Imported Intermediate Inputs and Workforce Composition: Evidence from India's Tariff Liberalization [*]

Shruti Sharma [†]
Indian Institute of Management, Ahmedabad

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Abstract

This paper extends the literature on trade liberalization and labour by investigating the relationship between imports of intermediate inputs and plant-level workforce composition during India's tariff liberalization. Using detailed plant-level data from the Indian manufacturing sector, I first show that the increase in imports of intermediate inputs in response to input tariff liberalization has strong displacement effects on production workers employed by importing plants. Next, I decompose the impact of intermediate inputs on labour into "quality", "variety", and "scale" effects, based on the availability and prices of domestically-produced inputs. I find that the displacement of production workers is driven by lower-priced imported intermediate inputs, the "scale" effect. Finally, I examine the differential effect of tariff liberalization based on whether plants experience import competition or not. This analysis reveals that domestic plants facing import competition experience a displacement of both skilled and unskilled workers in response to tariff liberalization. Plants that switch from in-house production to importing some intermediate inputs however only displace production workers while retaining skilled workers. This suggests that skilled workers are indispensable to plants switching to importing as a productivity enhancing strategy.

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[†] Department of Economics, Indian Institute of Management, Ahmedabad. Email: shrutis@iimahd.ernet.in

1 Introduction

The role of imported intermediate inputs in international trade has gained a new focus in recent literature. Various studies have now established that imports of intermediate inputs have strong productivity enhancing effects on firms (Amiti and Konings (2007), Goldberg, Khandelwal, Pavcnik and Topalova (2010b), Altomonte, Barattieri and Rungi (2008)). This suggests that beyond exports and foreign direct investment, firms are importing intermediate inputs as an important strategy to enhance competitiveness and innovate. Given that competitiveness and growth of the manufacturing sector is relevant to a country's economic policy both in terms of its contribution to gross domestic product and employment, it becomes important to understand how imports of these intermediate inputs impact the employment and wages of workers. This paper sets out to study the impact of liberalization of imports of intermediate inputs on labour in the Indian manufacturing sector. While India's manufacturing sector has been experiencing gains in productivity since the last decade of liberalization, the employment of unskilled workers has been suffering (Sincavage, Haub and Sharma (May, 2010)). This makes India an interesting case study in the literature on trade liberalization and labour.

Studies investigating the relationship between imports of intermediate inputs and labour are less extensive and have mainly been focused on wage outcomes. Additionally, there is no strong consensus on the relationship between imports of intermediate inputs and the wage-skill premium. Amiti and Davis (2012) find that in response to liberalization of imports of intermediate inputs (henceforth, input tariff liberalization), importing firms pay higher average wages to their workers as compared to non-importing firms in Indonesia. Given the established fact that plants experience increases in productivity in response to input tariff liberalization, and their assumption that workers are homogeneous, one can attribute this increase in average wages to rent sharing by importing firms.

Amiti and Cameron (2012) establish that wage-skill premium declines in response to input-tariff liberalization, again in the Indonesian context. They attribute this to a decline in demand for skilled workers due to the skill embodied in the production of imports of intermediate inputs. The argument is that most of this decline in demand comes from plants that were previously producing these inputs, but switch to importing post liberalization. In contrast, a study on imports of capital goods in Hungary (Csillag and Koren (2011)) finds that workers working on imported machines experience an increase in their wage-skill premium. This increase can

be attributed to the fact that higher skilled workers work with imported machines, and that they experience an increase in returns to their labour. What still remains to be clearly understood is whether and to what extent changes in worker-composition respond to changes in input tariffs.

This paper investigates how trade liberalization impacts both employment (of skilled workers, unskilled workers along with worker-composition) and wages (both average and relative) of workers with plant-level data from India. In this way, it provides a more complete picture of the linkages between international trade and labour. Further, in order to better understand the mechanisms, I decompose the effects of imports of intermediate inputs based on the various motivations behind importing, and also depending on whether plants experience competition from imported inputs or not. The paper therefore, contributes to the aforementioned literature in three important ways.

First, I establish that worker-composition does indeed change in response to changes in input tariffs. I investigate this relationship by considering the impact of industry level input and final goods tariff changes on plant-level skill composition. Following a balance of payments crisis in 1991, India embarked on a regime of trade policy reform, wherein under pressure from the IMF it began reducing tariffs in a phased manner. Subsequently, in 1995, it also became a member of the WTO, and has adhered to certain tariff reduction obligations. While this suggests that tariff declines are exogenous to plant-level behaviour, there may still be concern about lobbying by industries. I've addressed these concerns by showing that there is no significant relationship between lagged values of industry-level variables (such as size and employment) and tariffs, among other robustness checks.

The plant level data is available from the Annual Survey of Industries, which covers all industries in the Indian manufacturing sector. It would have been helpful to use panel data to control for time-invariant unobservable plant characteristics that could play a role in causing plants to select into importing. The data, however, is available as a repeated cross-section, and therefore to best mimic plant fixed effects I have used interactive industry-region-age fixed effects. Further, as a robustness check I create a synthetic panel by creating cohorts using information on the industry, region and age of plants and use 'cohort fixed effects' to best capture plant fixed effects.

I find that skill composition of an importing plant increases differentially compared to

non-importing plants. Final goods tariff (alternatively, output tariff) liberalization on the other hand, does not have any impact on worker-composition. Wage-skill premium, on the aggregate, is also unaffected by both input tariff and output tariff liberalization. This result is in contrast to previous literature that has only treated wage-skill premium as an indicator for labour demand (Amiti and Davis (2012), Csillag and Koren (2011)). Employment of workers is affected by trade liberalization for India, but is unaccompanied by changes in wage-skill premium. I confirm the Amiti and Davis (2012) result that average wages increase differentially for importing plants relative to non-importing plants as input tariffs decline. However, the evidence on movements in skill composition plays an important role in explaining these increases.

Further, I investigate whether this relative increase in skill composition is a result of a decline in production workers, an increase in skilled workers or both. In other words, are imported inputs substituting away production workers, or do skilled workers complement them, or both? My findings show that there are strong substitution effects for production workers, and there are some indications of a complementarity between imported inputs and skilled workers, but the former is the more dominant effect. This is also reflected in an overall decline for total workers at importing plants relative to non-importing plants in response to a decline in input tariffs. Given that importing plants comprise about forty per cent of the sample, these labour displacement effects become economically significant. In fact, the decline in employment at importing plants as a result of tariff liberalization may explain some of the concerns relating to the 'job-less growth' of the Indian manufacturing sector documented in various reports (Sincavage et al. (May, 2010)).

The second main contribution lies in decomposing the effects of imported intermediate inputs in order to better understand the linkages between imported inputs and workers. Based on the motivation behind importing, I decompose the effects of imported inputs into a "scale effect", "quality effect" and "variety effect". The "scale effect" refers to the effect of imports of intermediate inputs that are on average cheaper than the domestic counterpart, and are imported to primarily expand production and achieve economies of scale. The "quality effect" refers to intermediate inputs that are imported because they have a higher perceived quality than domestic inputs, and finally the "variety effect" refers to imports of intermediate inputs that are domestically unavailable.

This decomposition finds its motivation in the literature on impact of imported interme-

diate inputs on productivity of importing plants. Goldberg et al. (2010b) stress on the importance of variety showing that inputs of different varieties ease technological constraints faced by firms allowing them to produce more products and access more markets, which has a strong productivity enhancing effect on firms. Kugler and Verhoogen (2009) highlight that it is important to consider not just the role of an increase in input categories, but also the increase in input quality within a product category, as measured by an increase in unit values, on the productivity of a firm. Halpern, Koren and Szeidl (2011) show that quality of importing inputs contribute to total factor productivity but it is also the complementarity between the quality of imported inputs and the quality of domestic inputs that further contributes to this productivity. Along these lines, I investigate whether there are complementarities between the variety or quality of inputs, and quality of workers. Alternatively, imported inputs can have substitution effects on unskilled workers or on skilled workers as Amiti and Cameron (2012) find for Indonesia.

Using detailed data on codes and prices of both imported and domestic intermediate inputs I identify all these effects in the same model. To my knowledge, this is the first paper that provides insight into the scale, quality and variety effects of imported intermediates on worker-composition (or any labour market outcomes). I find that while all kinds of inputs lead to displacement of workers at importing plants relative to non-importing plants, the "scale" effect has the biggest substitution effect. There are no strong complementarities between these inputs and the skill of workers. The displacement of these workers, leads to a relative decline in total employment at importing plants. Because the substitution effects are strongest from "scale effects", I also find that plants importing these cheaper inputs also experience an increase in the wage-skill premium of workers. From this analysis, I find no significant relationship per se between the quality and variety of an imported input and the skill (or wages) of workers.

Finally, I examine the differential impact of input tariff liberalization based on whether plants face import competition or not in order to understand the main source of adjustment in worker composition. The motivation for this analysis comes from the mechanism proposed in Amiti and Cameron (2012), wherein they argue that plants which switch from in-house production of intermediate inputs to importing drive the relative decline in skill premium. I investigate this by dividing my sample into four sets of plants- plants that import intermediate inputs and also engage in in-house production of the same, plants that import these

inputs but always outsource them, domestic plants that only produce products that compete with imports of intermediate inputs, and domestic plants that do not face any competition. I find that importing plants, regardless of whether they compete in production with imported intermediates or not, experience a strong displacement of production workers only, relative to domestic plants that do not face import competition. However, this effect is stronger for plants that also engage in in-house production of intermediate inputs.

Domestic plants that compete with the imports of intermediate inputs on the other hand, experience displacement of both skilled and unskilled workers relative to non-competing domestic plants, due to a likely decline in derived demand for these workers. The fact that plants that reduce production of these inputs and engage in imports still retain their skilled workers is an indication that skilled workers are indispensable to the functions of importing plants. Unearthing this relationship is the third main contribution of this paper.

The remainder of this paper is organized as follows. The second section is a description of the data and policy. In the third section I lay out my empirical model. The fourth section contains the estimation results and robustness checks. The various mechanisms underlying the first result, including the decomposition of the effects of imported intermediate inputs and the differential impact of liberalization relating to import competition, are all contained in the fifth section. The sixth section concludes.

2 Data and Policy

This section begins with a description of India's trade policy in the first sub-section. In the second and third sub-sections the plant-level and tariff data used for the empirical investigation are discussed.

2.1 India's Tariff Liberalization Policy

Prior to 1991, India was a closed economy and one of the important elements of its import substituting industrialization strategy was high tariff barriers. In the face of a balance of payments crisis in August 1991, and under pressure from the IMF, India decided to liberalize the economy as a part of its economic reform. Post 1991, India has been reducing its tariffs in a

phased manner as per its structural adjustment program. In addition, India has been a member of the WTO since 1995, and has been reducing tariffs as per the guidelines. While there are still elements of protection in India's trade policy, these are mainly concentrated in the agricultural sector due to important livelihood concerns.

Tariff liberalization post 1991 can be assumed to be exogenous, because the BOP crisis and subsequent change in policy was unanticipated by plants. Therefore, changes in tariff will be used for identification in this study. The peak rate of customs tariffs was 150% in 1991-92. Since then the rate has been reduced in the successive Union budgets with the aim of bringing India' s tariff rates in line with the rates prevailing in the South East Asian countries (which is about 5%). During the period under consideration in this analysis, the average tariff rate fell from 38.55 per cent in 1999 to 23.63 per cent in 2003. While it is argued that pressure from the IMF may have abated by this time (Topalova and Khandelwal (2011)), India did continue however, to fulfil its obligations as a member of the WTO to reduce tariff rates as per the guidelines. Comparing the applied rate in 2001-02, with bound rate at the WTO, out of 3298 tariff lines bound by India at the WTO (mostly at 40% or 25%), 1040 lines had applied rates equal to the bound rates (for five lines, applied rate exceeded bound rate). In other cases, the applied rate was lower than the bound rate. The concerns about the potential endogeneity of trade reform within the manufacturing sector still remain. In general it is perceived that the governments try to protect either the most productive industries or the most laggard industries. Further, industries could be lobbying for lowering of tariffs on upstream industries. I try to rule out any strong correlations between movements in tariff and industry-level characteristics by three tests that include testing for correlations between lagged industry level characteristics and tariffs (both output and input), by using interactive industry-year fixed effects in my base-line specification, and finally by using instruments following the GMM approach by Blundell and Bond (1998). All these tests are explained in detail in the "Empirical Model" and "Robustness Checks" sections.

2.2 Plant-level Data

The plant level data used in this exercise is from the Annual Survey of Industries by the Department of Commerce of India. It is a comprehensive survey of all industries in India's manufacturing sector. The other advantage of using this data set is that among other variables, it

Table 1: Summary Statistics

Variable	Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
Skill Composition	46,839	26.39	17.39	0	100
Log(Employment of Production Workers)	46,629	4.17	1.56	0	10.63
Log(Employment of Non-Production Workers)	46,832	2.92	1.43	0	10.21
Log(Total Employment)	46,839	4.49	1.48	0	11.03
Log(Fixed Assets)	46,839	16.09	2.59	0	26.19
Log(Working Capital)	46,839	27.02	4.41	3.91	29.83
Log(Sales)	46,839	17.69	2.15	6.26	26.78
Input Tariff (2-digit NIC)	46,839	13.18	4.78	3.14	24.42
Final Goods Tariff (2-digit NIC)	46,839	33.93	13.34	15.38	96.48

Summary statistics calculated from plant-level data available from Annual Survey of Industries
Final Goods Tariff data from Hasan, Mitra, Ramaswamy (2007).
Input Tariff data calculated from Final Goods Tariff and Input Output Tables from CSO, India.

provides detailed information on employment and wages of production and non-production workers, and on the codes, prices and usage of both domestic and imported intermediate inputs. Information on both employment and imported intermediate inputs is absolutely essential to the central question of this paper. It also includes details on the location of the plant and the age of the plant, both of which have been used in order to control for time invariant characteristics of the plant. One important detail that is missing is the export status of a plant and will be captured by using proxies such as fixed assets and worker productivity, based on relationships established in prior literature (Bernard and Jensen (1994), Bernard and Jensen (1997), Bernard and Wagner (1997), Wagner (2007)).

This data set has been typically available as a repeated cross section, and only recently did ASI release plant identifiers. The repeated plants however, are a very small proportion of the entire sample, so in order to avoid issues of selectivity, a repeated cross section has been used over a balanced panel. After cleaning the data, the sample used for the analysis includes a total of 46,839 observations for the period 1999 to 2003. Summary statistics on variables that are used in the study are presented in Table 1. Skill Composition reported in this table and used for the analysis is defined as the ratio of non-production workers to total employment by a plant, as is common in the literature. I also use the detailed data on product codes and prices of domestic and foreign inputs to decompose the effect of lower priced inputs, higher quality inputs, and inputs of a domestically unavailable variety on various employment and wage outcomes.

Comparing these variables across plants that import intermediate inputs and plants that do not shows that there is a stark difference between the two kinds of plants (Table 2). Plants that import intermediate inputs have on average a higher skill composition, higher employment of production workers, non-production workers, total employment, fixed assets, working capital and sales. It will be important to control for both observable and unobservable plant level characteristics that could cause the plants to select into importing. While I can't control for plant fixed effects, I will be using information on time invariant characteristics of the plant such as its industry of operation, location and age, to capture these effects to the best possible extent. To further check for the robustness for these results I create a synthetic panel (Deaton 1985) by generating cohorts based on the same time invariant characteristics.

Table 2: Plant Heterogeneity

Variable (Total number of plants = 46,839)	Importing Plants (Mean) (Total number of plants = 10,397)	Non-importing Plants (Mean) Total number of plants = 36,442)	Difference (Importing - Non-Importing)
Skill Composition (Percentage)	29.71 (0.18)	25.44 (0.09)	4.27*** (0.14)
Log(Employment of Production Workers)	5.07 (0.01)	3.91 (0.01)	1.16*** (0.12)
Log(Employment of Non-production Workers)	4.04 (0.01)	2.60 (0.01)	1.44*** (0.01)
Log(Total Employment)	5.48 (0.01)	4.22 (0.01)	1.26*** (0.11)
Log(Fixed Assets)	18.20 (0.02)	15.49 (0.01)	2.71*** (0.02)
Log(Working Capital)	27.28 (0.04)	26.94 (0.02)	0.34*** (0.04)
Log(Sales)	19.15 (0.01)	16.35 (0.01)	2.80*** (0.02)

Notes: Standard Errors in parentheses * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

2.3 Input Tariffs

Identification in this study is based on changes in both output and input tariffs. Input tariffs are tariffs associated with inputs used by plants in the production process. A decline in final goods tariffs should lead to an increase in competition for a plant in an industry, and through a complementarity between quality of output and quality of workers (Verhoogen (2008)), we should expect an increase in the skill composition of a plant. Alternatively, we may observe this increase in demand via an increase in the wage-skill premium. If however, input tariffs decline; imports of intermediate inputs become cheaper creating an incentive for plants to start importing or to increase their imports of these inputs. These tariffs have been constructed using the following formula (Amiti and Cameron (2012)). Consider industry j that uses inputs from other industries denoted by k. Then

$$\textit{Input tariff}_{jt} = \sum_{k} s_{jk} \textit{*final goods tariff}_{kt}$$

Where s_{jk} is the share of input k used in producing output j. These shares have been obtained from the Input-Output Table for India obtained from the Department of Commerce for year 2003 (the last year of the analysis), and are not changing for the period considered in the analysis. Final goods tariffs have been obtained from Hasan, Mitra and Ramaswamy (2007). Using concordances from Ahsan (2013), sector codes from the input-output tables have been mapped to the national industrial classification 98 (at the four-digit level) which is used for tariff data.

While the biggest declines in tariffs were observed for the period immediately post reform in 1991, both input and output tariffs have been continuously declining from 1999 through 2003 as well. While final goods tariffs dropped from an average of 38.55 per cent in 1999 to an average of 23.63 in 2003 across industries, input tariffs declined on average from 14.64 per cent to 8.28 per cent for the same period (Figure 1). The decline in both tariffs is differential across industries, which is important for identification (Figures 2 & 3).

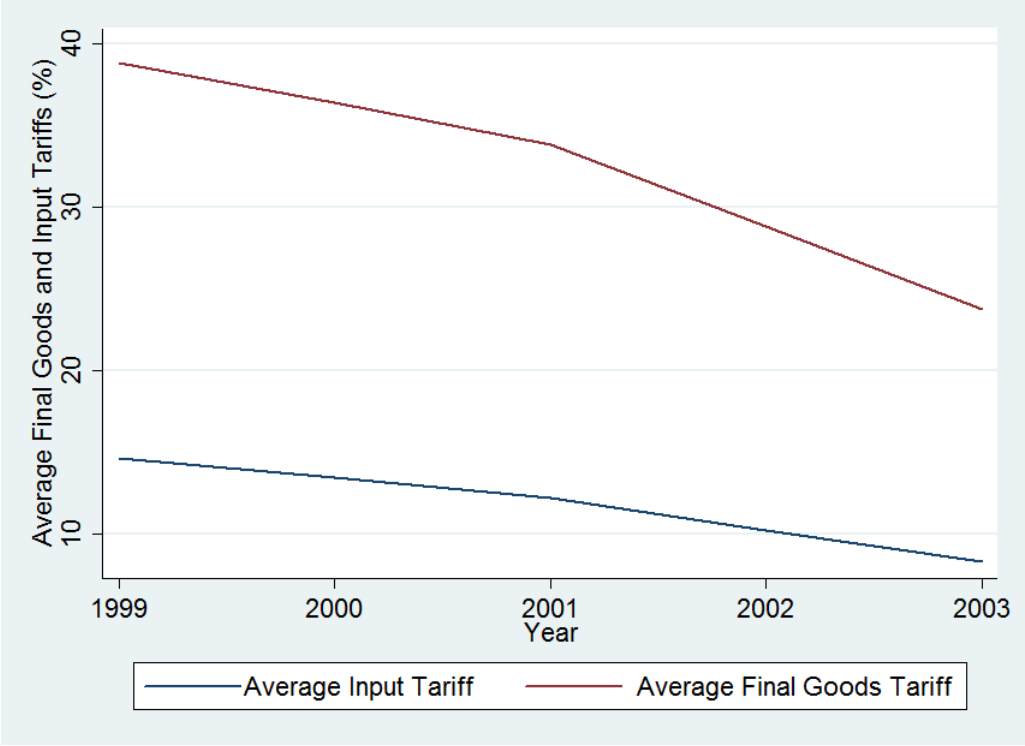

Figure 1: Input Tariff Liberalization.

Notes: Final Goods Tariffs obtained from Hasan, Mitra and Ramaswamy (2007).
Input Tariffs calculated from Final Goods Tariff using formula from Section 2.3.
Figure shows that Average Final Goods Tariffs (percentage) and Input Tariffs have been declining from 1999 to 2003.

3 Empirical Strategy

In this section I will first discuss the empirical model used for various estimations, and then I will address concerns regarding the endogeneity of trade reform, which is important for identification in this analysis.

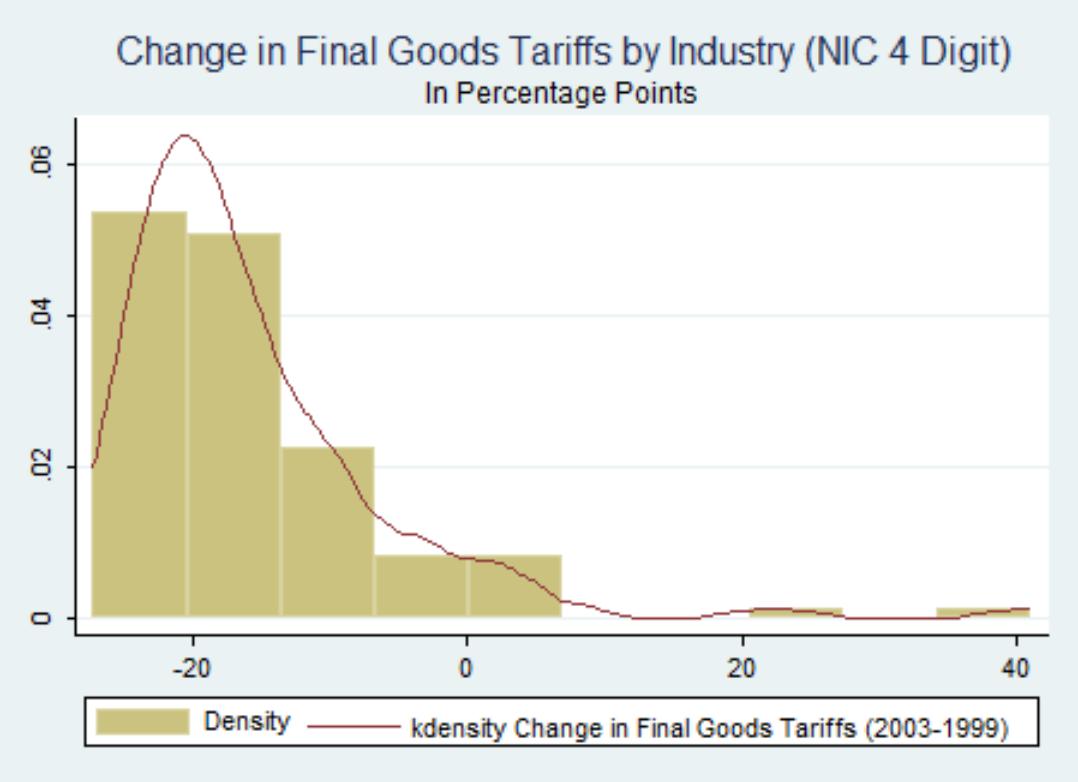

Figure 2: Changes in Final Goods Tariffs by Industry.

Notes: Industries are at 4-digit National Industrial Classification Level. Figure shows that Changes in Input Tariff (1999-2003) have been differential across Industries.

3.1 Empirical Model

The central question of this paper is, how does tariff liberalization, especially input tariff liberalization, impact plant-level worker-composition? I also want to examine whether the effect of input tariff liberalization is differential for importing plants relative to non- importing plants. I use the following empirical model:

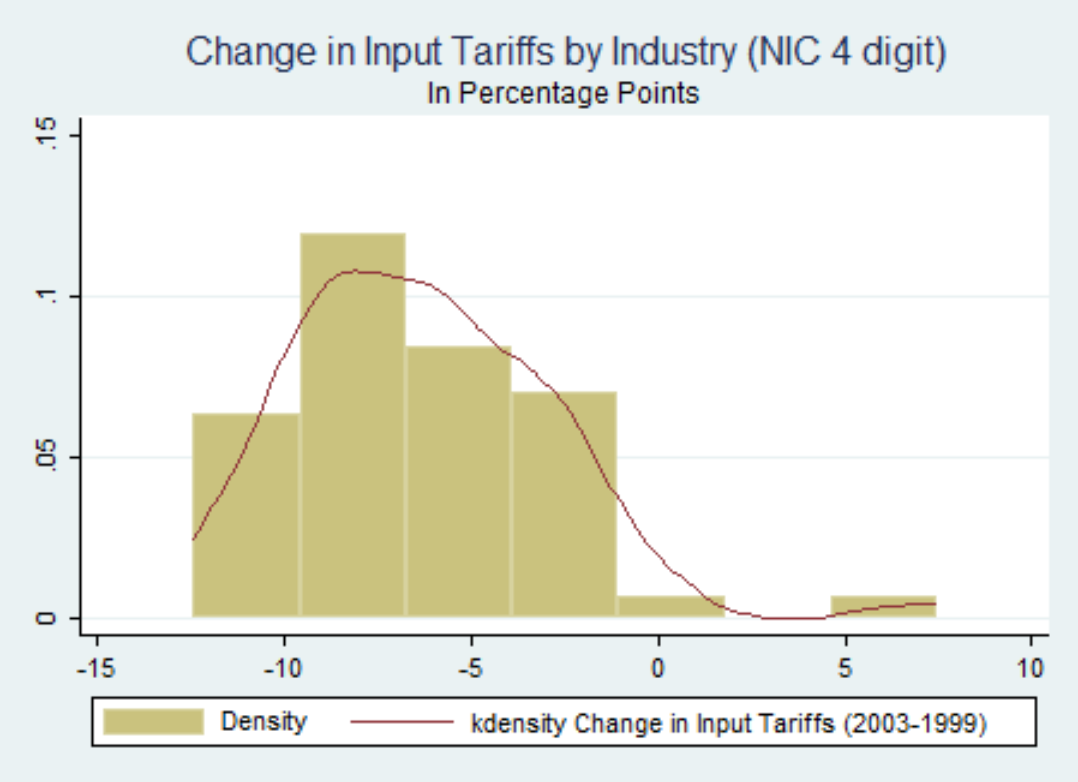

Figure 3: Changes in Input Tariffs by Industry.

Notes: Industries are at 4-digit National Industrial Classification Level. Figure shows that Changes in Input Tariff (1999-2003) have been differential across Industries.

$$
\begin{aligned}
S_{it} \quad = \quad & \alpha + \beta_1 * M_{it} + \beta_2 * M_{it} \textit{input tariff}_{jt} + \beta_3 * \textit{input tariff}_{jt} + \\
& \beta_4 * \textit{final goods tariff}_{jt} + \beta_5 * \textit{final goods tariff}_{jk} * \textit{fixed assets}_{jk} + \\
& \beta_6 * \textit{fixed assets}_{it} + \beta_7 X_{it} + \theta_{jrb} + \theta_t + \epsilon_{it} \qquad (1)
\end{aligned}
$$

where S_{it} is plant-level skill composition defined as the ratio of non-production workers to total employment at a plant. Final goods tariff and input tariff both have been included, and they vary across industries (four digit NIC) over time. M is a dummy denoting the import status of a plant, it takes on the value of 1 if a plant imports any intermediate input, and is zero

otherwise. Fixed Assets that denote the size of the plant have been used to proxy for exporting behaviour, given that most studies have documented that large firms are more likely to be exporters (Bernard and Jensen (1994), Bernard and Jensen (1997)). The model also includes other controls for plant size such as working capital and total sales, included in the vector of controls X_{it}.

Given that importing plants are very different from non-importing plants, it is important to control for unobservable time-invariant characteristics that may be causing the plants to select into importing. In the absence of panel data, I've used information on time invariant plant characteristics available in the data to control for this. The three characteristics are: the industry the plant operates in, the region the plant is located in, and the year of initial production of the plant. Based on this information I have included industry-region-age(range) fixed effects in the model. The interactive fixed effects control for unobservable characteristics for groups of plants that belong to the same industry, region and are of the same age. Assuming that plants belonging to this group are similar, one can say that these interactive fixed effects might closely mimic plant fixed effects. Further as a robustness check, I create a pseudo panel, as proposed by Deaton (1985) and carry out the same specification (see 4.2 Robustness Checks) In addition, included are year fixed effects that control for any policy or shock during a particular year that affected all plants identically. Standard errors are robust and have been clustered at the industry (4 digit NIC98) –year level.

Based on the overview from the summary statistics, one would expect β_1 to be positive indicating that importing plants have on average a higher skill composition than non- importing plants. Given that fixed assets is a proxy for exporting status of a plant (Bernard, Jensen, Redding and Schott (2011)), one would expect β_6 to be positive as well. Studies investigating the impact of tariff liberalization on exporters suggest that as tariffs of an industry decline, due to increased competition more productive firms access export markets (Melitz (2003)), and in a developing country context, these firms need to upgrade the quality of their product. Empirical evidence from Mexico (Verhoogen (2008)) shows that there are complementarities between the quality of the product and quality of workers. In such a context, one should expect β_5 to be negative, indicating that with a decline in final goods tariff, plants hire more skilled workers to upgrade the quality of their product relative to non-exporting plants. The coefficient of most interest in this specification is β_2. If imports of intermediate inputs have substitution effects on skilled workers (relative to non-importing plants) as in Amiti and Cameron

(2012), one would expect this to be positive. However, if these imports substitute production workers, or complement skilled workers, one would expect this coefficient to be negative. In general, I would expect β_3 and β_4 to also be negative, so that the relative effects we obtain for importing and exporting plants relative to domestic plants are absolute increases in skill composition. I have no strong hypotheses regarding the behaviour of domestic plants to tariff liberalization.

3.2 Endogeneity of Trade Reform

As highlighted in Section 2.1 there are some concerns relating to the endogeneity of trade reform. Topalova and Khandelwal (2011) suggest that post 1997, there was no clear trade policy and it is likely that the pressure from IMF had abated. There is a possibility that industry lobbying for tariff liberalization in upstream industries may have started playing some role. I address these concerns in three ways. First, I show that input tariff liberalization is not correlated with various industry characteristics. For this I calculate the following variables at the industry level: skill composition, fixed assets, total sales, total employment and working capital. I sequentially regress levels of input tariff on lagged values of these industry-level variables to check if there is any industry level influence in the process of tariff reform. The results are presented in Table 1, and one can see that none of the estimates are significant, allaying major concerns with this identification.

Ahsan (2013), who also uses tariffs from the same period to understand the role of contract enforcement on total factor productivity further shows that there is no significant relationship between input tariff liberalization and lagged industry level total factor productivity and changes in total factor productivity.

Further, in my section on Robustness Checks (4.2), I add interactive industry-year fixed effects to soak up any time varying industry specific influences that may be affecting the relationship I'm examining. Further I use Instrumental Variable approach for GMM estimation suggested by Blundell and Bond (1998), where instruments are created using first and second lagged values of the levels and differences of explanatory variables to avoid any issues of endogeneity.

Table 3: Endogeneity of Trade Reform (Dependent Variable: Input Tariff)

	(1)	(2)	(3)	(4)	(5)
Skill Composition (Lag-1)	0.0104				
	(0.02)				
Log(Fixed Assets (Lag-1))		0.145			
		(0.09)			
Log(Sales (Lag-1))			0.156		
			(0.15)		
Log(Working Capital(Lag-1))				0.112	
				(0.09)	
Log(Total Emp(Lag-1))					-0.0410
					(0.27)
Constant	10.83***	6.065***	12.35***	8.103***	15.06***
	(0.55)	(1.78)	(2.48)	(2.34)	(0.98)
R-sqr	0.841	0.843	0.847	0.842	0.840
N	195	195	193	195	195

Notes: Standard Errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01
Dependent variable is Input Tariff. All variables at the NIC four-digit Industry level.
Explanatory variables in all columns are lagged by one year. All columns include
Year Fixed Effects and Industry (NIC 4 digit) Fixed Effects. Standard Errors are robust.

Table 4: Dependent Variable: Skill Composition (Measured as the percentage of non-production workers in total employment)

	(1)	(2)	(3)	(4)	(5)
Input Tariff * M					-0.447***
					(0.08)
Input Tariff		-0.062	-0.093	-0.085	-0.008
		(0.08)	(0.13)	(0.13)	(0.12)
Import Dummy				3.333***	9.028***
(M)				(0.63)	(1.20)
Final Goods Tariff *					0.000
Log(Fixed Assets)					(0.01)
Final Goods Tariff	-0.004		0.015	0.012	0.010
	(0.02)		(0.04)	(0.04)	(0.21)
Log(Fixed Assets)	1.007***	1.277***	1.276***	1.168***	1.144**
	(0.10)	(0.12)	(0.12)	(0.12)	(0.40)
Constant	38.330***	40.910***	41.024***	45.793***	44.958***
	(2.63)	(4.36)	(4.31)	(4.55)	(5.57)
Controls	Yes	Yes	Yes	Yes	Yes
Industry x Region x Birth Year Range	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
R-sqr	0.023	0.025	0.027	0.032	0.035
N	46837	46837	46837	46837	46837

Notes: Standard Errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01
Dependent variable is Skill Composition. Input and Final Goods Tariff (in percentages) vary at the Industry (Four-digit NIC)-year level. All other variables vary at the plant-year level. Standard errors are robust and clustered at the industry-year level.

4 Estimation Results and Robustness Checks

In this section, I will present the estimation results from the previous model. Because this is the first main finding of this paper, I will show that this result is robust to alternative specifications within this section. The mechanisms stem from this established result, and the same strategy is used for further identification.

4.1 Estimation Results

The estimation results are presented in Table 4, which consists of five columns. One motivation behind presenting these results sequentially is to show that the impact of input tariffs is not being picked by final goods tariffs and vice-versa. Column 1 includes the effect of final goods tariffs along with fixed assets which serve as a proxy for exporting behaviour. There is no significant relationship between changes in final goods tariffs and skill composition. Also, plants that have higher fixed assets, on average have a higher skill composition. The second column, only considers input tariffs without final goods tariffs. Again, there is no significant relationship between input tariffs and skill composition. Introducing both tariffs in Column 3 does not change the significance of their relationship with skill composition allaying concerns of multicollinearity. Column 4 includes the import dummy in the model- the estimate shows that on average importing plants have higher skill composition as compared to non-importing plants by about 3.33 per cent.

The final column includes both interaction terms- final goods tariff interacted with the log of fixed assets, and input tariffs interacted with the import dummy. I find that there is no differential effect of final goods tariff on bigger plants (as measured by the log of fixed assets) relative to smaller plants. Since the log of final goods tariff is considered a proxy for exporting status of a plant, I find no evidence in support of Verhoogen's (2008) result for Mexico, i.e. as tariffs decline and with an increase in competition, exporting plants do not skill upgrade differentially. However, quality of workers may be reflected in wages paid out to them, and I test for this in the mechanisms section.

The interaction term between input tariff and importing status of a plant is however, both negative and significant. The estimate suggests that for a ten percentage point decline in input tariffs importing plants with skill upgrade their workforce by 4.47 per cent relative to

non-importing plants. This increase in skill composition suggests that either relative to non-importing plants, more skilled workers are being hired at importing plants or that more production workers are being displaced at these plants. In addition it could be possible that production workers are being displaced while the employment of skilled workers is increasing at importing plants relative to non-importing plants. Both these channels rule out the Amiti and Cameron (2012) result for Indonesia, where imports of intermediates were substituting away skilled workers at importing plants. I will discuss the mechanisms behind my result in section 5, where I also analyse how imports of these inputs impact total employment, relative wages, and average wages.

4.2 Robustness Checks

In this section, I will show that the result obtained above is robust to alternative specifications. There are various concerns, especially those regarding the lack of panel data, the lack of information on the exporting status of the plant, and the endogeneity of trade reform among others, all of which I address in the following robustness checks.

4.2.1 Share of Imported Intermediate Inputs (Intensive Margin)

Consider Table 5, Columns 1 and 2. It would be interesting to understand whether the results presented in the paper just hold on the extensive margin, i.e. whether plants decide to import or not, or also on the intensive margin, i.e. what share of total inputs by a plant are imported. In this specification, instead of considering the import dummy, I consider the share of expenditure on imported inputs in total expenditure on inputs by plants. This includes plants that do not import any intermediate inputs. The interaction term between input tariffs and the share of imported inputs continues to be negative and significant, suggesting relative skill upgrading by importing plants. In the second column, I run the same specification this time considering only importing plants in my sample in order to examine whether there any effects on the intensive margin. I find that in this specification, the interaction term while still negative, loses its significance. This suggests that the adjustment in skill composition due to a decline in input tariff, is mainly coming from plants that switch to becoming importers, i.e. the extensive margin is more important. One possible explanation is that there could be rigidities in

the labour market in the form of worker contracts. A plant therefore, instead of continuously skill upgrading may decide to change the structure of the organization especially in terms of employment in the year it starts importing in anticipation of the required adjustments.

4.2.2 Exporting Status (Worker Productivity)

In Table 5, Column 3, I consider worker-productivity as an alternative proxy for exporting status than simply the log of fixed assets. Empirical evidence suggests that it is the more productive plants that are exporters (Bernard and Jensen (1997), Bernard and Wagner (1997), Wagner (2007)). While there is strong evidence that bigger firms are more productive, there could be concerns that size does not imply productivity. Therefore, I replace the log of fixed assets with worker productivity. I find that this change does not alter my results. The interaction term between final goods tariff and worker productivity continues to be insignificant, while the interaction term between the import dummy and input tariffs is still negative and significant.

4.2.3 Lagged Responses

Lagged responses to changes in input tariffs are considered in Table 5, Column 4. Given frictions in the labour market, one might argue that plants may not be able to immediately adjust their workforce. Also, there may be delays in response to a decline in input tariff and switching to importing (for instance, it may cause the plant to obtain the necessary licenses or other administrative hurdles). In this specification, input tariffs, final goods tariff, fixed assets and the vector of controls have been lagged by one year to account for lagged adjustments in skill composition. The result of the relative increase in skill composition by importing plants relative to non-importing plants continues to be significant, although there is a slight decline in magnitude.

4.2.4 Industry-Year Fixed Effects

Estimates from this model are presented in Table 5, Column 5. In order to ensure that the interaction term between importing status of a plant and the decline in input tariffs is not pick-

ing up any policy changes or shocks that are affecting industries differentially, the interactive industry-year fixed effects are introduced to the baseline specification. These are accompanied by region-range of birth year fixed effects to control for the unobservable characteristics of the group of plants that belong to the same age group and same region. As a result of this specification, final goods tariffs and input tariffs, both of which vary across industries over time, are not identified. This robustness check also serves to purge the effect of any particular industry's influence over the input tariff of an industry for any particular year. This is another way in which I address the concern regarding the endogeneity of trade reform in my identification strategy. The coefficient on the interaction term between import status and input tariff continues to be negative, confirming my hypothesis.

4.2.5 Blundell and Bond (1998) GMM Estimates (Endogeneity of Trade Reform and Lack of Panel Data)

Estimates using Blundell and Bond (1998) Generalized Method of Moments are presented in Table 5, Column 6. This is another method which helps in overcoming the concern regarding the endogeneity of trade reform and that of importing behaviour. Following Blundell and Bond (1998), I use the Generalized Method of Moments framework wherein first and second lags of both the levels and differences of explanatory variables are used as instruments to estimate the model. These instruments are orthogonal to the unobserved time invariant characteristics of plants, so they overcome the problem of the lack of panel data. The GMM system method is used over GMM difference to avoid lack of observations due to unavailability of panel (Roodman (2006)). I find that the interaction term between the importing status of a plant and skill composition continues to be negative and significant.

Table 5: Robustness Checks (Dependent Variable: Skill Composition)

	(1) Share of Imported Inputs	(2) Share of Imported Inputs (M=1)	(3) Worker Productivity	(4) Lagged Values	(5) Industry Year-Fixed Effects	(6) GMM-IV Blundell and Bond
Input Tariff$_{jt}$ * (M or Share)$_{it}$	-0.975***	-0.009	-0.384***	-0.284***	-0.502***	-0.430***
	(0.24)	(0.19)	(0.08)	(0.06)	(0.10)	(0.70)
Input Tariff$_{jt}$	-0.037	-0.119	-0.030	0.062	(-)	-0.406***
	(0.12)	(0.14)	(0.14)	(0.04)		(0.12)
(M or Share)$_{it}$	17.170***	2.081	8.970***	5.404***	9.526***	6.492***
	(2.73)	(2.35)	(1.16)	(0.74)	(1.29)	(1.16)
Final Goods Tariff$_{jt}$ * Proxy for X_{it}	-0.005	0.002	-0.010	0.009	0.013	-0.251***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.15)	(0.01)
Final Goods Tariff$_{jt}$	0.098	-0.021	0.159	-0.140	(-)	0.641***
	(0.21)	(0.20)	(0.21)	(0.10)		(0.14)
Proxy X_{it}	1.375***	1.069**	5.700***	-0.085	0.837	2.727***
	(0.41)	(0.38)	(0.69)	(0.19)	(0.48)	(0.36
Constant$_{it}$	39.626***	37.004***	13.457*	39.845***	41.325***	25.562***
	(5.76)	(6.51)	(6.57)	(3.04)	(4.19)	(4.90)
IND x REG x Birth YR FE	Yes	Yes	Yes	Yes	No	No
REG x Birth YR FE	No	No	No	No	Yes	No
IND x YR FE	No	No	No	No	Yes	No
R-sqr	0.032	0.011	0.125	0.012	0.021	(-)
N	46837	10397	46628	39360	46837	46839

Notes: Standard Errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01
All columns include Controls. Year Fixed Effects are included in all columns except Column 5.

4.2.6 Cohort Analysis

Estimates from a pseudo panel analysis are presented in Table 6, and it addresses the concern of lack of panel data which disallows me to specifically control for plant fixed effects. Following Deaton (1985), who grouped households by the age of the oldest male earning member to create synthetic panels from repeated cross-sections, I create cohorts by using three time invariant variables: the year of birth of plants (by creating five broad ranges for these), the region, and the industry (two digit NIC98) to which they belong. The two digit industry classification is used to allow for more observations per cohort, so that the cohort mean is representative. The variables that are now reported are in terms of the means of each cohort, as opposed to observations pertaining to individual plants. The variable 'm' now denotes the share of plants in the cohort that import any input. The input tariff and final goods tariff are now at the two digit NIC 98 level as well. The specification includes year and cohort fixed effects to control for all common unobservable characteristics of plants belonging to this group. Standard errors are clustered at the industry (two digit NIC)-year level. Standard errors were also clustered at the cohort level in an alternative specification, and the results were robust.

The results are presented in Table 6. The coefficient on the share of importing plants in the cohort is positive and significant, suggesting that the higher the share of importing plants in a cohort, the higher is the skill composition. When the interaction term is included, one can see that the coefficient on it is negative and significant, again suggesting that cohorts with a higher share of importing plants skill upgrade more than non-importing plants in response to input tariff liberalization. For a 10 percentage point decline in tariffs, a cohort that is comprised of importers only skill upgrades by 2.1 per cent, whereas at the mean share of importing plants this effect is 0.7 per cent. There is no significant effect of the final goods tariffs on skill composition as in the repeated cross-section.

5 Mechanisms

This section is divided into three main parts. In the first sub-section, I study the impact of trade liberalization on the employment of production workers, non-production workers and total employment to understand how importing plants skill upgrade during tariff liberalization. Further I show how tariff liberalization impacts average and relative wages of workers

Table 6: Robustness Check: Cohort Analysis (Dependent Variable: Average Skill Composition per Cohort)

	(1)	(2)	(3)	(4)
Input Tariff * m			-0.157**	-0.154**
			(0.07)	(0.07)
Input Tariff	-0.087**	-0.038	-0.005	-0.005
	(0.04)	(0.04)	(0.04)	(0.04)
Share of Importing Plants (m)			8.718***	8.620***
			(2.22)	(2.24)
Final Goods Tariff * Log (Fixed Assets)				-0.001
				(0.00)
Final Goods Tariff		0.024***	0.021**	0.033
		(0.01	(0.01)	(0.04)
Log (Fixed Assets)	0.582***	0.590***	0.536***	0.556***
	(0.13)	(0.13	(0.13)	(0.013)
Constant	22.408***	19.562***	20.486***	20.436***
	(4.90)	(4.86)	(4.93)	(4.91)
Controls	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Cohort Fixed Effects	Yes	Yes	Yes	Yes
R-sqr	0.020	0.021	0.026	0.026
N	10155	10155	10155	10155

Notes: Standard Errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01
Dependent variable is mean percentage of Skill Composition per cohort. Input and Final Goods Tariff (in percentages) vary at the Industry (Four-digit NIC)-year level.
All other variables vary at the cohort-year level. All variables are reported as the mean of the cohort. Standard errors are robust.

to compare my results to previous literature. In the second sub-section, I delve into the relationship between the nature of imports of intermediate inputs and worker-composition. The final sub-section investigates whether there is any differential impact of tariff liberalization on plants that face import competition as compared with plants that do not.

5.1 Employment and Wages

Having established that skill composition of plants increases as a result of input tariff liberalization, this section moves on to investigating the mechanism behind this result. Skill composition could be increasing as a result of an increase in the employment of skilled workers, a decline in employment of production workers or both[1]. One possible mechanism could be a complementarity between the quality of intermediate inputs and quality of workers, causing the plant to hire more skilled workers as imports of intermediate inputs increase. This is simply extending the Csillag and Koren (2011) result to intermediate inputs. On the contrary, the adjustment might be taking place via a decline in demand for production workers. Imports of inputs embodying cheap production labour may be substituting away production workers at importing plants.

In order to determine what mechanism is at play, I investigate how employment of production workers and employment of non-production workers respond to both final goods and input tariff liberalization. The results are presented in Table 7[2], where Column 1 reiterates the result obtained for Skill Composition. Column 2 considers the employment of production workers. The interaction term between the import dummy and input tariff is positive and significant, indicating that with input tariff liberalization, employment of production workers decreases significantly at importing plants relative to non-importing plants. This suggests that a strong substitution effect between imports of intermediate inputs and production workers is operating at these plants. Employment of skilled workers in Column 3, on the other hand, is not affected by either input tariff liberalization or final goods tariff liberalization.

The relative decline in production workers at importing plants due to input tariff liberalization is also reflected in total employment (Column 4). Again, the interaction term between the import dummy and input tariffs is positive and significant; indicating that total employ-

[1] These effects are all relative to non-importing plants, and as a response to input tariff liberalization.

[2] In these estimation tables, employment, wage and relative wages are presented in logs.

ment is significantly declining with input tariff liberalization, at importing plants relative to non-importing plants. The fact that importing plants employ 42.57 per cent of the workers in my sample makes this economically significant. In fact, this decline in employment at importing plants may have a role to play in the absolute decline in employment observed in aggregate statistics for the Indian manufacturing sector during the same period.

Next, I move on to investigate how tariff liberalization impacts average and relative wages (Columns 5 and 6). I find that with input tariff liberalization, importing plants pay higher average wages to their workers as compared to non-importing plants. This is analogous to what Amiti and Davis (2012) find for Indonesia, however, the fact that I find differential increases in skill composition by importing plants play a very important role in explaining this result. I do not find any significant impact of final goods tariff liberalization on average wages. Krishna, Poole and Senses (2012), do find that in Brazil, exporting plants pay out higher average wages relative to non-exporting plants in response to trade liberalization. However, when they control for worker characteristics and account for endogenous worker mobility, they find that these effects disappear.

Contrary to previous literature (Amiti and Cameron (2012), Csillag and Koren (2011)), I do not find any impact of input tariff liberalization on the wage-skill premium of importing plants. Unlike Verhoogen (2008) I do not find any impact of final goods tariff liberalization on wage-skill premium either. While I don't find any of these effects in aggregate, the next subsection which considers the relationship between the nature of inputs and labour outcomes reveals that wage premium does respond to plants importing inputs that are cheaper than domestic counterparts. This analysis highlights the importance of considering both wage and employment outcomes to understand the linkages between trade liberalization and labour.

Amiti and Cameron (2012) show that intermediate inputs are relatively skill-intensive in production for Indonesia. They argue that liberalizing the imports of these inputs causes plants that previously engaged in in-house production of the same to switch to importing. This causes the relative demand for skilled workers at importing plants to decline pushing down the wage-skill premium. Like Amiti and Cameron (2012) I too find that plants that produce intermediate inputs have on average a higher skill composition than other plants. The displacement of production workers at importing plants becomes puzzling. It becomes important for me to understand two main questions. First, what is it about these inputs that could be causing a displacement of production workers? This leads me to my next analysis

where I decompose the effects of imported inputs based on the motivation behind importing. Secondly, how do plants that engage in in-house production of intermediate inputs adjust their work-force post liberalization? More importantly, is there any differential adjustment in the work-force by plants that previously purchased domestic intermediate inputs and switch to importing post tariff declines? I investigate these questions in the third subsection.

5.2 The Nature of Imported Intermediate Inputs

In this section I investigate whether the nature of inputs matters for worker- composition and whether decomposition along these lines can help explain the previous results. Plants import intermediate inputs either because they are either cheaper than their domestic counterparts (so they may increase the scale of production), possess superior quality (Amiti and Konings (2007), Kugler and Verhoogen (2009), Halpern et al. (2011)) or are simply unavailable at home (Goldberg et al. (2010b)). The impact of each of these categories of imports on skill composition (or any other dependent variable) will consequently be called the "scale effect", "quality effect" and "variety effect".

I use information on the prices and product codes (five digit AISSC) of both imported and domestic intermediate inputs to decompose the import dummy into the 'quality' dummy, 'scale' dummy, 'equal price' dummy and 'variety' dummy. Following Kugler and Verhoogen (2009), if the price of an imported input is greater than that of the domestic input within the five digit product sub-category, I assume that the motive for importing is the perceived higher quality of the foreign input. The 'equal price' effect can be classified into either the 'quality effect' or the 'variety effect', but I'll treat is as separate for the analysis. I decompose the import dummy in the following manner:

Table 7: Mechanisms: Employment and Wages

	(1) Skill Composition (Percentage)	(2) Log (Production Workers)	(3) Log (Skilled Workers)	(4) Log (Total Employment)	(5) Log (Average Wages)	(6) Log (Wage-Skill Premium)
Input Tariff$_{jt}$ * M_{it}	-0.447***	0.022***	-0.006	0.028***	-0.019***	-0.000
	(0.08)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
Input Tariff$_{jt}$	-0.008	-0.002	0.000	-0.004	0.014**	0.001
	(0.12)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)
M_{it}	9.028***	-0.104	0.36***	-0.243**	0.363***	0.016
	(1.20)	(0.07)	(0.05)	(0.09)	(0.04)	(0.03)
Final Goods Tariff$_{jt}$ * Log(Fixed Assets$_{it}$)	0.000	-0.000	0.000	-0.000	0.001	-0.000
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Final Goods Tariff$_{jt}$	0.010	0.005	-0.004	0.008	-0.011	0.007*
	(0.21)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Log(Fixed Assets$_{it}$)	1.144**	0.178***	0.220***	0.173***	0.062***	0.042***
	(0.40)	(0.02)	(0.02)	(0.03)	(0.02)	(0.01
Constant$_{it}$	44.958***	-4.551***	-5.409***	-5.142***	7.570***	-0.257***
	(5.57)	(0.28)	(0.26)	(0.32)	(0.27)	(0.11)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
IND x REG x Birth YR Range FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-sqr	0.035	0.621	0.637	0.563	0.385	0.032
N	46837	46837	46830	46627	46785	46592

Notes: Standard Errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01
Standard errors are robust and clustered at the industry-year level.

$$
M_{it}\begin{cases}
Quality_{it} & = & 1 & \text{If Average } P_{fip} > \text{Average } P_{dip} \\
 & = & 0 & \text{otherwise} \\
Scale_{it} & = & 1 & \text{If Average } P_{fip} < \text{Average } P_{dip} \\
 & = & 0 & \text{otherwise} \\
EqualPrice_{it} & = & 1 & \text{If Average } P_{fip} = \text{Average } P_{dip} \\
 & = & 0 & \text{otherwise} \\
Variety_{it} & = & 1 & \text{If there is no domestic equivalent of imported input} \\
 & = & 0 & \text{otherwise}
\end{cases}
$$

where 'Average P_{fip}' is the price on average of the foreign input, and 'Average P_{dip}' is the price on average of the domestic input, for each five digit product category. Now instead of one import dummy, I have four dummies based on the import subcategories above. Model 1 now transforms to:

$$
\begin{aligned}
S_{it} = \; & \alpha + \beta_1 Quality_{it} + \beta_2 Scale_{it} + \beta_3 Variety_{it} + \\
& \beta_4 \textit{Equal Price}_{it} + \beta_5 Quality_{it} * \textit{input tariff}_{jt} + \beta_6 Scale_{it} * \textit{input tariff}_{jt} + \\
& \beta_7 Variety_{it} * \textit{input tariff}_{jt} + \beta_8 \textit{Equal Price}_{it} * \textit{input tariff}_{jt} + \\
& \beta_9 \textit{input tariff}_{jt} + \beta_{10} \textit{final goods tariff}_{jt} + \beta_{11} \textit{final goods tariff}_{jt} * \textit{fixed assets}_{it} + \\
& \beta_{12} * \textit{fixed assets}_{it} + \beta_{13} X_{it} + \theta_{jrb} + \theta_t + \epsilon_{it} \qquad (2)
\end{aligned}
$$

If complementarities exist between the "quality" of imports of intermediate inputs and "quality" (here measured as skill) of workers as in Csillag and Koren (2011), I would expect β_5 to be negative. If cheaper inputs (or inputs of a different 'variety') embody cheap production labour, one should expect β_6 to be negative. A similar logic can be extended to β_7 and β_8. I test for these quality, scale, variety and equal price effects on employment of production workers and skilled workers, total employment and relative wages in addition to skill composition.

Estimation results are presented in Table 8. Column 1 considers skill composition as the dependent variable and reveals that as input tariffs decline, skill composition differentially increases for importing plants relative to non-importing plants for all categories of imports.

The employment of production workers is presented in Column 2, and I find that with input tariff liberalization the employment of production workers declines at importing plants relative to non-importing plants for all kinds of inputs. Similarly, there is no impact of input tariff liberalization on the employment of skilled workers across all categories of inputs (Column 3). The results from Column 2 and 3 are reflected in total employment in Column 4, which declines differentially for importing plants for all categories.

While I find no differential impact in terms of the direction of the effects across imported input categories for plant-level employment variables, there is a difference in the relative magnitude of these effects. For instance, the strongest displacement effect for production workers comes from the "scale effect" i.e. it is the cheaper imports that are having the biggest displacement effects for workers. Also, while I find no significant effects, the coefficient on skilled employment is negative for imports of a higher quality and different variety, while it is positive for the scale effect.

The differences in the relative magnitudes of displacement of production workers show up in the wage-skill premium variable in Column 5. This is negative and significant for plants importing cheaper inputs which experience the biggest displacement effects for production workers. As a result of this large displacement, there is a relative decline in the wages paid out to production workers. The wage skill premium for these importing plants (relative to non-importing plants) therefore, increases in response to input tariff liberalization.

This analysis reveals that displacement of production workers occurs at importing plants relative to non-importing plants during input tariff liberalization, regardless of the nature of inputs. The cheaper inputs however, cause the biggest displacement effects. The nature of inputs matters only for these relative effects in magnitude.

5.3 Import Competition

To provide further insight into the result obtained in 5.1, I test for whether plants competing in production of typically imported intermediate inputs adjust differently from those who do not. Mainly, I'm testing for whether the adjustment comes largely from plants that switch from in-house production of intermediate inputs to importing them. It is possible that there is also adjustment from plants that previously purchased imports from domestic producers switching to importing post tariff liberalization. Further it is interesting to see how competition of

Table 8: Mechanisms: Nature of Inputs

	(1) Skill Composition (Percentage)	(2) Log (Production Workers)	(3) Log (Skilled Workers)	(4) Log (Total Employment)	(5) Log (Wage-Skill Premium)
Input Tariff * Quality	-0.399***	0.026***	-0.003	0.020***	0.005
	(0.10)	(0.01)	(0.01)	(0.01)	(0.00)
Input Tariff * Scale	-0.681***	0.067***	0.004	0.058***	-0.011*
	(0.18)	(0.02)	(0.01)	(0.01)	(0.01)
Input Tariff * Variety	-0.641***	0.039***	-0.004	0.029***	0.002
	(0.13)	(0.01)	(0.01)	(0.01)	(0.00)
Input Tariff * Equal Price	-1.010***	0.036**	-0.019*	0.014	0.010
	(0.24)	(0.02)	(0.01)	(0.01)	(0.01)
Input Tariff	0.004	-0.005	-0.000	0.003	0.001
	(0.12)	(0.00)	(0.01)	(0.01)	(0.00)
Quality	7.119***	-0.180**	0.306****	-0.076	-0.031***
	(1.30)	(0.09)	(0.08)	(0.08)	(0.04)
Scale	10.501***	-0.631***	0.217***	-0.485***	0.112
	(2.22)	(0.17)	(0.07)	(0.15)	(0.07)
Variety	12.660***	-0.510**	0.267**	-0.307**	0.002
	(1.78)	(0.17)	(0.11)	(0.15)	(0.05)
Equal Price	17.197***	-0.338**	0.601***	0.007	-0.069
	(2.54)	(0.17)	(0.10)	(0.14)	(0.06)
Final Goods Tariff * Log(Fixed Assets)	-0.000	-0.000	0.000	-0.000	-0.000
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Final Goods Tariff	0.030	0.006	-0.004	0.003	0.007**
	(0.21)	(0.01)	(0.01)	(0.01)	(0.00)
Log(Fixed Assets)	1.177**	0.172***	0.220***	0.178***	0.042***
	(0.40)	(0.02)	(0.02)	(0.02)	(0.01)
Constant	44.958***	-4.551***	-5.142***	-5.409***	7.570***
	(5.57)	(0.28)	(0.32)	(0.26)	(0.27)
R-sqr	0.037	0.564	0.637	0.622	0.033
N	46837	46622	46831	46830	46593

Notes: Standard Errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01
All columns include Year Fixed Effects, Interactive Industry-Region-Age (range) Fixed Effects and Controls. Dependent variables mentioned in each column heading.
Input and Final Goods Tariff (in percentages) vary at the Industry (4-digit NIC)-year level. All other variables vary at the plant year level. Standard errors are robust and clustered at the industry-year level.

these inputs impact domestic plants that do not engage in importing.

I divide the sample of plants into four main categories based on two distinctions- whether they import intermediate inputs (M) or not (D) and whether they produce and therefore compete with typically imported inputs (C) or not (NC). The four categories are:

$$\text{All Plants} \begin{cases} MC_{it} = 1 & \text{If a plant imports an intermediate input it also produces i.e. } M \cap C \\ \quad = 0 & \text{otherwise} \\ MNC_{it} = 1 & \text{If a plant imports intermediate inputs it does not produce i.e. } M \cap NC \\ \quad = 0 & \text{otherwise} \\ DC_{it} = 1 & \text{If a domestic plant faces competition from imports of inputs i.e. } D \cap C \\ \quad = 0 & \text{otherwise} \\ DNC_{it} = 1 & \text{If a domestic plant if unaffected by imports of inputs i.e. } D \cap NC \\ \quad = 0 & \text{otherwise} \end{cases}$$

In this subsection, l I test for whether plants belonging to categories MC, MNC and DC respond to input tariff liberalization differently from domestic plants that do not compete. The following specification considers skill composition:

$$\begin{aligned} S_{it} = {} & \alpha + \beta_1 MC_{it} + \beta_2 MNC_{it} + \beta_3 DC_{it} + \beta_4 MC_{it} * \textit{input tariff}_{jt} + \\ & \beta_5 MNC_{it} * \textit{input tariff}_{jt} + \beta_6 DC_{it} * \textit{input tariff}_{jt} + \beta_7 \textit{input tariff}_{jt} + \\ & \beta_8 \textit{final goods tariff}_{jt} + \beta_9 \textit{final goods tariff}_{jt} * \textit{fixed assets}_{it} + \\ & \beta_{10} * \textit{fixed assets}_{it} + \beta_{11} X_{it} + \theta_{jrb} + \theta_t + \epsilon_{it} \end{aligned} \tag{3}$$

Estimation results are presented in Table 9. I find that plants that engage in in-house production of domestic intermediate inputs experience a differential increase in skill composition (via a decline in employment of production workers) relative to non- competing domestic plants in response to input tariff liberalization regardless of whether they engage in in-house production of the imported intermediate input or not. The magnitude of displacement however, is much higher for importing plants that do engage in some in-house production of the imported inputs. Again, total employment declines differentially for both kinds of plants, but

there is no response on the wage skill premium.

It is interesting to compare the effect of liberalization of both these categories of importing plants with domestic plants that face competition from imported inputs. Relative to non-competing non-importing domestic plants, domestic plants that face competition experience a decline in employment of both production and non- production workers in response to input tariff liberalization. This is presumably from a decline in the derived demand for these workers, as imports of intermediate inputs reduce the demand for domestic counterparts. The fact that importing plants that also engage in in-house production, do not experience a relative decline in skilled workers, is an interesting result. It indicates that skilled workers are required at importing plants, despite the fact that the production of inputs that is labour-intensive has declined. This relationship is therefore, suggestive of a complementarity between imports of inputs and skill of workers. Here the term 'complementarity' does not suggest that and increase in imports of inputs leads to a greater employment of skilled workers, but that skilled workers are essential or rather indispensable as a plant chooses to adopt importing inputs as a strategy.

This analysis is also essential in showing that adjustment in worker-composition comes not only from plants that switch to importing from in-house production of intermediates, but also from plants that previously used domestic inputs but switch to importing post liberalization. Furthermore, trade liberalization also leads to a differential decline in total employment at domestic plants that compete with the production of imports of intermediates, relative to domestic plants that face no import competition.

6 Conclusion

In this paper, using plant level data from India during a period of tariff liberalization, I show three important results relating to the relationship between imports of intermediate inputs and plant-level employment. First, as input tariffs decline, importing plants experience a differential increase in skill composition relative to non- importing plants. This occurs via a relative displacement of production workers which further leads to a decline in total employment at importing plants. Consequently, average wages at importing plants increases relative to non-importing plants. The latter is a result that has been established in previous studies

Table 9: Mechanisms: Import Competition

	(1) Skill Composition (Percentage)	(2) Log (Production Workers)	(3) Log (Skilled Workers)	(4) Log (Total Employment)	(5) Log (Wage-Skill Premium)
MC	13.122***	-0.567***	0.371***	-0.369**	0.045
	(2.48)	(0.18)	(0.07)	(0.15)	(0.04)
MNC	8.968***	-0.363**	0.214**	-0.236**	-0.007
	(1.62)	(0.13)	(0.09)	(0.12)	(0.05)
DC	2.671	-0.283**	-0.079	-0.248***	0.019
	(1.58)	(0.11)	(0.06)	(0.09)	(0.03)
Input Tariff * MC	-0.616***	0.046***	0.005	0.037**	-0.003
	(0.18)	(0.01)	(0.01)	(0.01)	(0.00)
Input Tariff * MNC	-0.420***	0.035***	0.006	0.030***	0.001
	(0.10)	(0.01)	(0.01)	(0.01)	(0.00)
Input Tariff * DC	-0.018	0.013**	0.010*	0.012**	-0.002
	(0.09)	(0.01)	(0.01)	(0.00)	(0.00)
Input Tariff	0.295	-0.052***	-0.027**	-0.053***	0.017
	(0.302)	(0.018)	(0.013)	(0.016)	(0.011)
Final Goods Tariff	0.023	0.006	-0.003	0.004	0.007**
	(0.20)	(0.01)	(0.01)	(0.01)	(0.00)
Final Goods Tariff * Log(Fixed Assets)	0.001	-0.001	0.000	-0.000	-0.000
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
Log(Fixed Assets)	1.081**	0.179***	0.221***	0.183***	0.041***
	(0.39)	(0.02)	(0.02)	(0.02)	(0.01)
Constant	44.600***	-5.146***	-5.214***	-4.551***	-0.245*
	(5.42)	(0.32)	(0.26)	(0.28)	(0.11)
R-sqr	0.039	0.564	0.637	0.622	0.032
N	46837	46622	46831	46830	46593

Notes: Standard Errors in parentheses * p < 0.10, ** p < 0.05, *** p < 0.01
All columns include Year Fixed Effects, Interactive Industry-Region-Age (range) Fixed Effects and Controls. Dependent variables mentioned in each column heading.
Input and Final Goods Tariff (in percentages) vary at the Industry (4-digit NIC)-year level. All other variables vary at the plant year level. Standard errors are robust and clustered at the industry-year level.

(Amiti and Davis (2012)), and this paper contributes to this literature by showing that changes in worker-composition play an important role in shifts in average wages at importing plants.

Secondly, after decomposing the effects of imported inputs based on their product codes and price, I show that it is the imports of cheaper (compared to domestic counterparts) inputs that cause the biggest displacement effects on production workers at importing plants relative to non-importing plants. Finally, I show that the effect of import competition on employment is differential across importing and non-importing plants. While domestic plants that face competition from imports experience a displacement of both skilled and unskilled workers post liberalization, plants that switch to importing by reducing some in-house production of intermediates only experience a displacement of unskilled workers. This result suggests that importing plants choose to retain their skilled workers because of a complementarity between imports of inputs and skills (reflective of know-how) of workers.

The contribution of this paper is in two broad areas. Firstly, it provides a complete picture of the impact of imported inputs on labour by showing how input tariff liberalization impacts both the employment and wages of skilled and unskilled workers. Secondly, it provides a better understanding of the linkages between imported inputs and labour by studying the impact of different kinds of imports on various labour outcomes, and also by providing an insight into the differential impact of input tariff liberalization on plants facing import competition versus plants that do not.

The main result of this paper i.e. the displacement of production workers at importing plants due to input tariff liberalization stands in contrast to what is suggested by evidence in other studies for other developing countries that mainly consider wage outcomes (Amiti and Cameron (2012), Csillag and Koren (2011)). This creates a concern about the generalization of results from country-specific studies, and warrants the need for a detailed approach towards the understanding of the relationship between imported inputs and workers for each country. The decomposition of the effects of inputs and understanding the differential effects based on import competition as applied in the paper, can be two ways of moving in this direction.

Further, in India's context, it provides a contributing explanation to the recent trend of "job-less growth" in the manufacturing sector. An important policy implication that emerges from this is that while the manufacturing sector gains in terms of productivity and efficiency from imported intermediate inputs, there needs to be a greater thrust towards providing skills

to production workers in the workforce. This is important both to ensure that the welfare of production workers is not worsened over time, and to be able to capitalize on the productivity gains from imported intermediate inputs.

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