Productivity linkages between services and manufacturing: Firm-level evidence from developing countries

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Abstract: This paper uses firm-level data from 119 developing countries to show that services sector productivity is positively associated with manufacturing productivity. Moreover, the link between productivity in services and manufacturing is particularly strong for manufacturing firms that are more intensive in their use of services inputs. At the mean level of services input use in the dataset, a 10% improvement in services productivity is associated with a 0.6% improvement in manufacturing productivity.

JEL Codes: L60; L80; O14.

Keywords: Services; Manufacturing; Productivity linkages; Firm-level data; Developing countries.

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1 Introduction

Two recent papers have highlighted the linkages between services sector liberalization and manufacturing productivity. Arnold et al. (2011) use firm-level data for the Czech Republic to show that sector-level measures of services liberalization are positively associated with manufacturing productivity. Arnold et al. (2012) apply a similar approach, and uncover similar findings, using Indian data. Both papers focus on services liberalization, but an intermediate step in this mechanism must be that liberalization boosts service sector productivity, which in turn boosts manufacturing productivity because services are important inputs into many manufacturing processes.

This paper builds on and extends these two recent contributions by examining the productivity linkage mechanism in greater detail. The approach is to calculate average measures of firm-level services productivity at the level of sub-national regions, and then to relate these data to firm-level productivity in manufacturing sectors. Results show that the linkage between the two variables is strong and robust to the addition of a variety of firm-level controls. Moreover, the data also show that the linkage between services productivity and manufacturing productivity is stronger for firms that use services inputs more intensively. This finding provides support for the view that the effect identified in the regressions is indeed a direct linkage between productivity in the two sectors, and is not driven by some other factor. In the final specification and at the average rate of services input intensity, a 10% increase in regional services productivity is associated with a 0.6% increase in manufacturing productivity.

The paper proceeds as follows. The next section discusses the dataset and provides some preliminary evidence linking productivity in services and manufacturing. Section 3 presents the econometric model, discusses results, and undertakes robustness checks. The final section concludes.

2 Data and Preliminary Analysis

This paper uses firm-level data from the World Bank's Enterprise Surveys project (Table 1). That project covers over 130,000 firms in 135 countries. I use the current standardized version of the dataset, which includes data from firms in 119 countries over the period 2006-2011. No high income countries are included, so the dataset is limited to developing countries only. After cleaning to remove unreliable observations, it covers a total of 58,875 firms in manufacturing and services. Firm activities are identified at the ISIC 2 digit level, with 23 manufacturing sectors and 26 services sectors.

Each survey covers a cross-section of firms for a single year of data in a given country, with firms selected by stratified random sampling. Some countries are surveyed over multiple years, but it is impossible to determine whether or not individual firms are included multiple times due to the way in which the World Bank assigns anonymous identifiers to firms in each survey. It is therefore not possible to observe entry or exit, or to estimate TFP using techniques that require the availability of true panel data at the firm-level. Productivity is therefore measured as labor productivity (sales per employee).

The hypothesis I am testing is that services sector productivity is positively associated with manufacturing productivity due to the fact that manufacturing firms use services as inputs. The dependent variable is therefore labor productivity (sales per worker) in manufacturing sectors, measured at the firm level. To construct the main independent variable, I calculate firm-level labor productivity in services sectors, and then take the average by sub-national region. The relationship I am interested in is therefore between a given manufacturing firm's productivity and the average productivity of services firms in the same sub-national region. This approach implies a focus on local linkages, and allows the inclusion of country-sector-year fixed effects in the regressions to control for outside influences.

The second independent variable of interest is a measure of the intensity with which manufacturing firms use services inputs. Services intensity is defined as the percentage of total costs accounted for by electricity, communications, transport, and water. I expect to observe a positive interaction effect, which would indicate that the link between services productivity and manufacturing productivity is stronger for firms that use services inputs relatively intensively. A positive and statistically significant interaction term would provide a strong indication that the effect identified is indeed a productivity linkage due to the input relationship, and not an artifact of some omitted factor.

Figure 1 presents the basic relation under test. It shows the relationship between productivity in services and manufacturing, as defined above. In each case, productivity is first regressed on a full set of country-sector-year fixed effects, so the figure represents the correlation between the two sets of residuals. The line of best fit is upward sloping, which provides some preliminary evidence of a positive association between services productivity and manufacturing productivity.

3 Econometric Model and Results

I use OLS to estimate an econometric model of the following form:

$$(1)\ \log\left(Labor\ Productivity_{fcsrt}\right) = b_1 \log(Services\ Productivity_{csrt}) + b_2 \log(Services\ Productivity_{csrt}) * Services\ \%\ Inputs_{fcsrt} + b_3 Services\ \%\ Inputs_{fcsrt} + \sum_i b_i X^i_{fcsrt} + \sum_j d_{cst} + e_{fcsrt}$$

where f indexes firms, c indexes countries, r indexes sub-national regions, and t indexes time. Labor productivity in manufacturing and services is measured as described above. The X variables refer to firm-level controls. The first group includes size (number of employees), capital intensity, and dummy

variables for different types of firm organization. The second group includes dummies for exporters and foreign-owned firms. The third group includes data on capacity utilization and the top manager's number of years of experience in the sector as proxies for management competence. Finally, the d terms refer to a full set of country-sector-year fixed effects.

Estimation results are in Table 2. Column 1 is a simple bivariate regression, which shows that the association between services productivity and manufacturing productivity is positive and statistically significant at the 1% level. The second column introduces the interaction term with services intensity in input use. The coefficient on services productivity remains positive and 1% statistically significant, as expected. The interaction term also has a positive coefficient, and it is statistically significant at the 5% level. The sign and significance of the interaction term confirm that the association that the regression is picking up between services productivity and manufacturing productivity results from the use of services inputs in manufacturing, in line with the mechanism put forward at the outset of the paper.

The remaining columns of Table 2 progressively introduce firm-level control variables. Column 3 includes size (number of employees) and capital intensity, both of which have positively signed and statistically significant coefficients, as expected. The dummy variables for sole proprietorships and partnerships have negative and statistically significant coefficients, which indicates that these forms of firm organization tend to have lower productivity than publicly listed firms (the omitted category). Most importantly, the addition of these control variables does not change the core result on productivity: the association between services productivity and manufacturing productivity remains positive and 1% statistically significant, and the interaction term is positive and 10% statistically significant. However, addition of the control variables causes the magnitude of the two coefficients of interest to drop substantially.

Column 4 adds two more firm-level controls to account for internationalization. As expected, exporters and foreign-owned firms tend to be more productive. Both effects are statistically significant at the 1% level. The signs, statistical significance, and magnitudes of the two variables of interest remain as in column 3.

Finally, column 5 adds two additional variables to account for management competence, namely the capacity utilization rate, and the number of years' experience of the top manager. In line with expectations, the coefficient on the former variable is positive and 1% statistically significant. However, the coefficient on the latter is positive, as expected, but not statistically significant. The coefficient on services productivity remains positive and 1% statistically significant, and the input intensity interaction term is now 5% statistically significant.

Taking the results in Table 2 column 5 as a benchmark, I can use data on input intensity to give an indication of the quantitative impact of services productivity on manufacturing productivity. The average proportion of total costs accounted for by services is 12%. Plugging that figure into the coefficients from the regression suggests that a 10% improvement in services productivity is associated with an increase in manufacturing productivity of 0.6%. Although relatively small, this effect is nonetheless economically and statistically significant.

4 Conclusion

This paper has shown that services productivity is positively associated with manufacturing productivity, and that the linkage is stronger for firms that use services inputs more intensively. Results are robust to the addition of a range of firm-level control variables, and the sign and statistical significance of the interaction term confirm that the relationship identified is due to the use of services as inputs by manufacturing firms. These results shed further light on the mechanism outlined by Arnold et al. (2011)

and Arnold et al. (2012), which focus on liberalization rather than the productivity of services firms as such.

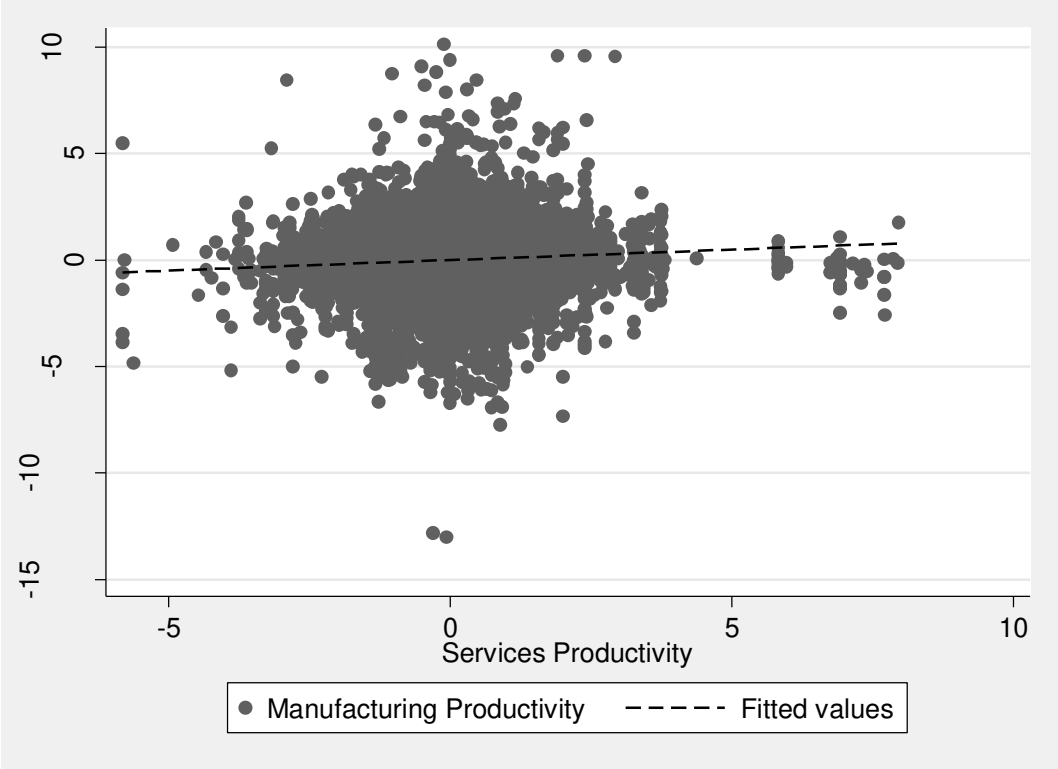
References

Arnold, J.M., B.S. Javorcik, and A. Mattoo. 2011. "Does Services Liberalization Benefit Manufacturing Firms? Evidence from the Czech Republic." *Journal of International Economics* 85(1): 136-146.

Arnold, J.M., B.S. Javorcik, M. Lipscomb, and A. Mattoo. 2012. "Services Reform and Manufacturing Performance: Evidence from India." Policy Research Working Paper No. 5948, World Bank.

Figures

Figure 1: Manufacturing productivity versus services productivity.



Note: Productivity in both cases is measured by the residuals from a regression of log(labor productivity) on a full set of country-sector-year dummies.

Tables

Table 1: Dataset description.

Variable	Definition	Source
Exporter	Dummy variable equal to unity for establishments that recorded non-zero direct exports as a percentage of total sales for the last fiscal year.	World Bank Enterprise Surveys question d3b.
Foreign	Dummy variable equal to unity for establishments that were owned more than 50% by foreign private individuals, companies, or organizations.	World Bank Enterprise Surveys question b2b.
Limited Partnership	Dummy variable equal to unity for establishments that are identified as a limited partnership.	World Bank Enterprise Surveys question b1.
Log(Capacity Utilization)	Logarithm of the level of utilization of facilities.	World Bank Enterprise Surveys question f1.
Log(Capital Intensity)	Logarithm of the establishment's purchases of machinery, vehicles, equipment, land, buildings, and information technology, divided by the number of employees.	World Bank Enterprise Surveys questions l1, l6, n5a, n5b, and n5c.
Log(Employees)	Logarithm of the total number of permanent full time employees and full time seasonal/temporary workers for the last fiscal year.	World Bank Enterprise Surveys questions l1 and l6.
Log(Labor Productivity)	Logarithm of total sales divided by the number of employees.	World Bank Enterprise Surveys questions d2, l1, and l6.
Log(Manager's Experience)	Logarithm of the number of years' experience working in the sector the establishment's top manager has.	World Bank Enterprise Surveys question b7.
Log(Services Productivity)	Logarithm of the sub-national regional average of sales per employee in services establishments.	World Bank Enterprise Surveys questions a2x, ISIC, d2, l1, and l6.
Partnership	Dummy variable equal to unity for establishments that are identified as a partnership.	World Bank Enterprise Surveys question b1.
Privately Held Company	Dummy variable equal to unity for establishments that are identified as a privately held limited liability company.	World Bank Enterprise Surveys question b1.
Publicly Listed Company	Dummy variable equal to unity for establishments that are identified as a publicly listed company.	World Bank Enterprise Surveys question b1.
Services % Inputs	Total annual cost of services inputs (electricity, communications, transport, and water) divided by total annual cost of all inputs (services plus labor, raw materials and intermediate goods, fuel, and rental of land/buildings, equipment, and furniture).	World Bank Enterprise Surveys questions n2a-n2h.
Sole Proprietorship	Dummy variable equal to unity for establishments that are identified as a sole proprietorship.	World Bank Enterprise Surveys question b1.

Table 2: Regression results.

	(1)	(2)	(3)	(4)	(5)
Log(Services Productivity)	0.099***	0.090***	0.053***	0.052***	0.048***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.003)
Log(Services Productivity) * Services % Inputs		0.098**	0.061*	0.063*	0.072**
		(0.013)	(0.088)	(0.076)	(0.046)
Services % Inputs		-2.737***	-2.655***	-2.686***	-2.805***
		(0.000)	(0.000)	(0.000)	(0.000)
Log(Employees)			0.112***	0.057***	0.051***
			(0.000)	(0.000)	(0.000)
Log(Capital Intensity)			0.235***	0.228***	0.228***
			(0.000)	(0.000)	(0.000)
Privately Held Company			0.068	0.055	0.032
			(0.169)	(0.262)	(0.523)
Sole Proprietorship			-0.259***	-0.252***	-0.282***
			(0.000)	(0.000)	(0.000)
Partnership			-0.180***	-0.168***	-0.202***
			(0.006)	(0.010)	(0.002)
Limited Partnership			-0.089	-0.084	-0.106
			(0.192)	(0.210)	(0.124)
Other			0.051	0.063	0.047
			(0.516)	(0.409)	(0.548)
Exporter				0.308***	0.297***
				(0.000)	(0.000)
Foreign				0.341***	0.336***
				(0.000)	(0.000)
Log(Capacity Utilization)					0.188***
					(0.000)
Log(Manager's Experience)					0.007
					(0.602)
Observations	30360	29486	19445	19383	18713
R2	0.637	0.465	0.647	0.631	0.627

*Note: The dependent variable is labor productivity in all cases, and the estimation sample is limited to manufacturing firms. Estimation is by OLS with robust standard errors clustered by country-sector-year. All models contain fixed effects by country-sector-year. P-values are in parentheses below the parameter estimates. Statistical significance is indicated by * (10%), ** (5%), and *** (1%).*