Firm Heterogeneity and Export Pricing in India

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Abstract. We examine the export pricing behavior of Indian manufacturing firms in the early 2000s using a unique data set that matches detailed firm characteristics with product and destination-level trade data. We find, in contrast to previous evidence for other countries, that firm productivity is negatively associated with export prices, that export prices are negatively associated with distance, and positively associated with remoteness. We argue that it is the higher cost of innovation in India, driving down the scope for quality differentiation, which leads to the negative association between productivity and prices. We use the framework of Antoniades (2015) to place our results (heterogeneous goods, homogeneous markets) relative to two other groups identified in the literature: (homogeneous goods, homogeneous markets) and (heterogeneous goods, heterogeneous markets). To our knowledge we are the first to find empirically this particular classification.

Acknowledgments. We thank participants at the Spring 2015 Midwest International Economics Group, the 2014 Southern Economics Association meetings, and especially Tom Prusa, for helpful comments. We also thank Matthew Reardon (American University), Sommer Ireland, Richard Marmorstein, George Nurisso, Daniel Molon and Daniel Rodriguez-Segura (all from Washington and Lee University) and Nathanael Snow (Office of Economics, USITC), for indefatigable research assistance.

I. Introduction

Our paper contributes to the literature on firm heterogeneity and export pricing by analyzing the behavior of Indian firms in the manufacturing sector. We exploit a new data set on Indian firms' exports—prices charged and quantities shipped—to determine the sources of exporting success. This allows us to ask the question: in comparison to exporters in other countries examined thus far, do Indian firms behave differently?

We make two primary contributions. We are the first to examine the pricing behavior of Indian exporters. Second, we find a negative association between firm productivity and the prices firms charge in destination markets. This result, combined with a finding that distance to destination market is negatively associated with product price, and positively associated with remoteness, stands in contrast to findings for exporters in other countries.

We contribute to a small, but burgeoning, literature which examines the pricing behavior of exporters in China (Manova and Zang, 2012), the United States (Harrigan, Ma, and Shlychkov 2015, hereafter Harrigan et al., 2015), and Europe (Portugal: Bastos and Silva, 2009; Hungary: Gorg, Halpern, and Murakozy, 2010; and France: Martin 2012). These papers all find similar results, namely that more productive firms charge higher prices in export markets, and that prices increase with distance. Further, Manova and Zang (2012) and Harrigan et al. (2015) also find that prices fall with remoteness. These results suggest that more productive firms are quality upgrading.

Our results stand in contrast to this body of literature. We find that for Indian exporters, more productive firms charge lower prices, and that prices fall with distance and rise with remoteness. We show that these results are robust across industries and that, while different from those for other exporting countries studied, they can be consistent with recent heterogeneous firm models that incorporate endogenous quality upgrading. In particular, the model by Antoniades (2015) provides a framework that shows that the relationship between prices and productivity could be positive or negative. This depends on whether the scope for quality differentiation, which itself depends on markets size, the degree of differentiation between varieties of goods, and the cost of innovation, is high or low.

As India is a developing country, Indian firms face a higher cost of innovation than for firms in developed countries noted above. This is also true for India relative to China, which has superior infrastructure and funding opportunities for innovators. We argue that the cost of innovation is the key factor driving down the scope for quality differentiation and leading to the observed negative correlation between price and productivity.

The paper proceeds as follows. Section II reviews the literature and Section III discusses data, where there are some particularly difficult issues posed in matching firm-level data with trade and destination information. Section IV presents our results in two parts: descriptive statistics on successful exporters' pricing patterns and regression results that relate price decisions to firm and destination market characteristics. Section V includes a discussion of our results and Section VI concludes.

II. Literature Review

The theoretical literature is instructive in highlighting the contrast in the behavior of Indian firms relative to the firms in other countries examined thus far. Melitz (2003) introduces firm level marginal cost heterogeneity into a model with beachhead costs and monopolistic competition. Firms compete only on price and, since mark-ups are constant, more productive firms charge lower prices. In addition, prices are decreasing in the distance from the export market and increasing in remoteness.

These predictions run counter to the empirical studies mentioned above, which find a positive correlation between productivity and price. The common explanation is that firms in these countries compete both on both quality and price. Baldwin and Harrigan (2011) modify the Melitz (2003) model to include a quality dimension. In their model firms with higher unit costs produce higher quality goods and, because quality is increasing in cost at a sufficient rate, while they charge higher prices their goods are more competitive because the price per unit of quality is less than for lower cost firms. This quality-adjusted heterogeneous-firms model predicts that export prices are increasing in distance, and decreasing in market size and remoteness. These predictions fit the empirical evidence collected thus far which suggests that more productive firms are quality upgrading (more precision needed in this statement)

The sample of firms we examine is drawn from a range of differentiated goods manufacturing sectors within which there are variations in quality and variety. In contrast to the papers noted above, we find the behavior of Indian firms, in terms of their pricing relative to productivity, matches perfectly the predictions of the Melitz (2003) model. However, this does not mean that Indian firms are not engaging in quality-upgrading.

Antoniades (2012) provides a framework which helps illuminate the position of our result within the literature. His paper extends Melitz-Ottaviano (2008), which includes a linear demand system in a model of monopolistic competition, to incorporate endogenous quality choice by firms. Lower cost firms choose higher quality and have higher mark-ups, which is a feature both of producing a variety of higher quality which increases demand, and facing a lower elasticity of demand. Since marginal costs and mark-ups move in opposite directions, it is possible that the relationship between price and productivity may be positive or negative.

Whether this relationship is positive or negative depends on the scope for quality differentiation which in turn depends on the factors which influence a firm's ability to recover the innovation costs of quality upgrading: on market size (*L*), the degree of differentiation between varieties (*1/γ*), and the cost of innovation (*θ*). The sign of this relationship depends on

$$\frac{dp(c)}{dc} = \frac{1}{2}(1 - (\beta + \delta)\lambda)$$

where *1/c* is productivity, β is a taste parameter which measures the appreciation of quality, δ measures the cost of upgrading quality, and λ is the scope for quality differentiation.[1] When $\lambda < 1/(\beta + \delta)$ then the scope for quality differentiation is low and $dp(c)/dc > 0$, and prices and productivity are negatively correlated.

When the scope for quality differentiation is high, or when quality ladders are long, then $\lambda > 1/(\beta + \delta)$ and the relationship between productivity and price is positive and prices are a good proxy for quality (Khandelwal, 2010). This is known as the heterogeneous markets case. There are two possibilities when the scope for quality differentiations is low ($\lambda < 1/(\beta + \delta)$) and quality ladders are short, which is the alternative homogenous markets case. First, when goods are homogenous, firms find no purpose in quality upgrading and the relationship between prices and productivity is negative, as in Melitz-Ottaviano (2008). The alternative is when goods are heterogeneous and the scope for quality differentiation is low. Here firms will engage in quality upgrading, however while higher productivity firms are choosing higher quality and

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[1] In Antoniades (2015) the scope for quality differentiation (*λ*) is dependent on market size (*L*), product substitutability (*1/γ*), the cost of innovation (θ), and *β* and *δ*, where $\lambda=L(\beta-\delta)/(4\theta\gamma-L(\beta-\delta)^2)$. The scope for quality differentiation is increasing in market size, and decreasing in product substitutability and the cost of innovation. For the case of homogeneous goods then *γ* approaches ∞, and the scope for product differentiation becomes zero.

mark-ups are larger, they do not rise at a rate sufficient to offset their lower costs. Thus, more productive firms are charging lower prices.

We now briefly summarize the empirical literature. Using 2005 Chinese firm and product data at the HS 8-digit level, MANOVA AND ZANG find that successful exporters earn more revenue in part by charging higher unit prices and by exporting to more destinations than less successful exporters. Even within narrowly-defined product categories, firms charge higher unit prices to more distant, higher income, and less remote markets. Manova and Zang (2012) argue that firms' product quality is as important as production efficiency in determining these outcomes.[2] Harrigan et al. (2015), using 2002 U.S. data at the HS 10-digit level, make a similar finding: U.S. firms charge higher prices for products shipped to larger, higher income markets, and to countries more distant than Canada and Mexico, a result they attribute to higher quality. Harrigan et al. (2015) also find that firms' ability to raise unit prices is positively affected by their productivity and the skill-intensity of production. On their face, the results relating to distance and number of markets appear consistent with the hypothesis first advanced by Alchian and Allen (1964), and developed by Hummels and Skiba (2004), that "per unit" transport costs raises relative demand for high quality goods (the "shipping the good apples out" hypothesis).

Bastos and Silva (2009) examine Portuguese firm-level data on exports by product and destination market. They find strong support that within-product unit values increase with distance; doubling distance increases unit values by 9 percent (their distance elasticity is 0.05). Firm productivity is positively associated with firm prices; in addition they find that firm

[2] MHZ p. 2. Manova and Zang (2012) present evidence that not only do successful exporters produce higher quality goods (with higher quality inputs), but that firms adjust product quality according to characteristics of the destination market. In particular, they find that the higher unit values associated with higher distance to destination markets and with serving more destinations are due to compositional shifts within narrow product categories towards higher product quality and higher quality inputs.

productivity “magnifies the positive effect of distance on within-product unit values,” which suggests that high-quality products from high-productivity firms are more successful in difficult markets. Likewise, Gorg, Halpern, and Murakozy (2010), with Hungarian firm-level data on exports by product and destination market find a substantial positive distance effect on unit values. They report distance elasticities consistently in the 0.08-0.10 range; Hungarian export unit values are 25-30 percent higher in the United States than in the EU. This effect holds most strongly for differentiated goods. They also report that unit values rise with firm productivity and with destination market income per capita, which they call “quality-to-market” effects.

Martin (2012) examines French exporting firms in 2003. Here again prices are positively associated with distance. The author finds that doubling distance increases prices by 3.5 percent (the elasticity of f.o.b. prices to distance is 0.05), an effect that is weakened for the Euro area subsample. The latter point the author attributes to incomplete exchange rate pass-through and the absence of country-specific tariffs for goods.

II. Data

Our detailed firm-level price, good, destination and firm characteristics dataset is assembled from several sources. Detailed firm-level data comes from Prowess, a private proprietary database of Indian firm characteristics.[3] The dataset contains information on approximately 23,000 large- and medium-sized firms in India, and includes all companies traded on India’s major stock exchanges as well as other firms, including the central public sector enterprises. Its broad swath of Indian firms pay around 75 percent of all corporate taxes and over 95 percent of excise duties collected. From Prowess we derive information on employment, labor skill, capital use, profitability, expenses, and other firm-level variables for manufacturing

[3] Previous firm-level research for India using the Prowess database include

firms (our sector of interest, about *x* percent of firms included in Prowess). While Prowess contains information on overall foreign sales, it lacks information as to the products exported, their destination markets, and their unit price.

We complement the data in Prowess with trade data from TIPS, a database of daily firm-level export transactions collected by Indian Customs. TIPS contains very detailed export data including the identity of the exporter, the date of transaction, the product type by 8-digit HS code, destination country, exit and destination port, and the quantity and the value of the export. We have useable data for four full fiscal years, 2000-2003 (Indian fiscal years run from April 1 through March 31; the actual data run from April 1999 through March 2003), which cover the transactions at eleven major Indian seaports and airports. These daily data are very rich, but for the purpose of our analysis we aggregate the data to fiscal-year average prices, by firm, product and destination and focus on those records that can be linked to the enterprise information in Prowess.[4] We explain our method to merge the two databases and the resulting matching rate below. Finally, we use country characteristic data (income, population, and distance from India) from the public online database maintained by CEPII, the Paris-based Institute for Research on the International Economy.

Our main analysis relies on a merged dataset built by a firm-by-firm match of TIPS and Prowess data. TIPS data required considerable preparation for this merge, over and above simply aggregating its daily data to a fiscal year basis.

Consider firm names, which are recorded by hand at the point of collection (ports) with occasional spelling errors and frequent variants. We use two fuzzy-logic routines, Levinstein distance and bigram comparisons, to match firm names in the sample. Some matches were done

[4] All told, TIPS records more than 5.8 million export transactions over 1999-2003.

"by hand" based upon values in the fuzzy-logic comparisons. Wholesalers are excluded for the sake of focusing on the trading behavior of production firms, which require several data-filtering criteria. If the firm name contains "Exporter," "Importer," or other key words it is removed from the sample.[5] More arbitrarily, perhaps, we exclude firms that export goods in more than nine two-digit HS chapters.

We measure export prices as unit values: export revenue by product category divided by the number of units exported in that category. This requires choices about how to define a "product." Although the TIPS data are reported at the 8-digit HS level, we use the firm's own product labels to obtain the actual product lines used in this study. For example, instead of looking at the unit value of 8-digit HS code 09101020 that includes a variety of spices, we are able to use the product labels to obtain the unit value, or price, of "curry powder" and "ginger" and other similar fine-grained prices. The result is something much more detailed than 8-digit data.[6] When this process is complete the mean number of individual product lines in an HS category is 11, with a median of 3. We refer to this level of disaggregated data as HS8+.

Finally, inside of an HS8 or HS8+ code the quantity units can vary widely. This matters. The dependent variable in our empirical work is the export product price, defined as an export unit value and calculated as the relevant total value of exports divided by quantity. So, for instance, a firm's average price for selling a particular product to the United States in any given

[5] The entire list of key words is: Exporter, Importer, Trading, Trader, Export, Import, IMPEX, and EXIM.
[6] In brief, here is how we obtained that information: Within each of the 16,109 8-digit categories, the median number of (reported) individual product lines is 8, and the mean is 166. In some cases the product-level labels are variants of names for the same product, differing only in punctuation, capitalization, or word order. Sometimes these differences are present along with changes in the product description; thus we may see "Curry Powder" and "SPICE CURRYPOWDER" describing what appears to be the same product. By contrast, in other cases the product names reflect substantively different products within a particular HS line. We used a computerized matching algorithm to match product names, to say (in the example above) that "Curry Powder" and " SPICE CURRYPOWDER" are the same product, but "Curry Powder" and "Ginger" are different products, even though all of these are inside the same HS-8 code.[6] We then aggregate together the quantity and value information for those product labels that our algorithm deems as the same product (from the same firm).

year would be the value of sales divided by, say, the metric tons sold. But in many of the single firm-product-destination categories, export values are reported in several different units, such as "buckles," kilos, pounds and "boxes," the sum of which yields the total value of exports for that firm-product-destination observation.

We choose to aggregate and "harmonize" these values where there are well-established conversion factors for the units. Therefore we convert pounds to kilos, and tons to metric tons, and so on, prior to calculating unit values. However, there remain thousands of lines of data where the conversion factors are unknown, or for which the reporting of separate lines based on different quantity measures strongly suggests that there are in fact underlying differences between the goods reported in those lines (even when they are in the same 8-digit HS category). It is not possible to make meaningful unit value comparisons, or aggregations, across different units in these instances. (Is a good sold to France at $2 per buckle earning a higher price than that same 8-digit HS good sold to France at $350 per ton?) Accordingly, for the analysis reported here we keep only the main unit in each HS line, by value, and drop the others. [7]

Merging the TIPS and Prowess databases presents further technical problems in matching firm names. But after this merge and a final merge with CEPII destination market characteristics we have a data set with 20,850 individual firm-product-destination-year-firm characteristic observations over 2000-2003. The merged dataset contains 1,018 unique manufacturing firms. [At this point I would provide an idea of the matching rate relative to Prowess; that is to show how good that 1,018 match is relative to the number of manufacturing firms in Prowess operational during FY 2000-2003 that export]

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[7] The data-cleaning issues relating to product descriptions and incompatible quantity units pose serious challenges to work in this area. Harrigan et al. (2015) by using 10-digit U.S. data, may have sidestepped this problem; Manova and Zang (2012) with 8-digit Chinese data, are silent on data-handling issues.

The rich detail of the TIPS side of our merged data is striking. The price of Tata Tea's loose leaf Darjeeling sold in the UK can be distinguished from its price in Italy. Likewise it is possible to calculate a firm's mean price for a product across all destinations, and the mean price across all firms for a product shipped to a single destination. These details are essential for understanding how exporters behave and, in particular, for understanding the role that firm and destination market characteristics play in firms' pricing and quality decisions.

Tables1 and 2 offer an initial view of the export behavior of the firms in our working sample. The picture that emerges is a familiar one, though with some differences from the United States. The most successful firms in export value terms dominate the export sector in many dimensions. The top 10 percent of the firms account for approximately 80 percent of exports by value (Table 1). This is less concentrated than the behavior of U.S. exporters in 2000, for which the top 10 percent account for 95 percent of the value of all exports.

A small group of successful exporters sell far more products per firm, and to far more destinations per firm, than do other exporters (Table 2): 13.5 percent of our sample sold 10 or more goods to 10 or more destinations in 2003. The modal Indian firm in our sample exports 2-5 products to 2-5 markets (21.2 percent of all firms). If one considers the proportion of firms that export to one market only, the figure in our sample is 26 percent versus 65 percent for the United States in 2000.[8]

Finally, Table 3 shows that there is considerable annual turnover in each year in the mix of products and destinations. There are only 92 unique firm-product-destination combinations for which shipments are recorded in all four years of our data (for 92 x 4 = 368 observations, or 1.8 percent of our sample). The most frequent combination in the data is a firm selling a product

[8] U.S. information referenced here and in the previous paragraph is from Bernard *et al.* (2007), pp. 116-8.

to a destination once in four years (52.2 percent of the observations), while 35.8 percent of the observations come from firms which sell a given product to a given destination for two or three years in our four-year window. The average value of shipments declines steadily with frequency: firm-product-destination combinations that appear in all four years average $567,000 in value per year, compared to $147,000 for those that show up in two or three years and $56,000 for those in only one year.

III. Results

We offer two sets of results. The first consists of descriptive findings about Indian exporters' pricing behavior. The evidence here suggests that, at least in our sample period, Indian firms may be achieving export revenue gains more through quantity increases than through price increases. In the second set of results, we estimate the relation between prices and destination market characteristics and firm characteristics. We are particularly interested in the relationship between firm productivity and export prices, and our finding is that firm productivity is associated with lower prices.

A. Indian Export Price Patterns

Exporters' overall revenue changes are the net effect of revenue changes on their intensive and extensive margins. Changes on the intensive margin are driven by price and quantity changes on shipments to "existing" markets, while revenues on the extensive margin are driven by "new" sales. There is considerable latitude in defining what constitutes "existing" or "new" markets, particularly when dealing with fine grained data with firm, product, and destination by year. For instance, is it an "extensive" or "intensive" change when a firm that has been exporting a good to, say, five destinations begins selling that good to a sixth? Or when a firm resumes sales to a destination after a year's hiatus, though it has been selling other products to that destination continuously? The trade literature offers no consensus methodology for decomposing revenue changes into their intensive and extensive components, let alone decomposing changes on the intensive and extensive margins into price and quantity components.[9]

As a first cut at assessing Indian exporters' pricing behavior, we decompose revenue changes into their price and quantity components on the intensive margin using a narrow definition of the intensive margin. (XX swap position of next two sentences?) We calculate, at the firm-product level, the weighted annual rates of change in price and quantity over all the continuing destination markets to which the given firm exports the given product, using destination market revenue as weights. We restrict ourselves to firm-product-destination combinations that can be thought of a plausibly "continuing." So, for instance, when a firm exports a product to a given set of destination markets in consecutive years, the destination-weighted rates of price, quantity and revenue change can be calculated. Further, we include all such observations with one- or two-year gaps (two years being the maximum possible gap in our four-year sample). For example, a firm that exports a particular good to a given destination only in 2000 and 2003 is considered to be "continuing." In an environment with high exit rates, these continuing firm-product-destination combinations can plausibly be taken to represent the behavior of some of India's most successful exporters.

We adopt a simple decomposition, as follows, where f, p, and d ($d = 1, 2, \ldots D$) subscript firms, products and destination markets (and where D represents the total number of a firm's

[9] The literature on this topic is increasing, and "count" methods remain popular though not dominant. See Besedes and Prusa (2011), Turkcan (2014), and Eaton *et al.* (2008).

destinations for any given product p). Define P_{fgd} and Q_{fgd} to be the unit value and quantity of firm *f*'s shipment of product *p* to destination *d*. Suppressing time subscripts, in any given period *t* the firm's revenue from exporting a product, R_{fp}, is the sum of revenue earned across all *D* destinations:

(1) $$R_{fp} = \sum_{d=1}^{D} P_{fpd} Q_{fpd}.$$

Taking the total differential of R_{fp} with respect to P_{fpd} and Q_{fpd}, and defining θ_{fpd} to be the firm's product *p* revenue share attributable to sales in destination *d*, we can decompose intensive margin export revenue growth for product *p* ($\hat{R}_{fp}^{IM}$) into the (destination-weighted average) contributions of price and quantity changes across destinations:

(2) $$\hat{R}_{fp}^{IM} = \sum_{d=1}^{D} \theta_{fpd} \hat{P}_{fpd} + \sum_{d=1}^{D} \theta_{fpd} \hat{Q}_{fpd}.$$

$\hat{P}_{fpd}$ and $\hat{Q}_{fpd}$ represent the rate of change in unit value and quantities, for destination *d*. The revenue-weighted averages, across destinations, of price and quantity changes give us the intensive margin's price change ($\sum_{d=1}^{D} \theta_{fpd} \hat{P}_{fpd}$) and quantity change ($\sum_{d=1}^{D} \theta_{fpd} \hat{Q}_{fpd}$) for each firm-product (*f-p*) observation. (For observations with gaps between appearances, we calculate price, quantity and revenue rates of change over the entire period and attribute that change to the final year.) All calculations are made at the HS8+ level. Note that each firm-product observation with continuing destinations allows calculation of price- and quantity-change observations as long as there is a previous year of data, regardless of the number of destinations to which the firm ships the product.

Results are summarized in Table 4.[10] There are 2,545 unique firm-product-year observations over fiscal years 2001-2003 (keeping in mind that 2000 is dropped in calculating the rates of change). The table reports medians of the pooled annual price, quantity and revenue variables calculated for each observation. Revenue changes appear to be dominated by quantity changes. The median firm-product annual revenue change was 38.7 percent, while the median price change was -1.0 percent and the median quantity change was 50.0 percent. When we restrict the sample to firm-product observations with positive revenue change only, the median annual revenue change rises to 158.2 percent, while the median price change is -0.1 percent (and of quantity, 157.2 percent). Cleary, any "successful" exporters—those with revenue increases—gained those revenue increases by large quantity increases in the face of falling unit prices. Cross-tabulations of the price and quantity changes (Table 5) confirm this: 50.3 percent of firm-product observations with positive revenue growth experienced lower prices (that is, 772 of the 1534 firm-product combinations). Many Indian exporters, at least in this period, experienced price decreases in their shipments as measured at a HS8+ level.[11]

In the next section we examine how firm prices are associated with a range of firm and destination characteristics.

B. Controlling for Destination Market and Firm Characteristics

[10] These calculations use nominal prices, but the mild inflation over the period of our sample should not affect the main conclusions.

[11] A given firm-product pair may be represented in this data up to three times (2001, 2002, and 2003). Note that its weighted average price change may switch signs from year to year, and, since it is an annual weighted average across destinations, may be negative even if prices are rising in one or more destinations.

In Table 6 we consider the relationship between export unit values and a set of firm and destination-market characteristics. The firm characteristics include the capital to labor ratio, labor usage (which we take as a proxy for size), and TFP.[12] Destination-market characteristics consist of distance, remoteness, GDP, and GDP per capita. We use product fixed effects, and destination standard-error clusters.

We must consider the possibility of selection bias because firm prices are only observed if firms choose to export to particular destinations. We implement Harrigan et al. (2015)'s 3-stage estimator, itself an extension of Wooldridge (1995). The first stage is a Probit of entry (of a firm in a particular destination in a particular year) on all exogenous export-market characteristics (X_d), firm characteristics (X_f), and a year-specific intercept α. Omitting time subscripts we have:

$$(3)\ \Pr(y_{fpd} > 0) = \Phi(\alpha + \delta_1 X_d + \delta_2 X_f)$$

Equation (3) is estimated over an expanded sample of all possible firm-destination-year combinations; that is, it is applied to a "rectangularized" data set with zeros added.[13] The inverse mills ratio $\hat{\lambda}_{fpd}$ is then included in the second stage which explains observed (i.e., positive) firm-product-destination revenue based upon export-market and firm characteristics and product fixed effects (α_p):

[12] Here capital is measured as the size of a firm's gross fixed assets, and labor is measured as the wage and salary bill. We calculate TFP using the Levisohn-Petrin (2003) technique, following Topolova and Khandelwal's (2011) approach (see pages 998-999) to calculating each firm's productivity index. One distinction in our approach from Topolova and Khandelwal's is that their measure of firm output is sales while ours is value-added.

[13] This is feasible with the smaller matched data set used for the TIPS-Prowess estimations; to do this with the full TIPS data base is computationally prohibitive.

(4) $\ln y_{fpd} = \alpha_p + \zeta_1 X_d + \zeta_2 X_f + \gamma \hat{\lambda}_{fpd} + u_{fpd}$

Quasi residuals, formed as the actual residuals plus the estimated term for the inverse mill ratio, $\hat{\eta}_{fpd} = \hat{u}_{fpd} + \gamma \hat{\lambda}_{fpd}$, from the second stage are then entered as a selection control in the price regression:

(5) $\ln p_{fpd} = \alpha_p + \beta_1 X_d + \beta_2 X_f + \psi \hat{\eta}_{fpd} + \epsilon_{fpd}$.

Harrigan et al. (2015) argue that this approach, which assumes normality only in the first step, is superior to the 2-step, Tobit approach proposed by Wooldridge.[14] While the rich data used in Harrigan et al. (2015) allows them to estimate regressions (3) and (4) product by product, the limited number of firms in our sample makes this approach unpractical. Thus we initially estimate these regressions over the whole sample and then relax this treatment by conducting the analysis by subsamples based on broad industries (e.g., textiles and textile articles).

Our regression are presented in Table 6. Column (1) is a regression on all firm-product-destinations in our sample, with no selection correction. Column (2) presents the results for the same, complete, sample as column (1) when we employ the three-stage selection correction.[15] Subsequent columns present results for products in particular 2-digit HS chapters: textiles and textile articles (columns 3 and 4); machinery, appliances and electrical equipment (columns 5

[14] The Wooldridge approach would fit a Tobit regression of revenues in the expanded data with zero revenues. The residuals from this estimation would then be used to control for selection bias in the price regressions.

[15] In results not reported here we employ the Wooldridge selection correction. Results are similar in magnitude, though statistical significance is weaker for destination country characteristics

and 6); and the rest of the two-digit HS chapters (columns 6 and 7). For each break-out the first column shows the uncorrected results, the second column shows the results with the selection correction.

These results are drawn from a sample that has been trimmed based upon the 5th and 95th percentiles of the distribution of the TFP variable. This variable has some extreme values, possibly related to data reporting errors for the firms in the sample. We observe the outliers for firms in particular years, and not typically by firms across all four years, which increases our doubts about the validity of the outliers. In results not reported here we estimated our equation across two other trim thresholds (90/10, 80/20) and on the entire sample. The results are robust to the various trims, with the exception that TFP is no longer significant in the entire sample.

Column (2) is our baseline regression on all firm-product destinations with a selection correction. We find a positive association between unit values and destination GDP, GDP per capita, and remoteness. The capital/labor ratio and our measure of labor size both have positive and significant coefficients. Overall our model performs well; R-squared values are about 87 percent.

In contrast to the literature we find a negative association between TFP and export prices; more productive firms on average charge lower prices. We also find, in contrast to the literature, a negative association between distance and prices, and a positive association between remoteness and prices.

In subsequent columns we examine the same model of firm prices applied to particular 2-digit HS chapters. In this discussion we focus only on the result with the sample correction (columns 4, 6, and 8). Across the three breakouts our results are similar: both firm TFP and distance have a negative association with prices, and remoteness bears a positive coefficient.[16]

Consider the TFP variable. The coefficient ranges from -0.14 to -0.21 in three of the four regressions (and is about -0.57 for the machinery category). At -0.17 it suggests firms with a ten percent higher productivity charge about 2 percent lower prices. We note that our negative coefficient on productivity is robust to how this variable is measured. When we use value-added per worker as a measure of firm productivity we again obtain a consistently negative (and statistically significant) association with firm prices.[17]

V. Discussion

As noted in the literature review there are three possible cases, which may be distinguished firstly by whether goods are heterogeneous or homogenous, and then for the heterogeneous goods case by whether the scope for quality differentiation is high or low. Taking market size as given, this depends on whether the cost of innovation is high or low. For firms in more developed countries where the cost of innovation is low, then the scope for quality differentiation is high, and prices and firm productivity are positively correlated. As noted by Antoniades (2015), in less developed countries where the cost of innovation is higher, the scope for quality differentiation is lower, and the correlation between prices and productivity may become negative. As noted above, we find this to be the case for India.

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[16] In results not reported we examined how our results changed (1) with the exclusion of firm characteristics beyond TFP (excluding individually and together our measure of firm size (log labor) and the capital to labor ration (log klabor), and, separately, (2) with the inclusion of firm-product fixed effects replacing our product fixed effects. For (1) all results (including those for TFP, distance, and remoteness) were robust to the exclusion of any combination of log labor and log klabor. For (2) all results are robust except for TFP, which loses statistical significance. We suspect that the TFP result reflects the product-firm fixed effects controlling for much of the cross-sectional variation in firm prices.

[17] These results are not reported here, but are available from the authors.

We present these three cases in Figure 1. Zone I is the homogeneous goods case for which the correlation between prices and productivity is negative. Since firms producing homogeneous goods are unconcerned with quality, whether the cost of innovation is high or low is irrelevant. Firm levels studies which align with zone I, which is classified as homogeneous markets, are Roberts and Supina (1996, 2000), Syverson (2007), and Foster, Haltiwanger, Syverson (2007). Zone III is the case of heterogeneous goods and a low cost of innovation. This leads to heterogeneous markets (or long quality ladders) and prices are a good proxy for quality. Harrigan et al. (2015), Manova and Zang (2012), Bastos and Silva (2009), Gorg, Halpern, and Murakozy (2010), and Martin (2012) all fit into zone III. Finally zone II is the case of heterogeneous goods and high cost of innovation. The correlation between prices and productivity is negative and, although goods are heterogeneous, this is classified as homogeneous markets because of this correlation. Our findings suggest that, on average, Indian firms belong in this zone.

To determine what is driving our results, and to make the case that more productive firms producing heterogeneous goods are charging lower prices, we divide our sample along two lines. Firstly by the ternary Rauch categories (homogeneous, reference, and differentiated), and secondly into the groups: textiles, machinery, and all other goods. We make this second distinction because the majority of our observations fall into the former two categories. We compare our results, examining both the unconditioned and conditioned correlations, with others in the literature, and in particular Kugler and Verhoogen (2012) and Manova and Zang (2012).

Following Sutton (1998), Kugler and Verhoogen (2012) use R&D and advertising intensity as a measure of the scope for quality differentiation. They find that the correlation between prices and firm size is increasing in the scope for quality differentiation. Similarly, using Rauch categories to measure the scope for quality differentiation, Manova and Zang find that the correlation between firm export prices and export sales increases as the scope for quality differentiation increases. Following Manova and Zang (2012) and using Rauch categories, we find that the correlation between prices and firm size, proxied by either by firm's total sales or labor force, is negative for homogeneous goods and positive for reference and differentiated goods (see Table 7).

Since we have measures of firm productivity, in contrast to Kugler and Verhoogen (2012) and Manova and Zang (2012), we can examine the conditioned correlations between export prices and productivity. Dividing our sample into textiles, machinery and all other goods, we find that the correlation between prices and productivity in machinery, where all goods are classified as differentiated according to the Rauch categorization, is significant and strongly negative.[18]

The empirical evidence suggests that the finding of a negative correlation between productivity and price in our sample is not driven by firms producing homogenous goods. Hence, although our result is classified as homogeneous markets because of the negative correlation between prices and productivity, the firms in our sample are in the majority producing heterogeneous goods. Further, our result is, if anything, strongest (most negative) for firms grouped in machinery in which all goods are classified as differentiated. Given that these goods are clearly heterogeneous and in addition given the findings of the papers located in Zone III, this is where one might expect the correlation to be most positive relative to the two other

[18] As a robustness check we also examine the conditioned correlations for the differentiated goods in the textiles and all other goods groups. We find here that the coefficients are negative, although less so than for machines, and insignificant due to the smaller sample sizes of these finer divisions. These results are not reported although available from the authors.

groups. This positions our overall result in zone II, where goods are heterogeneous and the scope for quality differentiation is low. Although the analysis of Antoniades (2015) alludes to the possibility of this relationship, to our knowledge we are the first to find this result empirically.

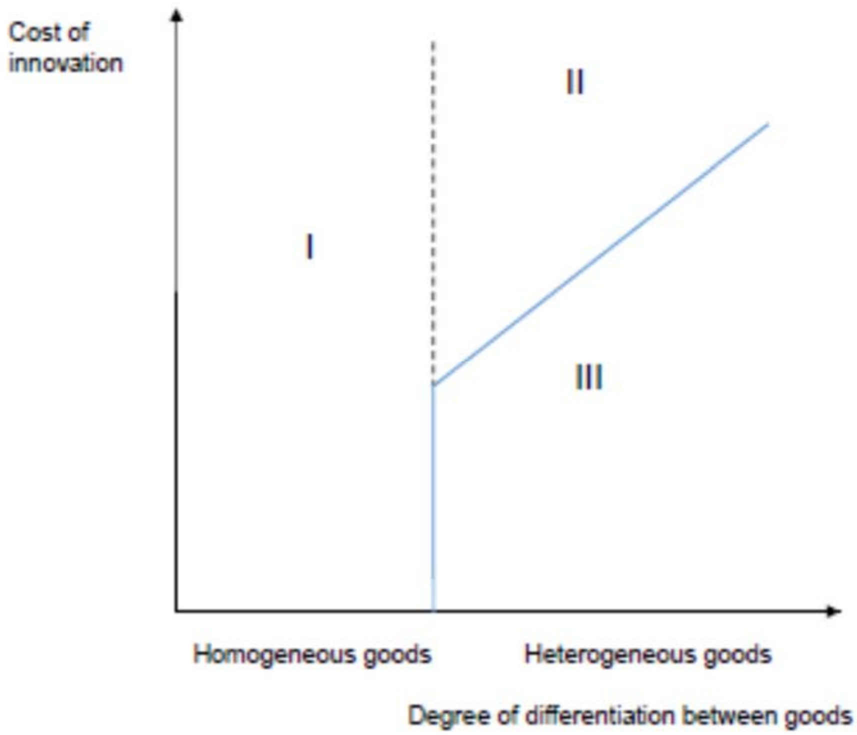

Figure 1

Zones
I: Roberts and Supina (1996, 2000); Syverson (2007); Foster, Haltiwanger, Syverson (2007)
II: Anderson, Davies, Signoret, Smith (2015)
III: Harrigan et al. (2015); Manova and Zang (2012); Bastos and Silva (2009); Gorg, Halpern, and Murakozy (2010); Martin (2012)

VI. Conclusion

Using a unique dataset, we examine a sample of Indian exporters we find a negative correlation between prices and productivity, a negative correlation between prices and distance and a positive correlation between prices and remoteness. The heterogeneous firms and export pricing literature, thus far, finds the opposite sign for each of these relationships.

Because India firms face a higher cost of innovation then the scope for quality differentiation is low (quality ladders are short) and while India firms are quality upgrading, the quality upgrades and mark-ups of higher productivity firms are not substantial, and as a result prices fall as productivity rises.

Using the framework of Antoniades (2015) we position our results, which are classified as (heterogeneous goods, homogeneous markets), in the literature relative to two other identified groups: (homogeneous goods, homogeneous markets) and (heterogeneous goods, heterogeneous) markets). To our knowledge we are the first to find empirically this particular classification.

Table 1. Distribution of Export Values by Firm, Percent Shares

Year	Top 1 percent	Top 5 percent	Top 10 percent	Top 20 percent	Bottom 80 percent
2000	32.1	60.1	73.6	87.7	12.3
2001	44.4	68.9	79.5	89.1	10.9
2002	43.6	67.6	79.7	89.1	10.9
2003	40.6	70.1	83.3	93.5	6.5

Source: Authors' calculations from estimating sample of merged TIPS-Prowess data; 1,018 unique firms.

Table 2. Cross-Tabulation of Firm Export Destinations and Product Diversification, 2003
Percent of firms by category

	Destinations				
Products	1	2-5	6-10	>10	Total
1	17.8	3.4	0.3	0.2	21.7
2-5	6.7	21.2	3.3	0.7	31.9
6-10	0.8	9.0	6.8	2.6	19.2
>10	0.7	4.9	8.2	13.5	27.2
Total	25.9	38.6	18.6	16.9	100

Source: Authors' calculations from estimating sample of merged TIPS-Prowess data. Products are defined at HS8+ level discussed in text.

Table 3. Appearance Patterns of Unique Firm-Product-Destination Combinations

Percent of estimating sample	Appearance			
	2000	2001	2003	2004
1.8	X	X	X	X
0.8	X	X	X	
1.4	X	X		
0.4	X		X	X
0.4	X	X		X
0.4	X		X	
0.4	X			X
2.8		X	X	X
8.8		X	X	
1.1		X		X
3.7			X	X
6.0	X			
19.5		X		
16.1			X	
36.3				X
100.0	Total			
n = 20,848	Total unique firm-product-destination-year observations			

Source: Authors' calculations.

Table 4. Price and Quantity Contributions to Changes in Revenue, 2001-2003
Pooled Annual Medians by Firm-Product for Continuing Destinations

	%ΔPrice	**%ΔQuantity**	**%ΔRevenue**
All Firm-Product Observations (n = 2,545)	-1.0	50.0	38.7
All Firm-Product Observations with Positive Revenue Change (n = 1,552)	-0.1	157.2	158.2

Note: Products defined at HS8+, using all continuing firm-product-destination observations as defined in text. Figures presented are the medians by variable.

Table 5. Cross-Tabulation: Signs of Annual Weighted Price and Quantity Changes by Firm-Product Observations

A. All Firm-Product Observations (n = 2,545)
Percent (number)

	%Δquantity		
%Δprice	**(-)**	**(+)**	**Total**
(-)	17.2 (439)	36.2 (921)	53.4 (1,360)
(+)	18.3 (466)	28.3 (719)	46.6 (1,185)
Total	35.6 (905)	64.4 (1,640)	100.0 (2,545)

B. Firm-Product Observations With Positive Revenue Growth (n = 1,534)
Percent (number)

	%Δquantity		
%Δprice	**(-)**	**(+)**	**Total**
(-)	0.1 (2)	50.2 (770)	50.3 (772)
(+)	4.7 (73)	44.9 (689)	49.7 (762)
Total	4.9 (75)	95.1 (1,459)	100.0 (1,534)

Table 6. Firm-Product Pricing by Destination and Firm Characteristics—For All Goods and Selected Industries

	All Goods		**Textile and textile articles**		**Machinery, appliances, elect. equipment**		**All other HS chapters**	
VARIABLES	**(1) logprice**	**(2) logprice**	**(3) logprice**	**(4) logprice**	**(5) logprice**	**(6) logprice**	**(7) logprice**	**(8) logprice**
loggdppc	0.0892***	0.177***	0.0326	0.127***	-0.0765	0.0136	0.106***	0.163***
	(0.0209)	(0.0277)	(0.0216)	(0.0249)	(0.0499)	(0.0472)	(0.0221)	(0.0274)
loggdp	0.0366***	0.271***	0.0135	0.189***	-0.0153	0.194***	0.0514***	0.230***
	(0.0133)	(0.0540)	(0.0126)	(0.0387)	(0.0401)	(0.0555)	(0.0167)	(0.0449)
logdist	-0.0242	-0.373***	0.105**	-0.162**	0.0330	-0.330***	-0.0471	-0.300***
	(0.0473)	(0.0661)	(0.0440)	(0.0678)	(0.105)	(0.112)	(0.0519)	(0.0586)
logremote†	0.00446	0.361***	0.0344	0.240***	0.00256	0.347***	-0.0319	0.244***
	(0.0432)	(0.0779)	(0.0384)	(0.0510)	(0.117)	(0.126)	(0.0561)	(0.0701)
logtfp	-0.171**	-0.162**	-0.123*	-0.137**	-0.570***	-0.565***	-0.214**	-0.208**
	(0.0827)	(0.0816)	(0.0670)	(0.0688)	(0.193)	(0.173)	(0.0869)	(0.0881)
logklabor	0.0823	0.0933*	0.00903	0.0102	0.106	0.0258	0.126*	0.158**
	(0.0554)	(0.0560)	(0.0311)	(0.0308)	(0.194)	(0.183)	(0.0717)	(0.0754)
loglabor	0.0645*	0.181***	0.0965***	0.162***	0.309***	0.388***	0.0161	0.0973**
	(0.0345)	(0.0334)	(0.0226)	(0.0269)	(0.116)	(0.105)	(0.0466)	(0.0394)
selection††		0.211***		0.0355***		0.269***		0.242***
		(0.0464)		(0.00698)		(0.0386)		(0.0567)
Observations	20,850	20,850	2,915	2,915	4,233	4,233	13,657	13,657
R-squared	0.862	0.871	0.917	0.919	0.904	0.913	0.829	0.842
Fixed effects	Prod	Prod	Prod	Prod	Prod	Prod	Prod	Prod
SE clusters	Country	Country	Country	Country	Country	Country	Country	Country

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
†Remoteness definition as used by Harrigan et al. (2015) or Harrigan mark I (XX)
††Selection procedure from Harrigan et al. (2015) or Harrigan mark I (XX), as described in text.

Notes: Pooled annual data for fiscal years 2000-2003. All regressions include year fixed effects. Wholesalers excluded. Quantity units are harmonized and each regression is run on the dominant quantity unit for each product. Compare with Harrigan et al. (2015) Table 4.

Table 7. Correlation of Export Price with Firm Size

A. Measuring size by sales: independent variable = ln(Sales)

Type of good	Coefficient	SE	t	P-val
Differentiated	0.168	0.019	8.78	0.000
Reference priced	0.289	0.022	13.06	0.000
Organized exchange	-0.106	0.033	-3.23	0.001
Reference priced and organized exchange	0.239	0.02	12.06	0.000

B. Measuring size by labor force: independent variable = ln(Labor)

Type of good	Coefficient	SE	t	P-val
Differentiated	0.218	0.018	11.95	0.000
Reference priced	0.337	0.019	17.66	0.000
Organized exchange	-0.06	0.031	-1.93	0.054
Reference priced and organized exchange	0.286	0.017	16.56	0.000

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