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Pinelopi Goldberg
*Princeton University*

Amit Khandelwal
*Columbia University*

Nina Pavcnik
*Dartmouth College*

Petia Topalova
*International Monetary Fund*

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Pinelopi Goldberg,

Corresponding Author

Princeton University, Department of Economics, 1021 Fisher Hall, Princeton, NJ 08544-1021.

Phone: (609) 258-4016. Fax: (609) 258-6419. Email: pennykg@princeton.edu

Amit Khandelwal,

Columbia Business School, 3022 Broadway, Uris Hall 606, New York, NY 10027.

Phone: 212-854-7506. Fax: 212- 316-9219. Email: ak2796@columbia.edu

Nina Pavcnik,

Dartmouth College, Department of Economics, 6106 Rockefeller Hall, Hanover, NH 03755.

Phone: (603) 646-2537. Fax: 603 646-2122. Email:nina.pavcnik@dartmouth.edu

Petia Topalova,

International Monetary Fund, Asian and Pacific Department, 700 19th Street NW, Washington, DC 20431.

Phone: (202) 623-5329. Fax: (202) 623-9667. Email: PTopalova@imf.org

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# Trade Liberalization and New Imported Inputs

Pinelopi Goldberg, Amit Khandelwal, Nina Pavcnik, and Petia Topalova*

Understanding the role of international trade in explaining vast differences in productivity across countries remains a key question in international economics. Recent literature emphasizes the micro-foundations underlying this relationship. One strand of literature highlights how new export opportunities and toughness of competition generate aggregate productivity gains by reallocating resources from less to more productive firms (Marc J. Melitz (2003), Marc J. Melitz and Gianmarco Ottaviano (2008)). Trade also increases aggregate productivity through improvements in firm productivity (Nina Pavcnik (2002)), which have recently been linked to the reallocation of resources across products within firms (Andrew B. Bernard, Stephan J. Redding and Peter K. Schott (2006)) and use of imported inputs (Mary Amiti and Jozef Konings (2007)). The latter relate to the idea that trade provides domestic firms access to cheaper and previously unavailable inputs.

The idea that international trade benefits countries by providing access to new products or new varieties of existing products is reflected in many trade and growth models (e.g., Luis Rivera-Batiz and Paul M. Romer (1991), Gene Grossman and Elhanan Helpman (1990)). In

*Goldberg: Princeton University, Department of Economics, Fisher Hall, Princeton, NJ 08544-1021 BREAD, and NBER, (email: pennykg@princeton.edu) and NBER; Khandelwal: Columbia Business School, 3022 Broadway, Uris Hall 606, New York, NY 10027 (email: ak2796@columbia.edu); Pavcnik: Dartmouth College, Department of Economics, 6106 Rockefeller Hall, Hanover, NH 03755, BREAD, CEPR, and NBER, (email:nina.pavcnik@dartmouth.edu); Topalova: International Monetary Fund, Asian and Pacific Department, 700 19th Street NW, Washington, DC 20431 (Email: PTopalova@imf.org). We thank Beata Smarzynska Javorcik for comments.

these models, a country's access to foreign inputs raises productivity levels thereby generating static gains from trade. New foreign inputs also lower the cost of innovation, enabling the creation of new varieties, and this generates dynamic gains from trade. With a few exceptions (Robert C. Feenstra, Dorsati Madani, Tzu-Han Yang, and Chi-Yuan Liang (1999) and Christian Broda, Joshua Greenfield and David E. Weinstein (2006)), however, the empirical evidence on dynamic gains from trade has remained elusive.

Our research on India (Pinelopi K. Goldberg, Amit K. Khandelwal, Nina Pavcnik, and Petia Topalova, henceforth GKPK, (2008a, 2008b)) indicates that access to new input varieties from abroad enables the creation of new varieties in the domestic market. The raw data provide initial support for this hypothesis based upon two facts following India's trade liberalization during the 1990's. First, the trade liberalization dramatically increased Indian firms' access to new imported inputs; two-thirds of the surge in imported inputs occurred in products not imported prior to the reforms. Inside India's borders, firms were expanding their product scope during this same period; during the 1990s, a quarter of India's manufacturing output growth was driven by new products (GKPT (2008a)). In order to connect these two facts, which are consistent with the models mentioned above, we rely on methods developed by Robert C. Feenstra (1994) and Christian Broda and David E. Weinstein (2006) to quantify the gains from new imported input varieties for Indian firms. We find that these new imported varieties generated an additional annual 4.7 percent decline in the imported input price index, and that firms' access to new imported inputs increased firms' ability to manufacture new products.

In this article, we dissect changes in the composition of Indian imports following its 1991 trade liberalization to illustrate the potential scope for previously unavailable inputs to bolster the performance of domestic firms. The analysis reveals that trade reform spurred imports of

previously unavailable products and varieties in many products that arguably can be characterized as important inputs for manufacturing firms. New imported inputs in large extent originated from more advanced countries and new imported varieties exhibited higher unit values relative to existing imports. These findings are consistent across narrow classifications of inputs and therefore indicative that India's trade liberalization relaxed the technological constraints faced by Indian firms under import substitution policies. This more descriptive analysis provides further confirmation of the importance of the extensive product margin in input trade noted in GKPT (2008b).

## I. Decomposing imports

Our analysis relies on official Indian import data from Tips Software Services. The data record the quantity and values of India's imports at the eight-digit Harmonized Tariff System (HS) level by trade partner from 1987 to 2000. However, we analyze trade flows primarily at the HS6 level, which contains about 5,000 product codes, since HS6 codes are standardized across countries. Thus, the focus on trade flows at the HS6 level ensures that the level of detail of product codes does not reflect factors specific to India's trade patterns. We rely on the original 1987 HS code classification in order to distinguish "true" product turnover from "false" product changes reflecting the revisions of HS6 classification. Conducting the analysis at the HS6 level provides a more conservative estimate of variety growth and therefore biases our estimate of the extensive margin downwards.

The literature on new goods and varieties in international economics often focuses on varieties, where a variety is defined as a product (for example, an HS6-category) imported from a particular country. Since most developed countries import a majority of HS6 products, variations in the extensive margins of trade is driven by the variety margin (Broda et. al (2006)).

The distinction between products and varieties might be potentially more important in a developing country setting, where a country's level of economic development or trade policy might not only constrain the varieties they import within a particularly product, but entire sets of products as well. In what follows, we thus distinguish between products, defined as a HS6 category, and varieties, defined as HS6-country combination. For example, HS6 854220 (Hybrid integrated circuits) is a product that is distinct from HS6 854280 (Electronic integrated circuits/microassemblies, nes), while a hybrid integrated circuit imported from Japan is treated as a distinct variety from a German hybrid integrated circuit.

The raw trade data reveal a large expansion in both products and varieties following India's trade reform. While India imported 3,249 products and 23,571 varieties in 1987, these numbers grew to 4,443 and 55,819, respectively, by 2000. Not only did India import about 35% more products, but products were, on average, sourced by 12.6 countries compared to 7.3 countries prior to the reform.

The observed increases in the number of imported products and variety translate into substantive gains from trade only if the extensive margin of trade accounts for a sizable share of imports. In Table 1, we analyze the role of the extensive margin by decomposing the growth in India's imports between 1987 and 2000 (column 1) into the contribution due to the (net) extensive product margin (new HS6 codes, column 2), the extensive variety margin (new HS6-country pairs, column 5), and the intensive variety margin (existing HS6-country pairs, column 8). The rows of Table 1 report this decomposition for different subsets of products.

The first row decomposes India's import growth over all products. Overall, imports increase 130 percentage points between 1987 and 2000. Of this growth, 65 percent (84/130) can be attributed to new HS6 products entering the economy. The remaining growth occurred within

existing HS products and about half of this growth is due to growth in imports of new varieties (22/(22+23)). Thus, new products and new varieties within existing products account for 82 percent ((84+22)/130) of India's import growth during the reform period.

Table 1: Extensive and Intensive Margin of India's Imports, 1987-2000

| | Import Growth | Product Extensive Margin | | | Variety Extensive Margin | | | Intensive Margin |
|---|---|---|---|---|---|---|---|---|
| | | Total | OECD | Non-OECD | Total | OECD | Non-OECD | Total |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| All Products | 130 | 84 | 59 | 25 | 22 | 9 | 13 | 23 |
| Final Products (Consumer Durable and Non-Durables) | 90 | 33 | 21 | 11 | 25 | 9 | 16 | 32 |
| Inputs (Capital, Basic, Intermediates) | 227 | 153 | 115 | 38 | 42 | 15 | 26 | 32 |
| Basic Products | 260 | 154 | 124 | 30 | 62 | 31 | 31 | 45 |
| Capital Products | 125 | 37 | 27 | 10 | 33 | 23 | 10 | 55 |
| Intermediate Products | 297 | 278 | 200 | 78 | 28 | -12 | 39 | -9 |
| HS Code 27 (Mineral Fuels and Oil) | 89 | 59 | 0 | 59 | 11 | 1 | 11 | 19 |
| HS Code 28 (Inorganic Chemicals) | 227 | 7 | 4 | 2 | 92 | 4 | 88 | 128 |
| HS Code 29 (Organic Chemicals) | 158 | 4 | 2 | 2 | 58 | 12 | 46 | 95 |
| HS Code 71 (Precious Stones and Metals) | 668 | 666 | 576 | 89 | 28 | 20 | 8 | -25 |
| HS Code 72 (Iron and Steel) | 27 | 34 | 16 | 18 | 24 | 4 | 20 | -31 |
| HS Code 84 (Nuclear Reactors, Boilers, and Machinery) | 100 | 33 | 23 | 10 | 27 | 21 | 6 | 39 |
| HS Code 85 (Electrical Machinery And Equipment) | 173 | 72 | 63 | 9 | 35 | 19 | 16 | 66 |

Notes: The table decomposes import growth into the extensive and intensive margins between 1987 and 2000. The first column reports overall import growth. Column 2 reports the contribution to import growth due to the extensive (new HS6) margin. Columns 3 and 4 disaggregate column 2 according to the source country. Column 5 reports the contribution to growth due to existing HS6 codes. This product extensive margin is decomposed into the variety extensive margin (column 5) and the variety intensive margin (column 8). Columns 2, 5 and 8 to column 1. The variety extensive margin is decomposed in the variety extensive margins in columns 6 and 7. All variables are deflated by wholesale price indices. Please see text for the list of OECD countries.

Further analysis suggests that the growth in the extensive margin of trade is particularly pronounced for products that serve as inputs into production process of Indian firms. Rows 2 and 3 of Table 1 decompose imports across two mutually exclusive groups: final products and imported inputs.[1] Two features are striking. First, growth in imported inputs is substantially higher than for final goods, 227 percentage points versus 90 percentage points.[2] Second, the margins through which each product classification grows differ. While the product intensive margin dominates growth in final goods, 67 percent (153/227) of the growth in intermediate products is driven by new HS6 products. An additional 20 percent of the growth in intermediate

[1]Each HS6 code is assigned to an end use category following the classification from Hasheem Nouroz (2001), which relies on India's input-output matrix and distinguishes between consumer durables, consumer non-durables, intermediates, capital, and basic products. We group these categories into imported final products (consumer durables and non-durables) and imported inputs (comprised of intermediate products, capital products, and basic products.

[2]This could in part reflect that import licenses were removed later on consumer products than imported inputs.

imports occurs through new varieties. Thus, new products and new varieties within existing products account for 86 percent ((153+42)/227) of India's imports of inputs during the reform period. The corresponding number for final goods is 65 percent. These figures imply that India's trade liberalization enabled Indian firms to import more, and new types of, production inputs.

The next three rows of Table 1 reinforce this point by further classifying imported inputs into basic, capital and intermediate products. The contribution of the product extensive margin for basic, capital and intermediate import growth is 59, 30 and 93 percent, respectively. Adding the variety-extensive margin indicates that new products and varieties accounted for 83, 59 and 103 percent of each product's import growth. Thus, the growth of all subcategories of imported inputs is driven predominantly by products and varieties unavailable prior to the trade reform.

While columns 2, 5, and 8 of Table 1 delineate the importance of the extensive margin, these columns are silent on the country-origin of these new products and varieties. Recent research in international trade provides compelling evidence that export quality differs across countries, with the finding that richer and more capital-abundant countries export higher quality varieties (see Peter K. Schott (2004), Amit K. Khandelwal (2008)). We address the origin of imports by decomposing new products and varieties according to OECD plus Taiwan, Hong Kong and Singapore and the rest of the world.[3] The product extensive margin in column 2 is decomposed into these two mutually exclusive country groupings in columns 3 and 4. Overall, 70 percent (59/84) of the growth in product extensive margin occurred in products exported by OECD countries. New products imported from advanced countries account for 75 percent of the growth in product extensive margin. Looking at the finer classifications of inputs in rows 4-6,

[3] These countries are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Hong Kong, Iceland, Ireland, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Portugal, Poland, Slovak Republic, Singapore, Spain, Sweden, Switzerland, Taiwan, Turkey, UK and USA.

OECD countries were responsible for over 70 of the product extensive margin in the basic, capital and intermediate products.

Columns 6 and 7 provide an analogous decomposition of the variety extensive margin. Overall, OECD countries account for 41 percent of new varieties within existing HS6 products during the reform period. This is a remarkable number given that OECD countries were already likely exporting these products to other countries in 1987; this is suggestive that India's trade liberalization enabled firms to cover the fixed costs of exporting to India. For basic and capital products, new OECD varieties accounted for more than half of the variety extensive margin. Only in the case of intermediates do we observe some evidence that new varieties are taking away the market share of existing varieties.

Table 1 therefore offers compelling evidence that not only did India experience a surge in new types of inputs to be used in the manufacturing process from abroad following the trade liberalization, but that these new inputs were sourced from more advanced countries. We also find that within HS6 products, new OECD varieties were 2.7 percent more expensive than existing OECD varieties, and new non-OECD varieties were 5.5 percent more expensive than existing non-OECD varieties.[4] While acknowledging the caveat of interpreting unit values as quality (Khandelwal (2008)), these price differences reflect differentiation in products and are consistent with new imported varieties plausibly possessing higher quality than existing varieties.

The results discussed so far are obtained from fairly coarse product classifications. The bottom panel of Table 1 focuses on specific HS two-digit sectors to obtain a better understanding of specific imported inputs that India began importing following the trade liberalization. We focus on two-digit HS codes related to the imports of fuels (HS 27), chemicals (HS 28 and 29), precious stones and metals (HS 71), iron and steel (HS 72), and machinery (HS 84 and 85).

[4] Results are available upon request.

These sectors account for two-thirds of India's imports in 2000 and include many products classified as imported inputs. The analysis of these more detailed categories paints the picture consistent with the findings from more aggregate groups of imported inputs. Although the importance of the (net) extensive product and variety margin differs across sectors, new products and varieties account anywhere from 40 (organic chemicals) to 214 (iron and steel) percent of the import growth in the sector.[5]

**II. Case in Point: Machinery**

The results up to now do not condition on the substitutability of the imports. As discussed extensively in Feenstra (1994) and Broda and Weinstein (2006), the importance of new varieties is diminished if the varieties have a high elasticity of substitution. We use the methodology developed by Feenstra (1994) and Broda and Weinstein (2006) to compute a variety index that accounts for the both the share of expenditure tilted towards new varieties and the elasticity of substitution.[6] This variety index is defined as

$$\Lambda = \left( \frac{\sum_{\Omega'} v_i' \Big/ \sum_{\Omega' \cap \Omega} v_i'}{\sum_{\Omega} v_i \Big/ \sum_{\Omega' \cap \Omega} v_i} \right)^{\frac{1}{1-\sigma}},$$

where $v_i$ denotes imports from a country-product pair in 1989, $\Omega$ is the set of country-product pairs imported in 1989, and the corresponding values with primes refer to 1997 data. In assessing the gains from variety, this index accounts for both the increase in expenditure on new varieties in 1997 and for the elasticity of substitution across varieties. So, an increase in imports will not deliver substantial gains to the price index if the imported varieties are highly

[5] The large extensive margin growth in HS71 (Precious stones and metals) mostly reflects the growth of two HS categories: unworked diamonds (HS 710231) and gold in unwrought form, non-monetary (HS 710812). The exclusion of these two categories lowers the magnitude of overall import and extensive margin growth in HS71, but the extensive product and variety margin continue to account for a large share of import growth.

[6] We compute the index for each HS4 category. We obtain estimates for the elasticity of substitution from Broda et. al (2006) who estimate India's elasticities of substitution at the three-digit HS level.

substitutable. Note that a lower variety index indicates larger gains from new imported varieties. In GKPT (2008b), we show that variety growth deflates India's (overall) conventional import price index by 31 percent between 1989 and 1997. Moreover, variety growth deflated the overall conventional imported *input* index by 38 percent, or 4.7 percent annually.

In Table 2, we continue our dissection of the sources of variety growth by investigating one particular sector, HS 84 (Nuclear Reactors, Boilers, and Machinery). We choose this sector because it plausibly contains important capital inputs for several manufacturing industries. The top panel reports the largest five HS4 codes, which accounted for 30 percent of the imports into sector HS 84 in 2000. The largest category, automatic data process machines (HS 8471), also had the lowest variety index across four-digit HS codes within HS84. The middle panel reports additional HS4 codes that experienced large gains in varieties, as indicated by a relatively low variety index. For instance, the index for machine tools for forging metal (HS 8462) was .702 over this period. This implies that new varieties deflated the conventional import price index, which only considers changes in prices of existing varieties, by an additional 30 percent. This is indicative of the substantial benefit for firms using forging machinery in their production process. Furthermore, Table 2 shows that while there was heterogeneity in the importance of new varieties across machinery types, the average variety index over these machinery codes was .861. Thus, this detailed picture of the types of new inputs that Indian firms began to use provides evidence for dismantling trade barriers potentially can deliver both static and dynamic gains from trade.

Table 2: Variety Index within Nuclear Reactors, Boilers and Machinery (HS 84)

| HS4 Code | Variety Index |
|---|---|
| 8471 Automatic Data Process Machines | 0.196 |
| 8479 Machines Having Individual Functions | 0.940 |
| 8473 Parts for Office Machines | 0.319 |
| 8443 Printing Machinery | 0.822 |
| 8445 Machines For Preparing Textile Fibers | 0.940 |
| 8406 Steam Turbines | 0.899 |
| 8416 Furnace Burners, Mechanical Stokers, etc. | 0.978 |
| 8428 Lifting, Handling, Loading & Unloading Machinery | 0.744 |
| 8429 Self-Propelled Bulldozers, Graders, Shovels, etc. | 0.774 |
| 8438 Machinery for Industrial Preparation of Food & Drink | 0.747 |
| 8439 Machinery for Making Pulp | 0.834 |
| 8453 Machinery for Working Leather | 0.903 |
| 8462 Machine Tools For Forging, Bending, etc | 0.702 |
| 8475 Machines For Assembling Electric Tubes, etc. | 0.816 |
| 8454 Converters, Ladles and Casting Machines | 0.873 |
| Minimum (8471 Automatic Data Process Machines) | 0.196 |
| Maximum (8476 Vending Machines) | 1.135 |
| Median Variety Index | 0.911 |
| Mean Variety Index | 0.861 |

Note: Table reports variety index developed by Feenstra (1994) for selected HS4 codes within sector HS 84 between 1989 and 1997. The top panel reports the five largest HS4 codes in 1997. Summary statistics computed over the 85 possible HS4 codes within HS 84 are reported in the bottom panel. Estimates for the elasticity of substitution from Broda, Greenfield and Weinstein (2006) who estimate India's elasticities of substitution at the HS-3 level.

## III. Concluding remarks

This article provides evidence that the trade reform might have benefited Indian firms by providing access to not only more and cheaper inputs, but crucially, through importing of new input goods and varieties as trade barriers fell. In future work we plan to more directly link increased access to a broader range of imported inputs to dynamic gains from trade. While our work focuses on a particular developing country, India, Estevadeordal and Taylor (2008) offers cross-country evidence that declines in tariffs on capital and intermediate goods that raise GDP growth in countries that implement trade reforms. This suggests that the microeconomic

mechanisms uncovered from detailed analyses of firms in specific developing countries may be generalizable.

More generally, the availability of detailed firm and trade flow data enable researchers to explore the exact mechanisms through which international trade affect the performance of domestic firms, and ultimately productivity growth. Examining the micro foundation of the link between international trade and growth will thus likely continue to be a promising area of research.

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