvt-1})/(\ln s_{mvt} - \ln s_{mvt-1})}{\sum_{m \in I_m} ((s_{mvt} - s_{mvt-1})/(\ln s_{mvt} - \ln s_{mvt-1}))} \tag{3}$$

and

$$s_{mvt} = \frac{p_{mvt}M_{mvt}}{\displaystyle\sum_{m \in I_m} p_{mvt}M_{mvt}} \tag{4}$$

The exact price index for *m* given by (2), also known as the conventional price index, is based on the premise that all varieties are available in both periods. As shown by Feenstra (1994), this index can be modified to account for the role of new import varieties as long as there is some overlap in the varieties available between periods. The modified index takes the form:

$$P_m(p_{mt}, p_{mt-1}, M_{mt}, M_{mt-1}, I_m) = P_m^c(p_{mt}, p_{mt-1}, M_{mt}, M_{mt-1}, I_m)\left(\frac{\lambda_{mt}}{\lambda_{mt-1}}\right)^{1/(\sigma_m - 1)} \tag{5}$$

where

$$\lambda_{mt} = \frac{\displaystyle\sum_{v \in I_m} p_{mvt}M_{mvt}}{\displaystyle\sum_{v \in I_{mt}} p_{mvt}M_{mvt}} \quad \text{and} \quad \lambda_{mt-1} = \frac{\displaystyle\sum_{v \in I_m} p_{mvt-1}M_{mvt-1}}{\displaystyle\sum_{v \in I_{mt-1}} p_{mvt-1}M_{mvt-1}} \tag{6}$$

Equation (5) states that the exact price index when there are new varieties is the product of two terms: the first term is the conventional price index, i.e. the price index for the products that are common across periods, while the second term captures the role of new and disappearing varieties. As has been noted in the literature, the second term has an intuitive interpretation: λ_{mt} is the fraction of expenditure on the varieties that are available in both periods relative to the expenditure on the set of varieties available in *t*. The more important the new varieties are (in the sense of having a higher expenditure share), the lower will be λ_{mt}, and the smaller will be the exact price index relative to the conventional one. From equation (5) it is also evident that the exact price index will depend on the substitutability of varieties, as captured by the elasticity of substitution σ_m. The more substitutable the varieties are, the lower is the term $1/(\sigma_m - 1)$, and the lower is the difference between the exact and conventional price indices. In the limit case of a zero elasticity of substitution, the second term becomes unity indicating that changes in the available varieties have no effect on the price index.

The exact price index as given by (5) plays a central role in our empirical analysis. We compute it using detailed data on imports and unit values and decompose it into the conventional price index and the variety index using the formulas (2)-(4) and (6). These two components correspond to the two channels through which imported inputs affect the introduction of new domestic products. The first term captures the "price" effect; decreases in the prices of imported

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varieties of existing intermediate goods would lead to a decrease (or, more accurately, slower increase) of the conventional price index. The second term captures the "extensive margin" aspect of imports in intermediates; as new imported varieties become available, the variety index falls.

While calculations as in (5) have been conducted before, an important aspect of our analysis is that we argue that changes in the exact price index as well as its components are due to India's trade liberalization. This is important because our goal is to provide evidence that the relationship between imports of intermediate inputs and domestic product growth can be interpreted as a causal one: higher imports of intermediates contribute to the development of new products. The difficulty in establishing such a causal relationship lies in the fact that new products can be introduced domestically for a variety of reasons that have nothing to do with trade. Once domestic firms decide to produce them, they may increase their demand for imported intermediates, both existing ones and new varieties. We therefore rely on trade policy changes that were plausibly less influenced by the usual political economy pressures (see discussion below) to address the concern that the growth of domestic products led to the import of new varieties rather than vice versa.

Our empirical analysis implements this framework in the following steps. First, we examine the impact of the liberalization on those variables that are important in our empirical analysis: total imports, imports of intermediates, unit values and the number of imported varieties. The purpose of this step is to establish that liberalization was "real" in the sense that it affected the relevant variables in the expected way. In other words, if tariff reductions had no effect on unit values or the extensive margin of imported intermediates, there would be no reason to proceed with the rest of the analysis.

Next, we examine the reduced-form relationship between input tariffs and scope of domestic production. Estimating this relationship requires using information from India's Input-Output Transaction Tables to construct input tariffs and match them to final goods sectors. In the same step we also examine the impact of trade liberalization on several other variables that are relevant in endogenous growth models, such as total factor productivity, R&D, as well as firm sales. This reduced form analysis is central to our analysis as it establishes our main empirical findings.

In the final stage, we explore the mechanisms underlying the relationships uncovered by the reduced form regressions. To this end, we first compute the exact price index for imports and decompose it into the conventional price index and the part capturing the extensive margin of imports using the equations above. Next, we run the exact price index and the two components through the input-output matrix to obtain a sector's input indices. Once we calculate the input price indices, we explicitly show that changes during this period in the exact import price index, and its two components, were driven by trade policy changes, namely tariff reductions. In the last step, we relate

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the changes in the import price index, as well as each component, to changes in the domestic scope of production. The purpose of this step is examine whether the development of new products by domestic firms was primarily due to the fact that they faced lower prices for existing imported intermediates (as captured by the conventional import price index) or to the availability of new, previously unavailable import varieties (i.e., the extensive margin of imported intermediates).

Before we report the findings of this exercise, we describe our data and the particular policy experiment, as well as how we constructed the main variables used in our analysis, input tariffs in particular.

3. Data and Policy Background

3.1 Data Source 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). Unlike the Annual Survey of Industries, India's manufacturing census, the Prowess data is a panel of firms, rather than a repeated cross section, and spans the period from 1989-2003. The Prowess database is therefore particularly well suited for understanding how firms adjust their product lines over time in response to increased access to intermediate inputs.[6]

The Prowess database 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 (2008), 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' manufacturing output and exports. More crucially, product-level sales comprise 99 percent of the (independently) reported manufacturing sales.[7] Our final database includes the 4,216 manufacturing firms that report product-level information and span the period from 1989-2003.

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

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[6] The CMIE database 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 the largest 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. Firms in Prowess account for 60 to 70 percent of the economic activity in the organized industrial sector and comprise 75 percent of corporate taxes and 95 percent of excise duty collected by the Government of India (CMIE).

[7] Table A.1 in GKPT (2008) provides detailed product-level summary statistics by each two-digit National Industrial Classification (NIC) sector.

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 $\tau_{st}^{input} = \sum_b \alpha_{sb} \tau_{bt}$, where α_{sb} is the share of input b in the value of industry s. 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.[8] 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. We also assign products according to their end use into five classifications: basic, capital, intermediate, consumer durables and consumer non-durables. This classification is adopted from Nouroz's (2001) classification of India's IO matrix. Final goods are consumer durables and non-durables and intermediates include goods classified as basic, capital and intermediate. The codes from the IO matrix are then matched to the four-digit HS (HS4) level following Nouroz (2001), which enables us to classify imports broadly into final and intermediate goods.

3.2 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 amongst 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

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[8] The IO table includes weights for manufacturing and service (e.g., electricity, utilities, labor, etc.) inputs while tariffs, of course, only exist for manufacturing. Therefore, the calculation of input tariffs implicitly assumes a zero tariff on services and, thus, zero change in tariff on services. All of our regressions rely on changes in tariffs over time and not cross sectional comparisons.

was to abandon the extremely restrictive trade policies.[9] 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)).   India remained committed to further trade liberalization beyond the Eighth Plan (1992-97) which ushered the radical changes to its trading regime. Since 1997 there have been further adjustments to import tariffs. However, at the time the government announced the export-import policy in the Ninth Plan (1997-2002), sweeping reforms outlined in the previous plan had been undertaken and pressure for further reforms from external sources had abated.

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)).[10] Thus, the liberalization of the trade regime was unanticipated by firms in India. Second, reforms were passed quickly as sort of a "shock therapy" with little debate or analysis to avoid the inevitable political opposition (Goyal (1996)). Consequently, while there is significant variation in the tariff changes across industries, these changes are not strongly correlated with baseline industry characteristics such as productivity, size, capital intensity (Topalova (2007)).[11] It is precisely this variation in tariffs, and consequently input tariffs, across industries that will enable us to analyze how firms change their product mix in response to opening to trade. We refer readers to Topalova (2007) for more details regarding the liberalization episode.

4. Empirical Analysis and Results

4.1 A First Look at the Data

We begin our empirical analysis by (a) decomposing the sources of growth of aggregate imports during the 1990s, and (b) examining the impact of trade liberalization on key trade variables

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[9] 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 (2008).

[10] 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 investor's confidence.

[11] 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.

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 extensive product margin was an important component of import growth (especially for intermediates) and that trade liberalization affected the variables relevant for our framework in expected ways.[12]

4.1.1 Raw Import Decompositions

We begin our empirical analysis by taking a closer look at the growth of imports during the 1990's. Total import growth reflects the contribution from 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). Let IM_{ht} denote the imports of product h at time t, C the set of products that India imports in both periods t and t-1 (i.e., the intensive margin), and E the set of products that are imported only in t or t-1 (i.e., the extensive margin). Then changes in total imports between periods t and t-1 can be decomposed as follows:

$$\Delta IM_t = \sum_{h \in E} \Delta IM_{ht} + \sum_{h \in C} \Delta IM_{ht},$$

We decompose import changes due to the extensive margin further into changes due to product additions (A) and product droppings (D):

$$\sum_{h \in E} \Delta IM_{ht} = \sum_{h \in A} \Delta IM_{ht} + \sum_{h \in D} \Delta IM_{ht}.$$

Continuing products can be further decomposed into the contributions from growing (G) and shrinking products (S):

$$\sum_{h \in C} \Delta IM_{ht} = \sum_{h \in G} \Delta IM_{ht} + \sum_{h \in S} \Delta IM_{ht}.$$

We can substitute these equations and re-write the aggregate change in imports as

$$\Delta IM_t = \sum_{h \in A} \Delta IM_{ht} + \sum_{h \in D} \Delta IM_{ht} + \sum_{h \in G} \Delta IM_{ht} + \sum_{h \in S} \Delta IM_{ht}.$$

The first two terms capture the import growth due to changes in the extensive product margin and the final two terms capture changes in the intensive margin.

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[12] Note that in GKPT (2008), we attempted to link the extensive margin growth during this period to various measures of liberalization in *final* goods, but had little success (see Table 10 in GKPT (2008)).

There are two striking features that emerge from this decomposition reported in Table 1. The first observation is that India experienced a surge in overall imports; column 1 indicates that imports rose by 130 percent between 1987 and 2000. More interestingly, however, is that 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.

The second fact that emerges from Table 1 is that the relative contribution of the extensive margin to overall growth was substantially larger in the intermediate imports. New intermediate imported products 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. Table 1 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.

4.1.2 The effect of tariffs on total imports, prices, and the import extensive margin

We next examine whether the expansion in trade noted in Table 1 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 imports, (b) Lower tariffs were associated with lower unit values of existing product lines and (c) More importantly, lower tariffs were also associated with increased imports of new product varieties. This expansion of varieties in response to tariff declines was particularly pronounced for intermediate products.

We begin by examining the responsiveness of import volumes to tariffs by regressing (log) import value of a HS6 product on the lagged HS6-level tariff, a HS6 level fixed effect and year fixed effects. Because political factors may have influenced tariff changes after 1997 (see our trade policy discussion above), we restrict the analysis to 1987-1997.[13] 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.[14]

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[13] The regression is run at the HS6-year level since this level of aggregation of the tariffs.

[14] Subsequent results in Table 2b confirm that tariff pass-through is not complete. 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.

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Table 2a reports the coefficient estimates on tariffs for all sectors (column 1), intermediate sectors (column 2) and final goods sectors (column 3). In all cases, declines in tariffs are associated with higher import volumes. This analysis therefore confirms that the trade reform played an important role in the expansion of imports documented in Table 1.

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 (c.i.f.) unit values of HS8-country varieties by regressing the variety's unit value on the lagged tariff, a year fixed effect and a variety (HS8-country) fixed effect.[15] 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 2b. 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, as expected, 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 in Indian firms.[16]

The aggregate decomposition in Table 1 suggested 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 and tariff declines would therefore lead to an expansion along the extensive margin as noted in Table 1. To provide direct evidence of the effect of tariffs on the extensive margin of imports we estimate the following specification:

$$\ln(1+v_{ht}) = \alpha_h + \alpha_t + \beta\tau_{h,t-1} + \varepsilon_{ht}, \qquad (7)$$

where v_{ht} is the number of varieties within a HS6 product h at time t, $\tau_{h6,t-1}$ is the (lagged) tariff rate at the six-digit HS level, α_h is a HS6 fixed effect and α_t is year fixed effect. The results are reported in Table 2c. To show that our results are not sensitive to the definition of a variety, the table reports equation (7) with different definitions of a "variety" as the dependent variable: HS6 -country (panel

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[15] We could also run this regression at the HS6-country level, but this would require sometimes aggregating HS8 products of different units to the HS6 level.
[16] We have also performed this analysis using f.o.b. unit values rather than c.i.f. unit values. The results, available upon request, also indicate that lower tariffs are associated with lower import prices. This finding is driven by declines in the prices of intermediate sectors.

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. Column 1 estimates equation (7) for all sectors and indicates 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 emphasized in Romer (1994).

We re-run regression (7) for the intermediate and final goods sectors in columns 2 and 3 of each panel, respectively. Consistent with the evidence in Table 1, the relationship between tariff declines and the extensive margin is particularly pronounced for intermediate products. The results indicate that coefficient on tariffs for the intermediate sectors in column 2 is more than twice as large as the tariff coefficient for the final goods sectors. Moreover, while the results for intermediate products are also robust to the alternative definitions of a variety used in panels B and C, the results for final products are more sensitive across different variety definitions.[17]

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 1 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 section 4, we quantify the magnitude of the gains from new varieties.

In sum, a first look at the 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. This is strongly suggestive that input tariff reductions were important for Indian firms, and in the next section, we quantify the overall impact of input tariff reductions on firm-level outcomes

4.2 Input Tariffs and Domestic Production

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[17] 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 also 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.

4.2.1 Input Tariffs and the Extensive Margin of Domestic Production

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

$$\ln n_{it}^{s} = \alpha_i + \alpha_t + \beta \tau_{s,t-1}^{input} + \varepsilon_{it}, \qquad (8)$$

where n_{it} is the number of products manufactured by firm i operating in sector/industry s at time t and $\tau_{s,t-1}$ is the lagged 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, as defined in Section 2. Standard errors are clustered at the industry level.

Table 3 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 estimates imply that a 10 percentage point fall in tariffs results in a 3.2% expansion of a firm's product scope.[18] 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, on average, for 31 percent of the observed expansion in firms' product scope.

In GKPT (2008), 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 only impacted growth via this extensive margin, our estimates imply that the lower input tariffs would have contributed 7.7 percent (.25*.31) of overall manufacturing growth. This back-of-the-envelope calculation suggests how important firm access to imported intermediate inputs, through both the intensive and extensive margins, is to overall growth via the expansion of firm product scope. The regression in (8), combined with the evidence from the previous section, is consistent with a

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[18] In unreported regressions, we demonstrate that the negative coefficient on input tariffs is robust to controlling for other changes in India's policy environment over this period, including output tariffs, industry licensing and labor regulations.

microeconomic mechanism underlying endogenous growth models: lower input tariffs lead to new import varieties, which in turn lead to the production of new domestic varieties.

4.2.2 Input Tariffs and Other Measures of Firm Performance

In the remaining panels of Table 3 we estimate variants of equation (8) that use other outcome variables on the left hand side. These variables 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).[19] This evidence is consistent with predictions of theoretical papers that 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 productivity gains (see Kasahara and Rodrigue (2008), Amiti and Konings (2007), Topalova (2007), Halpern, Koren and Szeidl (2006)). Finally, we find that lower input tariffs are associated with a higher probability that a firm performs research and development (column 4). This last effect is however imprecisely estimated. The imprecision might in part reflect heterogeneity of responses across firms. In fact, when we allow for 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 size indicator is negative (-.620) and statistically significant (standard error is .111). 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 (2008) indicate no systematic relationship between India's liberalization of output tariffs on domestic product scope. In sharp contrast, here we demonstrate 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.

The results presented in this section quantify the overall impact of access to imported inputs on firm scope and other outcomes and are obtained by relying on plausibly exogenous policy

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

changes. This enables us to interpret the estimated effects as the causal impact of trade liberalization. A limitation of this analysis is that it is unable to uncover the exact mechanism through which lower input tariffs influence product scope or other firm level measures of performance. 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 as in Ethier (1979, 1982), Markusen (1989), Romer (1987, 1990), Rivera-Batiz and Romer (1991), and Grossman and Helpman (1991)). The next subsection explores the mechanisms through which lower input tariffs influence product scope and quantifies the relative importance of the price and variety margins in the expansion of domestic product scope.

4.3 The Channels

We disentangle the impact of lower input tariffs through the price and variety margins using the methodology discussed in Section 2. We proceed in the following steps. We begin by using the import data to compute the exact import price index and decomposing it to the conventional price index and the variety index. We show that new varieties contributed significantly to the import price index, especially for intermediate goods. Using India's input-output matrix we then generate an imported input price index for each industry. In the final step, we relate the components of the input price indices to firms' extensive product margin.

Recall that according to equation (5) the exact price index is equal to $P_{mt} = P_{mt}^C \cdot \Lambda_{mt}$, where

P_{mt}^C is the conventional price index and $\Lambda_{mt} \equiv \left(\dfrac{\lambda_{mt}}{\lambda_{mt-1}} \right)^{\frac{1}{\sigma_m - 1}}$ is the variety index defined in equations

(2) and (5) of Section 2, respectively. Although our import data are available at a high level of disaggregation, we compute the import price indices 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) are designed to quantify the gains from new varieties within existing codes, the method is unable to quantify the introduction of entirely new codes.[20] We obtain estimates for the elasticity of substitution σ_m from Broda, Greenfield and Weinstein (2006) who estimate India's elasticities of substitution at the HS-3 level.

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[20]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 4 shows how the exact price indices and their components evolved between 1989 and 1997, the first and last year used in our analysis. The left panel reports the mean of each component across all sectors. The mean variety index fell from 1 to .899 over this period. This implies that the import price index adjusted for new 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. If one aggregates across HS4 categories to compute the overall import price index (reported at the bottom of Table 4), variety growth deflates the conventional import price index by 31 percent between 1989 and 1997. This implies that accounting for introduction of new varieties lowers import prices on average by 3.9 percent per year relative to the conventional price index. 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 according to Broda and Weinstein (2004) aggregate import prices are on average 1.2 percent lower per year due to new imported varieties. 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 figures in Table 4 clearly suggest that importing new products generated substantial gains from trade for the Indian economy during this period.

The second and third panels of Table 4 report the price index computed separately for the intermediate and final sectors. Consistent with the import decompositions in Table 1 and the import variety regressions in Table 2C, we observe that new variety growth was more important in the intermediate sectors than in the final goods sectors. The mean variety component for intermediate sectors fell to .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 had such a large impact on the intermediate import price index that the exact price index hardly changed between 1989 and 1997. Variety growth deflated the conventional price index by 38 percent compared to 15 percent for the aggregate price index for final good imports. This implies that the import price index for intermediates is on average 4.75 percent lower per year due to new varieties.

Having established that variety growth has a substantial impact on the import price index facing each industry, 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 generate imported *input* price indices by passing the sector-level price indices in Table 4 through the input-output matrix using a procedure analogous to obtaining input tariffs (described in section 3.1). That is, the input variety index faced by industry *s* is

$\Lambda_{st}^{input} = \sum_m \alpha_{sm} \Lambda_{mt}.$, where α_{sm} is the share of input m in the value of industry s and

$\Lambda_{mt} \equiv \left(\dfrac{\lambda_{mt}}{\lambda_{mt-1}} \right)^{\frac{1}{\sigma_m-1}}$ is the variety index defined in section 2.[21] We follow the same procedure to

obtain the conventional input price index faced by industry s, $P_{st}^{C,input}$, and the exact input price

index, P_{st}^{input} .

Table 5 relates the so-constructed input price indices to input tariffs. It explicitly

demonstrates that the trade liberalization played a role in lowering the input price index, as well as

each of its components. The table reports the estimate of the coefficient on input tariffs from a long

difference regression (between 1997 and 1989) of input price indices on input tariffs. That is, we

regress the input price index in each industry in 1997 (relative to the 1989 base) to the change in the

input tariff experienced by this industry between 1989 and 1997. The results using the exact input

price index as the dependent variable are reported in column 1. A positive and significant coefficient

on input tariffs indicates that a decline in input tariffs is associated with a decline in the exact input

price index. Columns 2 and 3 decompose this effect by showing how input tariff declines influenced

the conventional input price index (column 2) and the input variety index (column 3). The positive

and significant coefficient in column 2 suggests that lower input tariffs reduced the prices of existing

imported inputs that are reflected in the conventional price index. The positive and significant

coefficient in column 3 further implies that lower input tariffs lowered the exact import price index

by increasing the use of new input varieties (i.e. lower lambda ratio). The sum of the coefficients on

the two components equals the coefficient on the input tariffs from the first column. The

magnitudes therefore imply that about half of the decline in the exact import price index that resulted

from lower input tariffs can be attributed to lower prices of existing inputs, while new input varieties

account for the other half.

Having established that both lower prices for existing imported inputs and the expansion of

imported input varieties were important consequences of India's trade liberalization between 1989

and 1997, we now assess their relative importance in explaining the introduction of new products in

the domestic market. To this end, we relate firms' changes in product scope between 1989 and 1997

to changes in the input price indices in the following two regressions

$$\Delta \ln n_{it}^s = \alpha_1 + \beta_1 \ln P_{st}^{input} + \varepsilon_{1it} \tag{9}$$

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[21]The input indices are computed at the 4-digit NIC level since that is the finest level of disaggregation at which we can identify a firm's industry.

$$\Delta \ln n_{it}^s = \alpha_2 + \beta_2 \ln P_{st}^{C,input} + \beta_3 \ln \Lambda_{st}^{input} + \varepsilon_{2it}, \qquad (10)$$

where P_{st}^{input} denotes the exact input price index in industry s, $P_{st}^{C,input}$ is the conventional input price index, and Λ_{st}^{input} is the input variety index. These two equations separate the channels through which trade liberalization has affected domestic firms. The coefficient on β_1 captures the overall impact of changes in the prices and availability of intermediate inputs on firm scope, while β_2 and β_3 in the second regression capture the relative importance of price changes among existing imported intermediates, $P_{st}^{C,input}$, versus access to new imported inputs, Λ_{st}^{input}.

The results are reported in Panel A of Table 6. The key coefficient of interest is the one on the input variety index in column 2. Before focusing on this coefficient, we briefly comment on the results in column 1. Consistent with the theory, the coefficient on the exact input price index is negative; a lower input price index is associated with an expansion of domestic product scope. However, the coefficient is statistically insignificant. The results in column 2 are substantially stronger. We find strong support that input price declines due to for the role of increased variety of imported intermediate products in the expansion of domestic product scope. The coefficient on the input variety index reported is negative and statistically significant. The link between the imported input variety index and firm product scope is also economically significant: the coefficient on the imported input variety index in column 2 suggests that a 1 percent decline in the variety component of price index leads to more than a 2 percent increase in firm product scope, holding the conventional price index constant. During the period of our analysis input tariffs declined on average by 24 percentage points. This decline in input tariffs leads to a 3.6% decline in the variety component of the imported input price index (see Table 5, column 3) on average, which in turn translates into a 9.3% increase in the firm product scope. The estimates of the direct effect of input tariffs on firm product scope from section 4.2 are within the 95 percent confidence interval of this estimate. Overall, our analysis suggests that input tariffs influence firm product scope primarily through Indian firms gaining access to previously unavailable input varieties after the trade reform. Even though input tariffs also lowered prices of existing inputs, these lower prices don't appear to contribute much to domestic product growth. Given than new product additions accounted for about 25% of growth in Indian manufacturing output during our sample (GPKT (2008), it seems that the availability of new imported intermediates has played an important role in the growth of Indian manufacturing in the 1990's.

The remaining panels in Table 6 estimate similar specifications using other firm level outcomes such as output, TFP, and R&D activities as a dependent variable. We examine the responses of these outcomes to components of imported input price index because of their relevance for the mechanisms emphasized in endogenous growth models. This analysis confirms the importance of access to new imported input varieties for firm growth. Increased access to new imported varieties (i.e., lower input variety index) leads to higher firm sales (column 2, panel B) and increased spending on R&D activities (column 2, panel D).[22] These results seem consistent with the mechanisms emphasized in the endogenous growth literature.

5. Conclusions

After decades of import substitution policies, Indian firms responded to the 1991 trade liberalization by dramatically increasing imports. This growth in imports was dominated by a surge in intermediate product imports and, 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. This paper provides evidence that the expansion in domestic product scope can be explained, in part, by the increased access of Indian firms to new imported intermediate varieties.

By relying on an explicit trade liberalization episode and a unique firm-level database, we are able to offer insights for the microeconomic mechanisms underlying the relationship between lower input tariffs and domestic product expansion. Our analysis involves a sequence of steps. First, we use the methods developed by Feenstra (1994) and Broda and Weinstein (2006) to construct exact import price indices and decompose those into two parts: the conventional import price index and the variety adjustment index. This allows us to separate changes in the exact price indices due to changes in prices of existing import varieties from changes due to the introduction of new import varieties. We then pass these indices through the input-output matrix to construct sector-level *input* price indices and explicitly show that changes in both the components and the overall import price indices can be linked to reductions in input tariffs. Lower input tariffs mean lower prices for varieties imported prior to the liberalization. But lower input tariffs mean also a significant increase in new imported varieties, which implies a reduction in the exact, variety-adjusted import price index facing domestic firms. In the final step of our analysis we directly relate these input price index components to firm-level product growth and find that the expansion of product scope is driven by increases in imported

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[22] The positive (and insignificant) coefficient on variety index in TFP regression in panel C is counterintuitive. This result could in part reflect the difficulties associated with measuring TFP already noted in section 4.2.

input variety (e.g., a lower variety adjustment index); the latter is also associated with firm sales growth and higher R&D expenditures.

These results are broadly consistent with the findings of recent research on TFP that reports that TFP increases with input tariff liberalization. Given that TFP is typically constructed based on revenue data, it is difficult to identify the precise channels through which input tariff liberalization increases TFP, especially since many firms produce multiple products and revenues are not broken down by product. Against this background, we can interpret our findings as offering evidence on one particular mechanism—product scope—through which measured TFP is affected by lower tariffs.

Our findings are also consistent with endogenous growth models that highlight the importance of access to new imported varieties in the development of new products by domestic firms. While our analysis does not focus on aggregate growth, the fact that the creation of new domestic products accounted for nearly 31 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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Table 1: Decomposition of Import Growth, 1987-2000

Product Type	Import Growth	Extensive Margin			Intensive Margin		
		Net	Product Entry	Product Exit	Net	Growing	Shinking
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 import growth into the extensive and intensive margins. The extensive margin refers to new six-digit HS codes that were not imported in the previous period. The intensive margin refers to changes in imports within products that India imported in the previous period. Rows 2 and 3 decompose import growth in the intermediate (basic, capital and intermediates) and final (consumer durables and non-durables) sectors. The HS codes have been standardized to remove any issues due to changes in the Indian HS classification system. Source: Authors' calculations from official Indian import data.

Table 2a: Import Values and Tariffs

	All products	Intermediates	Final Goods
Lag Tariff	-0.136 ***	-0.117 ***	-0.151 **
	0.035	0.044	0.076
R-squared	0.82	0.82	0.80
Observations	35,833	20,140	11,819
Year FEs	yes	yes	yes
HS6 FEs	yes	yes	yes

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 sectors, respectively. Tariffs are at the HS6 level and regressions are run from 1987-1997. Standard errors clustered at the HS6 level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 2b: Import Unit Values and Tariffs

	All Products	Intermediate	Final Goods
Lag Tariff	0.279 ***	0.313 ***	0.246 ***
	0.05	0.077	0.079
R-squared	0.89	0.86	0.93
Observations	48,659	32,209	11,010
Year FEs	yes	yes	yes
HS8-Country FEs	yes	yes	yes

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

Table 2c: Import Extensive Margin and Tariffs

	All Products	Intermediate	Final Goods
	Panel A: Variety: HS6-country		
Lagged Tariff	-0.073 ***	-0.094 ***	-0.044 **
	0.009	0.011	0.020
R-squared	0.86	0.86	0.86
Observations	35,833	20,093	11,836
	Panel B: Variety: HS8		
Lagged Tariff	-0.011 **	-0.017 ***	-0.003
	0.005	0.006	0.009
R-squared	0.89	0.9	0.86
Observations	35,833	20,093	11,836
	Panel C: Variety HS8-country		
Lagged Tariff	-0.086 ***	-0.118 ***	-0.038 *
	0.011	0.013	0.023
R-squared	0.88	0.88	0.88
Observations	35,833	20,093	11,836
All regressions also include:			
Year FEs	yes	yes	yes
HS6 FEs	yes	yes	yes

Notes: The table reports coefficients on tariffs from product-level regressions of log (1+ number of varieties) on lagged 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 sectors, 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: * 10 percent, ** 5 percent, *** 1 percent.

Table 3: Firm Outcomes and Input Tariffs

	Panel A: Firm Scope (Number of Products)
Lagged Input Tariff	-0.323 **
	0.139
R-squared	0.9
Observations	14,882

	Panel B: Log Firm Sales
Lagged Input Tariff	-0.987 **
	0.414
R-squared	0.93
Observations	14,204

	Panel C: Log TFP
Lagged Input Tariff	-0.454 *
	0.233
R-squared	0.81
Observations	13,714

	Panel D: R&D Indicator
Lagged Input Tariff	-0.293
	0.268
R-squared	0.52
Observations	14,233

All regressions include:	
Year effects	yes
Firm FE	yes

Notes: The table summarizes firm-level regressions of various firm outcomes (listed in the heading of each panel) on lagged input tariffs, firm and year fixed effects. See text for the construction of the input tariffs. The regressions are run from 1989-1997. Standard errors clustered at the industry level. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 4: Average HS4 Import Price Indices and Aggregate Import Price Index (1989-1997)

Year	All Sectors			Intermediate Sectors			Final Goods Sectors		
	Exact Price Index	Conventional Price Index	Variety Adjustment Index	Exact Price Index	Conventional Price Index	Variety Adjustment Index	Exact Price Index	Conventional Price Index	Variety Adjustment Index
				Median Index (HS4)					
1989	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1997	1.000	1.103	0.986	1.168	1.352	0.954	1.000	1.000	1.000
				Mean Index (HS4)					
1989	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1997	1.589	1.792	0.899	2.021	2.273	0.881	1.245	1.413	0.904
				Overall Aggregate indices					
1989	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1997	1.439	2.091	0.688	1.014	1.626	0.624	1.124	1.322	0.850

Notes: The components of price indices are computed at the HS4 level using elasticities of substitution from Broda, Greenfield, and Weinstein (2006) for India. The price indices use HS6-country pairs as the definition of a variety. The top and middle panels report the median and mean of each component across HS4 groups. The bottom panel aggregates the HS4 components of the price index to the overall economy level using equation (13) in Broda and Weinstein (2006). The left columns report price indices over all imported sectors, the middle over the intermediate sectors and the right columns over the final goods sectors. If an HS4 is missing during the middle of the sample, we replace the missing values with ones. This index thus cannot compute gains from entirely new HS4 codes, but only gains within existing HS4 codes. The numbers are computed using data between 1989 and 1997.

	Log Exact Price Index	Log Conventional Price Index	Log Variety Index
Input Tariff	0.28 ***	0.132 ***	0.148 ***
	0.051	0.05	0.014
R-squared	0.18	0.05	0.47
Observations	136	136	136

Table 5: Input Price Index Components and Input Tariffs

Notes: This table reports regressions of components of the exact input price index on input tariffs. The dependent variable in the first column is the (log) exact input price index. The dependent variables in columns 2 and 3 are the (log) conventional price input index and the (log) variety input index. Since the log exact price index is equal to the sum of the two (log) subcomponents, the coefficients in columns 2 and 3 sum to the coefficient in column 1. Table reports the results of a long difference between 1989 and 1997. Significance: * 10 percent, ** 5 percent, *** 1 percent.

Table 6: Firm Outcomes and Input Indexes

	Panel A: Log Firm Scope (Number of Products)	
Log Exact Price Input Index	-0.491	
	0.343	
Log Conventional Input Price Index		-0.009
		0.485
Log Variety Input Index		-2.615 **
		1.186
R-squared	0.00	0.01
Observations	696	696
	Panel B: Log Firm Sales	
Log Exact Price Input Index	-0.374	
	0.669	
Log Conventional Input Price Index		-0.142
		0.833
Log Variety Input Index		-1.391
		2.251
R-squared	0.00	0.00
Observations	642	642
	Panel C: TFP	
Log Exact Price Input Index	0.104	
	0.424	
Log Conventional Input Price Index		-0.242
		0.42
Log Variety Input Index		1.681
		1.424
R-squared	0.00	0.01
Observations	589	589
	Panel D: R&D Indicator	
Log Exact Price Input Index	0.169	
	0.627	
Log Conventional Input Price Index		1.023
		0.675
Log Variety Input Index		-3.577 **
		1.674
R-squared	0.00	0.02
Observations	642	642

Notes: Table summarizes firm-level regressions of various firm outcomes (listed in the heading of each panel) on the exact input price index and the two subcomponents. Regressions are a long difference from 1989 to 1997. Standard errors clustered by NIC4. Significance: * 10 percent, ** 5 percent, *** 1 percent.