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Alina Mulyukova

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ABSTRACT

SERVICES LIBERALIZATION AND PRODUCT VARIETY OF MANUFACTURING FIRMS*

Alina Mulyukova

This paper investigates the impact of services sector liberalization on product innovation of downstream manufacturing firms. Leveraging firm-product panel data from India and employing a shift-share research design, I find that services liberalization significantly increases firms' product portfolio. Allowing foreign investments in the banking sector decreases firm's credit-constraint and increases the amount of interest payments on short-term loans. This shows that services liberalization reduces firms' fixed costs of product innovation. Firms diversify into input-similar industries which changes the distribution of sales across products with the core product experiencing the most pronounced decline in the sales share.

Keywords: Product mix, services liberalization, India

JEL classification: F10, F61, D22, L8

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Alina Mulyukova
University of Göttingen,
Email: alina.mulyukova@uni-goettingen.de
www.uni-goettingen.de

and

Kiel Institute for the World Economy
Kiellinie 66
D-24105 Kiel, Germany
Email: alina.mulyukova@ifw-kiel.de
www.ifw-kiel.de

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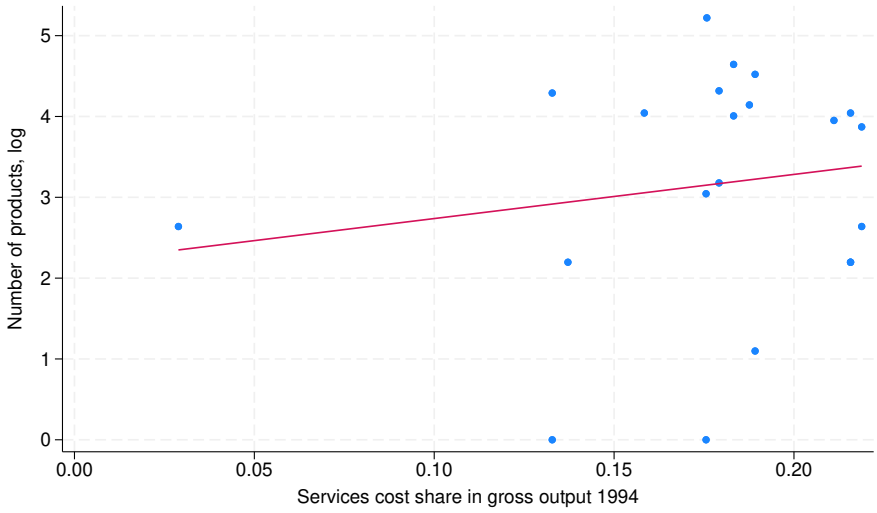
1 Introduction

Services such as transportation, telecommunications, and banking are essential inputs for manufacturing production processes. In many developing countries, however, these sectors remain predominantly state-controlled with only a few service providers (World Bank, 2004; Bas, 2020). Over recent decades, several countries have sought to liberalize their services sectors by increasing foreign and domestic competition (e.g., Fernandes and Paunov (2012) for Chile; Arnold et al. (2016) for India). In India, services liberalization was accompanied by a decline in the price of services of about 20% and an annual sectoral growth rate of 7.6%.[1] This period also saw a rise in newly manufactured products, which accounted for 25% of the manufacturing output growth (Goldberg et al., 2010a).

This paper examines the impact of services liberalization on product innovation of downstream manufacturing firms, utilizing firm-product level panel data from India. Previous research by Goldberg et al. (2010b) found no significant link between output tariff liberalization and the product mix of Indian manufacturing firms. Why might services liberalization yield different results? Unlike output tariff liberalization, which mainly reduces variable costs through lower input costs and increased competition from imported goods, services liberalization directly influences fixed costs of product innovation by improving access to finance and telecommunications infrastructure. Figure 1 illustrates a positive relationship between service expenditures and product variety across 2-digit manufacturing sectors in 1994, providing a basis for this empirical investigation.

Figure 1: Correlation between the number of products and service expenses.



Note: The figure plots the log number of products and the services cost share in total output for the initial pre-treatment 1994 year at the 2-digit manufacturing industry level. When dropping the outlier industry "Coke & refined petroleum products" with low service cost share and high number of products (left dot), the slope remains the same, see Appendix Figure A.1. Source: KLEMS database, Reserve Bank of India.

This study focuses on the liberalization of four service sectors - transportation, banking, insurance, and telecommunications - that underwent significant reforms between 1994

[1] Appendix Figure A.2 shows the evolution of the price of services from 1980.

and 2004. Before 1994, these sectors were dominated by public entities, faced limited competition, and had inefficient infrastructure. However, the economic expansion following the balance of payments crisis and the increasing demand for improved infrastructure prompted the government to liberalize these sectors. The reforms allowed private domestic and foreign providers to enter the market, introducing competitive pressures on incumbents.

Services provide relevant inputs to innovation processes, and decreasing service costs have the potential to foster innovation. Easier access to diverse, affordable transportation opens new markets, fostering the creation of tailored products for varied consumer demands. Liberalization of the banking sector improves access to affordable credit and financial services, enabling investments in new technologies, and research for developing diverse products. A liberalized telecommunications sector improves connectivity across dispersed supply chains, fostering new customer-supplier linkages and diversifying production inputs. Goldberg et al. (2010a) have shown that increased access to new imported varieties following the input tariff liberalization drives domestic product growth in India. While input tariff liberalization reduces marginal costs and increases input variety, services reforms primarily lower initial investment costs in infrastructure, technology, and risk management, thereby promoting product diversification in manufacturing firms. Hence, assessing the specific effects of services liberalization on downstream firms' diversification is required.

To guide my empirical analysis and outline the main mechanism through which services liberalization affects manufacturing firms product innovation, I provide a simple theoretical framework that follows closely the model by Dhingra (2013). The model predicts that the decreased price of service inputs for R&D purposes reduces the fixed cost of product innovation, which increases the product range. I test this prediction in the data and show that the liberalization of the services sector decreases the cost of adding new products and increases the product range.

My identification rests on a shift-share research design that exploits the gradual introduction of reforms and variation across manufacturing sectors in the intensity of service input use. I use the measure of services liberalization constructed by Arnold et al. (2016). Based on the staggered introduction of the deregulating measures, the liberalization index ranges from 0 to 5, with 0 corresponding to complete public dominance and 5 to equal treatment of foreign and domestic providers and unrestricted entry into the sector. To link service reforms to manufacturing firms, I use the pre-treatment 1993 Input-Output table. The identifying assumption is that firms more reliant on service inputs are more likely to be affected by the reforms than those less service-input dependent.

My analysis is based on a firm-product level data from Prowess collected by the Centre for Monitoring the Indian Economy (CMIE). Prowess is a commercially available database of the financial performance of Indian companies and is a firm-level panel that records detailed product-level information on the sales value, production and installed capacity. Unlike another widely used panel dataset for India that contains product-level information, the Annual Survey of Industries (ASI), Prowess covers the entire liberalization period from

1994 to 2004, while the ASI panel starts only in 1999, which makes it unsuitable for my analysis. Using the panel structure, I am able to track product adding and dropping within the same firm over time. Prowess accounts for 60-70% of the economic activity in the industrial sector and has been used extensively in all strands of research (Goldberg et al., 2010a; De Loecker et al., 2016).

My analysis yields that the product scope of manufacturing firms increases significantly following the liberalization in the services sector. A one standard deviation change in the services liberalization index increases the product scope of manufacturing firms by 2.1%, on average. Since product scope is measured in logs but is actually a step function, this effect translates into product addition by an average firm. Although service expenses constitute, on average, only 10% of the total firm's costs, they play a crucial role in driving product innovation. This effect is comparable to previous findings in India (Goldberg et al., 2010a).

To identify the causal effect, there should be no anticipation effect and no simultaneous unobserved demand or productivity shocks that are perfectly correlated with the liberalization. I conduct a pre-trends check where pre-reform changes in manufacturing product scope are regressed on future changes in services liberalization. Finding no significant effect indicates no differential pre-trends. Two placebo tests where the liberalization date is shifted forward and three non-liberalized service sectors are used instead of the treated sectors further corroborate the validity of my results.

The aggregate index may mask substantial heterogeneities as four service sectors may have differential effects on product scope. Liberalization of the transport and telecom sectors can increase access to new markets, and reforms in the banking and insurance sectors can decrease the initial investment costs for designing a new product. Decomposing the aggregate index, I find that liberalizing the banking sector plays the most crucial role for product innovation, conditional on other reforms. Intuitively, the liberalization of the banking sector relaxes financial constraints and allows firms to borrow at a lower interest rate to invest in product innovation. Indeed, the amount of interest payments on short-term loans has increased significantly following reforms in the banking sector. All these indicate that firms take up more short-term loans, as conditions become more favorable, which allows them to diversify their product portfolio.

Allowing foreign and domestic competition may have differential effects on product innovation because foreign service providers may introduce frontier technologies and adopt a more risk-taking approach to innovation activities compared to their domestic counterparts. Foreign banks, for instance, are willing to extend credit based on internal credit ratings rather than relying on a firm's history of relationships. This shift in lending criteria allows firms, especially those that might not have extensive credit histories, to overcome traditional credit constraints. Thus, the entry of foreign banks following the liberalization enables firms to engage in more ambitious and riskier product innovation activities (Chen et al., 2017; Beck et al., 2018). Indeed, I show that allowing foreign participation in the banking sector was the most important policy for manufacturing firms, ceteris paribus.

Which products do firms add? I show that firms are more likely to add products that are

within the same 3-digit industry as their core product. This is in line with previous findings by Boehm et al. (2022), who show that firms are more likely to diversify into input-similar industries, which allows them to gain comparative advantage in industries that use the same set of inputs. Because the newly added product is a close substitute to the core product and multi-product firms internalize the demand linkages across product varieties, newly added products cannibalize the demand for the core product as consumers re-optimize their consumption bundle (Eckel and Neary, 2010). Hence, services liberalization changes the distribution of sales across products with the core product experiencing the most pronounced decline in the sales share.

My results are robust to alternative specifications, such as including firm controls, controlling for FDI in the manufacturing sector, using multi-way clustering, or instrumenting for services liberalization with similar services reforms for China. I rule out other channels through which services liberalization could affect manufacturing firms, such as affecting the variable cost, increasing the demand from expanding services sector and lowering entry costs for firms. Heterogeneity analysis shows that firms with initially fewer products benefit significantly more from services liberalization relative to firms with initially larger product range. Moreover, firms that were less financially constrained before the reform benefit less relative to firms that were initially credit-constraint. This suggests that banking sector liberalization alleviates financial constraints, particularly for smaller and initially credit-constraint firms.

This paper contributes to two different strands in the literature. First, it contributes to the literature on the local availability of services and manufacturing firm performance. The existing literature has documented that improved service availability boosts manufacturing firm performance (Arnold et al., 2011; Fernandes and Paunov, 2012; Arnold et al., 2016), and promotes internationalization activities of firms (Görg and Jabbour, 2016; Bas, 2020; Deardorff, 2001; Debaere et al., 2013; Lodefalk, 2014; Bas, 2014; Bamieh et al., 2020; Liu et al., 2020; Konan and Maskus, 2006). While firm performance is typically measured using total factor productivity (TFP), previous studies do not differentiate between single- and multi-product firms, which is crucial to consider, since extending the production function estimation to multi-product firms may introduce bias due to unobserved allocation of inputs across products. Bas (2020) has shown that services liberalization stimulates firm's R&D activities. In contrast, this paper focuses specifically on one type of innovation activity in multi-product firms - product innovation.

My findings that foreign participation in the banking sector drives product innovation are related to the literature on financial constraints and firm performance. Greenaway et al. (2007); Minetti and Zhu (2011); Amiti and Weinstein (2011); Manova (2013); Manova and Yu (2017) have shown that credit constraints restrict firms' exporting activities. Specifically, this paper focuses on the effects of foreign lending on firm performance (Giannetti and Ongena, 2009; Bose et al., 2020; Giannetti and Ongena, 2012). In contrast to these studies, I evaluate the exogenous policy that deregulated the banking sector by allowing FDI and more domestic competition. In India, Gormley (2010) shows that foreign banks

financed only the most profitable firms, whereas, on average, firms were 8 percentage points less likely to receive a long-term loan. In contrast to Gormley (2010), I focus on short-term loans because they better capture foreign banks' risk-averse lending behavior and are more sensitive to changes in firm-level liquidity.

Last, this paper relates to several theoretical works that examine the impact of trade shock on multi-product firms (Feenstra and Ma, 2007; Eckel and Neary, 2010; Bernard et al., 2011; Dhingra, 2013; Nocke and Yeaple, 2014; Mayer et al., 2014, 2021). When new varieties are introduced, consumers re-optimize their consumption bundle and adjust their expenditures on all other products, including those products produced by the same firm. Because multi-product firms internalize the demand linkages across varieties produced, this leads to changes in the distribution of sales across products. On the empirical side, with the exception of a recent paper by Eckel et al. (2023), there is no documented empirical evidence on the presence of the cannibalization effect. In India, Goldberg et al. (2010a) and Goldberg et al. (2010b) have examined the extensive margin adjustment of multi-product firms following trade shocks, but these studies do not consider the intra-firm distributional effects of product sales. I contribute to this literature by documenting the existence of the cannibalization for Indian multi-product firms.

Two papers are most closely related to mine. The first is the paper by Arnold et al. (2016), which shows that services liberalization in India increased the productivity of manufacturing firms. In contrast to this study, I provide an explicit treatment for multi-product firms and look at within-firm extensive margin adjustments. The second paper is by Fernandes and Paunov (2012) who documents that FDI in services increased the productivity of manufacturing firms in Chile. I decompose the aggregate effect and find that FDI, particularly in the banking sector, plays a critical role for manufacturing firms.

This paper is structured as follows. Section 2 provides background information on the evolution of services reforms. Section 3 introduces the datasets. A simple theoretical framework that guides my empirical analysis is presented in Section 4. Section 5 describes the identification strategy. Results are presented in Section 6 and Section 7 concludes.

2 Background Information on Services Liberalization

Before the 1990s, India was a closed economy with a low annual growth rate. During this period, the government had a monopoly in the services sector. After a balance of payments crisis in 1991, a series of reforms were implemented to stabilize the economy. Trade was liberalized in the 1980s and 1990s and the services sector was deregulated in the 1990s and 2000s. This section presents the main features of the policies implemented in four service sectors, namely telecommunications, transportation, banking and insurance, and how these reforms have affected the performance of the services sector.

Transportation Sector. Prior to 1991, the government had a monopoly in air transport, highways and railways due to the need for large investments, uncertain returns and the

public good nature of the service (Mukherjee, 2009). The expansion of the economy and the growing demand for adequate infrastructure led the government to liberalize the sector with the aim to attract private and foreign investment. In 1995, the National Highways Act of 1956 was amended to encourage private sector participation through incentives like user fees (tolls), 100% income tax exemption for ten years, lower loan costs, and duty-free imports of construction equipment. In railways, private companies gained access to operate container trains on specific routes, develop logistics infrastructure, and enhance port connectivity, though foreign participation remains restricted (World Bank, 2002).

Air transport reform began in 1994 with the end of the public monopoly, allowing private operators in domestic and designated international routes under incentives like a 10-year tax exemption and the open-sky policy for cargo. In port development, up to 100% FDI and similar tax exemptions were introduced. These reforms significantly boosted the transportation sector: road networks expanded from 2 million km in 1990 to 3.3 million km by 2007, while rail freight traffic increased from 3 million tons in 1990 to 8 million tons in 2007. Consequently, the sector attracted 10% of total FDI between 1990 and 2005 and grew by 6.9% annually (Gordon and Gupta, 2005).

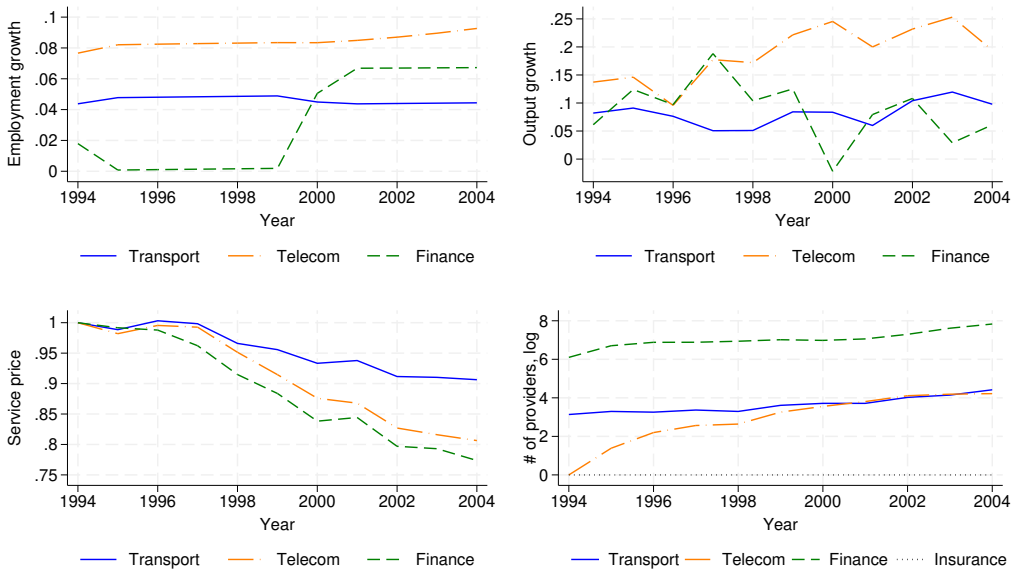
Figure 2 provides some stylized facts about the evolution of the services sector in the light of the reforms. While employment and output growth in the transport sector have not changed much over time, the price of transport services has fallen by about 15%, as indicated by the slower growth of the services deflator relative to the GDP deflator. The number of transport operators has also increased from 23 in 1994 to 83 in 2004. Note that the data on the number of providers come from the subsample of service companies in Prowess, which is a sample of relatively large firms. However, in the absence of data on the universe of service providers, it gives us a good approximation of the entry of new players after liberalization. This increased transport connectivity opens up prospects of serving new markets, which could stimulate firm's innovation activities.

Financial Sector. Before 1991, India's banking sector was largely state-controlled, regulated by policies such as statutory pre-emptions, regulated interest rates, and directed credit programs (Roland, 2007). Statutory pre-emptions required banks to hold substantial reserves in the central bank and government bonds, with combined liquidity ratios at 53.5%. Post-reform, these requirements decreased to 30% by 2005, reducing financial repression and allowing banks greater autonomy in credit volume and terms (Roland, 2007).

Prior to liberalization, the Reserve Bank of India (RBI) set both lending and deposit rates to facilitate cross-subsidization across sectors. Post-reform, however, the government ceased to control lending rates for loans exceeding ₹200,000 (equivalent to $16,000 in 2024). Banks were then required to announce a prime lending rate based on their funding and transaction costs, while loans below ₹200,000 could have freely set rates, capped at the prime lending rate. This deregulation promoted a shift toward market-driven banking and increased competition, enabling banks to use interest rate strategies to enhance their market position. Appendix Figure A.3 illustrates the evolution of the prime lending rate.

Since 1969, Indian banks have been required to direct 40% of net credit to priority

Figure 2: Descriptive statistics of service sectors.



Note: The figure plots employment growth, output growth, service prices and the number of service providers over 1994 to 2004 for each service sector. Service price is measured as the price deflator of each service sector to the GDP deflator (base=1994). Number of service providers is measured in log terms. Annual data on employment growth, output growth and service price comes from KLEMS database provided by the Reserve Bank of India. KLEMS does not provide data on the insurance sector. Data on the number of service providers comes from Prowess.

sectors such as agriculture and small-scale industries, which are high-risk and yield low profitability due to low interest rates. While this lending target remains, eligible sectors have expanded to include IT, reducing some burden on banks. In 1993, RBI guidelines opened the market to increase competition, allowing 9 domestic and 20 foreign banks to enter, with foreign banks operating through branches or subsidiaries. By 2005, newly established private and foreign banks held 25% of total assets, reflecting a more diversified banking landscape (Roland, 2007). Appendix Figure A.4 shows that the percentage of foreign banks increased from 6% in 1995 to 9% in 2004. Figure 2 shows significant employment growth in the finance sector, with a spike in 2000 when several new banks entered the market. The number of banks and non-banking financial companies rose sharply from 446 in 1994 to 2,519 in 2004, driving a 25% decrease in banking service prices due to increased competition. This relaxes financial constraints faced by firms as they have access to more affordable credit. Further, foreign banks tend to fund riskier innovation activities of firms, which could create stimulus for innovation.

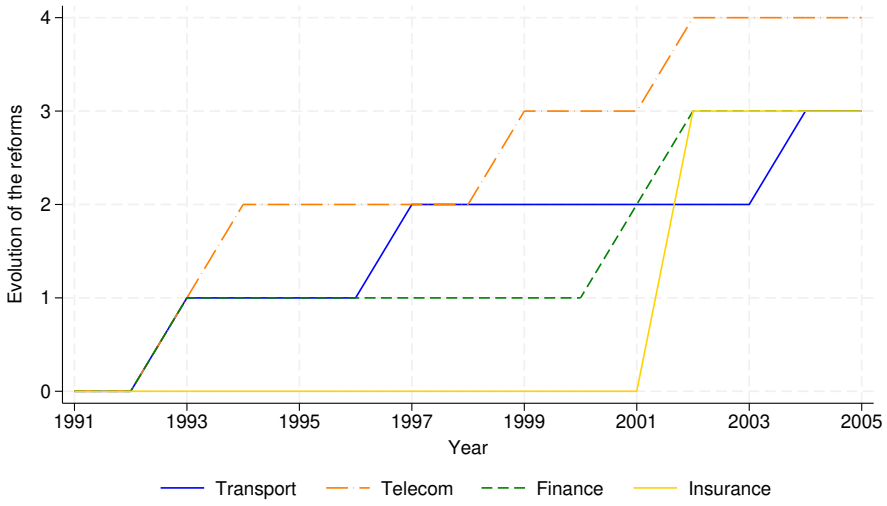
Telecommunication Sector. In 1994, India began liberalizing its state monopoly in telecommunications through the National Telecom Policy, aiming to remove entry barriers, expand infrastructure, and invest in cellular networks. By 1995, 44 cellular licenses were issued nationwide, and the 1998 Internet Policy further allowed unlimited competition without license fees, though the Department of Telecommunications retained significant control over the market (Gupta, 2002).

The 1999 New Telecom Policy permitted 100% FDI in services like email, voice mail, and non-gateway internet services (subject to approval over 49%), while other telecom areas allowed up to 49% FDI without approval. This opened the market to numerous foreign entrants, boosting teledensity from 4 per 1,000 people in 1986 to 45 per 1,000 by 2002, with calling prices dropping significantly (World Bank, 2004). Employment and output in the sector steadily increased from 1994, as prices declined about 25% and the number of providers grew from 1 in 1994 to 68 by 2004. The enhanced connectivity eases the search of potential suppliers, thus increasing the input variety, and help find new customers, which stimulates innovation activities of firms.

Insurance Sector. Reforms in the insurance sector were taking place relatively slowly compared to the deregulations in other sectors. In 1993, a governmental committee was established to assess the performance of the insurance sector and provide guidelines for attracting private players into the market. The Insurance Regulatory and Development Authority (IRDA) was set up in 1999 with the primary objective to develop and regulate the insurance market. Entry of foreign players was also allowed provided that their equity in the paid-up capital does not exceed 26% (Kumari, 2002). The IRDA Act also requires that the services of insurance providers be made available to rural and social sectors, and to the backward classes, which also includes crop insurance. These changes resulted in the entry of 21 new private providers between 2000 and 2002, of which 12 were in the life insurance sector and 9 in the general insurance sector. The number of offices has also doubled. This decreases the insurance costs for cargo and technology protection.

Figure 3 summarizes in a graph line the pace of the implemented reforms. The greater the degree of liberalization, the higher the value of the index.

Figure 3: Timeline of the pace of the reforms.



Note: The figure plots the evolution of the reforms in each of the services sector. With each liberalization episode a higher value is assigned to the liberalization index. Appendix Table B.1 provides detailed information on the implemented reforms in each year.

3 Data

To recall, this paper examines how services liberalization in India affects product innovation of manufacturing firms. For that, I need production data for a panel of firms which will allow me to track product addition within the same firm over time and a measure of services liberalization.

3.1 Firm and Product-level data

Firm-level data are obtained from Prowess, a commercially available database of the financial performance of Indian companies, collected by the Centre for Monitoring the Indian Economy (CMIE). Prowess accounts for 60-70% of the economic activity in the industrial sector and has been used extensively in the literature (Goldberg et al., 2010a; De Loecker et al., 2016; Bau and Matray, 2023). Information is collected primarily from the balance sheets and income statements of publicly traded companies. Prowess covers the period from 1994 to 2004 - the time when the reforms were implemented.

Another widely used dataset to study firm dynamics in the manufacturing sector in India is the Annual Survey of Industries (ASI) compiled by the Ministry of Statistics and Program Implementation. Unlike Prowess, the panel ASI is only available after 1999, which makes it unsuitable to study the effects of services liberalization, as using ASI would result in omitting the most drastic reforms in the services sector. Thus, I use Prowess to estimate the baseline results, but, I provide a robustness check using panel ASI from 1999 to 2004, which captures the universe of manufacturing establishments.

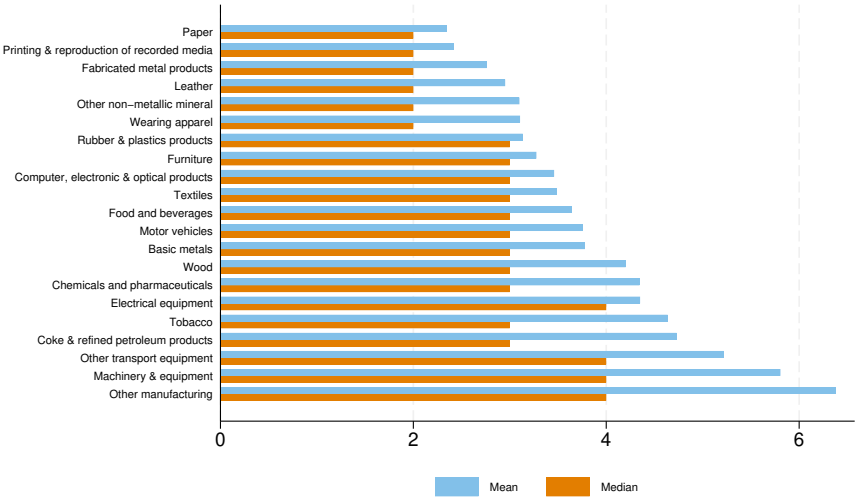
Firms are required by the 1956 Company Act to disclose product-level information on installed capacities, sales, and quantities produced. Products are classified according to the internal Prowess product classification. To standardize product names into distinct, time-invariant codes, I follow Goldberg et al. (2010b) and map 15.421 product names to standardized 1.803 12-digit CMIE product codes which are comparable to HS6 product categories.[2] Examples of products include printed circuit boards (160605050000), synthetic rubber (110301020000), stainless steel seamless tubes and pipes (130106040200), etc. These codes are consistent over time and are corrected for spelling errors. Furthermore, these product codes are mapped to 3-digit industry codes according to the 1998 National Industrial Classification (NIC).[3]

In addition to product-level information, Prowess reports standard firm performance indicators such as sales, assets, export activity, and total spending on services. Since firms are not required to report to Prowess, I work with the subsample of surviving firms so that I can track changes in the product mix of incumbents. The sample is restricted to firms in the manufacturing sector over the period 1994 to 2004, which covers the services liberalization episode. All variables are deflated using the sector-specific wholesale price index (WPI) and are log transformed.

[2] I would like to thank Amit Khandelwal for kindly sharing the data with me.
[3] NIC-1998 revision was updated to be consistent with ISIC Rev 3.1.

My identification strategy exploits variation across industries in the use of service inputs. Figure 4 documents that there is heterogeneity in the number of manufactured products across 2-digit industries. On average, firms in the paper manufacturing industry produce 2.34 products, while firms in the machinery and equipment industry produce, on average, 5.8 products. Looking at the median, we observe relatively smaller values, ranging from 2 products in the least diversified industry to 4 products in the most diversified industry. This suggests that within an industry there are a few firms with a highly diversified portfolio that produce a relatively large number of products and shift the averages to the right of the distribution.

Figure 4: Mean and median number of products per 2-digit industry.



Note: This figure plots the mean and the median number of products for the 2-digit manufacturing industry. The data are taken from Prowess.

3.2 Measure of Services Liberalization

This paper uses the index of services liberalization created by Arnold et al. (2016). Given the staggered introduction of deregulation measures, the liberalization index ranges from 0 to 5, where 0 corresponds to complete public dominance and 5 to equal treatment of foreign and domestic providers and unrestricted entry into the sector. Appendix Table B.1 shows the evolution of policy reforms for each service sector from 1994 to 2004.[4]

A key challenge in evaluating services reform is constructing a reliable measure of the implemented deregulations. The constructed index allows assessment of the reforms, but it is based on certain assumptions that should be noted. First, it assumes that the index

[4]Another alternative would be to use the Services Trade Restrictiveness Index compiled by the OECD. These data cover 22 services sectors and span the period from 2014 to 2022. However, the removal of restrictions on services trade was not exogenously imposed, which would raise additional endogeneity concerns. On the contrary, the liberalization index of Arnold et al. (2016) covers the period when the reforms were externally imposed and thus allows me to get closer to a causal effect of services liberalization.

values are comparable across increments (e.g., a change from 1 to 2 is equivalent to a change from 3 to 4) and across sectors. To test the robustness of this assumption, I create binary indicator variables for each reform, which relaxes the linearity assumption and helps identify the most significant reforms.[5] Second, although the index is carefully constructed in consultation with local policymakers, some measurement error may remain due to the subjective nature of assessing the reforms' relative importance.

To address these concerns, I provide a robustness check using the prices of the services sector. The prices for banking, transportation, and telecommunications are constructed as the ratio of the price deflator for each of the services sectors relative to the GDP deflator, as in Gordon and Gupta (2005). Figure 2 shows that the price of finance and banking decreased by about 25% and that of transportation fell by 15%, indicating that the reforms were accompanied by sizeable price changes (Appendix Figure A.2 shows that service prices were increasing from 1980 to 1994, when the first reforms were introduced). Unfortunately, the price deflator for the insurance sector is not available separately. The data are taken from the KLEMS database provided by the Reserve Bank of India. I use the change in the price index from 1994 to 2004 as a measure of the treatment shock.

3.3 Combining Firm Data with Services Liberalization

To link the index of the services sector to manufacturing firms, the 1993 pre-treatment Input-Output table is used. Appendix Figure A.5 shows that some manufacturing industries rely more heavily on services than other industries, thus creating differential exposure to liberalization across manufacturing sectors. To reflect this, the liberalization index is weighted by the importance of service inputs in the manufacturing sector j using the 1993 Input-Output table. The matrix coefficient is at factor cost, meaning that it reflects the share of each service sector in the total value of the inputs sourced. Thus, the services liberalization measure is constructed as follows:

$$\mathcal{L}_{jt} = \sum_{s} \omega_{js} reform_{st} \tag{1}$$

Each reform index for four service sectors is weighted by the share ω_{js}, which is defined as the ratio of input cost sourced by firms in the manufacturing sector j from the services sector s relative to the total input costs. The sum of these indices forms the liberalization index for each manufacturing sector j and time t. For comparability, the lagged liberalization index, $\mathcal{L}_{jt-1}$, is standardized with a mean 0 and a standard deviation of 1. Appendix Figure A.6 plots the evolution of the liberalization index over time. Analogously, the exposure measure is constructed in the same way using the change in the prices for each of the service sectors between 1994 and 2004 instead of the index:[6]

[5] The most important reform in the transportation sector was implemented in 1997, in banking in 2001, in telecommunications and insurance in 2002.

[6] Appendix Figure A.7 shows the evolution of the service cost shares from Input-Output tables in 1993 and 1998.

$$\mathcal{P}_{jt=1994-2004} = \sum_{s} \omega_{js} \Delta Price_{st=1994-2004} \tag{2}$$

Table 1 presents summary statistics of the index by the 2-digit manufacturing industry for the first and last years in the sample. We observe that the value of the index is higher in 2004 compared to the value of the index in 1995. Given that the weights from the Input-Output table are constant, it indicates that the change in the aggregate liberalization index is attributed to the change in the index of services reform over time. The higher the value of the services reform, the more liberalized the services sectors are. Second, we also observe that some manufacturing industries depend more on service inputs than others. To illustrate, the printing and reproduction of recorded media uses more service inputs relative to the manufacturing of food and beverages. This creates differential exposure across manufacturing industries, as it is more likely that those industries that rely more on service inputs are more exposed to liberalization than those industries that are less service input intensive.

Table 1: Summary statistics of services liberalization index.

	Year 1995 Mean	Year 2004 Mean
Food and beverages	0.023	0.150
Tobacco	0.030	0.189
Textiles	0.073	0.305
Wearing apparel	0.039	0.184
Leather	0.035	0.209
Wood	0.046	0.234
Paper	0.062	0.277
Printing & reproduction of recorded media	0.117	0.441
Coke & refined petroleum products	0.000	0.084
Chemicals and pharmaceuticals	0.036	0.202
Rubber & plastics products	0.036	0.191
Other non-metallic mineral	0.066	0.296
Basic metals	0.067	0.310
Fabricated metal products	0.108	0.441
Computer, electronic & optical products	0.081	0.355
Machinery & equipment	0.126	0.434
Electrical equipment	0.145	0.495
Other manufacturing	0.244	1.000
Motor vehicles	0.090	0.452
Other transport equipment	0.029	0.218
Furniture	0.088	0.337
Total	0.073	0.320

Descriptive statistics of the firm-level outcomes and the liberalization index are presented in Table 2. The average firm in the sample produces 4 products. However, the aggregate number masks substantial heterogeneity, with the number of products ranging from 1 to 68 across firms. Looking at the input-output linkages, expenses on banking and transportation account for 2.6% and 5.4% of the total expenses of an average firm in the manufacturing industry, respectively, while telecommunications and insurance expenses together account for only 1.2%.

As part of the IMF adjustment program to address the balance-of-payments crisis, India implemented a large-scale trade liberalization policy in August 1991. The average tariff dropped from 80% in 1990 to 39% by 1996 (Goldberg et al., 2010b). Extensive literature has shown that trade liberalization improved manufacturing firm performance (Topalova

Table 2: Summary statistics.

	N.obs.	Mean	Std.dev.	Min	Max
# products	23054	3.994	3.818	1.000	68.000
# products, log	23054	1.088	0.751	0.000	4.220
$\mathcal{L}_{jt-1}$	23054	0.000	1.000	-1.220	5.715
Telecom_{jt-1}	23054	0.000	1.000	-0.622	3.964
Transport_{jt-1}	23054	0.000	1.000	-1.978	2.656
Banking_{jt-1}	23054	0.000	1.000	-0.608	6.705
Insurance_{jt-1}	23054	0.000	1.000	-0.645	4.771
Finance expenditure share	23054	0.026	0.023	0.005	0.117
Telecom expenditure share	23054	0.007	0.009	0.001	0.035
Transport expenditure share	23054	0.054	0.021	0.024	0.101
Insurance expenditure share	23054	0.005	0.003	0.001	0.014
$\mathcal{P}_{jt=1994-2004}$	23054	0.000	1.000	-3.808	0.978
Services expenses, log	15007	3.369	1.822	-3.283	10.653
Assets, log	15020	5.264	1.657	-2.407	12.392
Tariff_{jt-1}	23054	0.000	1.000	-1.528	2.989
$\text{Input tariff}_{jt-1}$	23054	0.000	1.000	-1.583	5.089

and Khandelwal, 2011) and facilitated the introduction of new products in the domestic market (Goldberg et al., 2010a). To account for other sector-level changes coinciding with services liberalization, I control for input and output tariffs at the 2-digit sector level in all specifications. Data are sourced from Arnold et al. (2016).[7]

4 Theoretical Framework

To fix ideas and motivate my empirical analysis, in this section, I provide a simple theoretical framework outlining the main mechanism of how liberalization in the services sector affects the product scope of manufacturing firms. The model follows closely Dhingra (2013), where manufacturing firms choose the range of products to produce and the quantity of each product. I build on the model and make one additional assumption that is crucial in showing my mechanism. In contrast to Dhingra (2013), I assume that the cost of investing in product R&D depends on the price of services. The cheaper the services, the lower the cost of product innovation.

Demand. Consider a closed economy with L identical agents, each endowed with a unit of labor. Total income in the economy is $I = wL$, where w is the wage which is normalized to 1. Agents have identical preferences across homogeneous and differentiated goods. Agent k consumes q_0^k of homogeneous good and q_{ij}^k of variety $i \in \Omega$ of brand $j \in \mathcal{J}$ of the differentiated good. ${q^k}_j = \int_i q_i di$ denote the total consumption of goods of brand j. $Q^k = \int_i q_j^k dj$ is the aggregate consumption of differentiated goods of all brands. Agent k derives the following utility from the consumption of homogeneous and differentiated goods.

$$U^k = q_0^k + \alpha Q^k - \frac{\delta}{2}\int_j\int_i (q_{ij}^k)^2 didj - \frac{\gamma}{2}\int_j (q_j^k)^2 dj - \frac{\eta}{2}(Q^k)^2 \tag{3}$$

[7] I thank Jens Arnold for sharing the data.

Parameters α, δ, γ and η are strictly positive. α and η determine the substitutability between homogeneous and differentiated goods. δ captures the degree of differentiation across varieties. The lower the δ, the less differentiated the goods are. Parameter γ captures the degree of differentiation across brands with $\gamma = 0$ implying no brand differentiation.

Solving the utility maximization problem subject to the budget constraint gives us the following inverse demand function, where, in an equilibrium, agent k consumes both homogeneous and differentiated goods.

$$p_{ij} = \alpha - \delta q_{ij}^k - \gamma q_j^k - \eta Q^k \tag{4}$$

In equation (4), $\gamma > 0$ implies that consumer's willingness to pay falls more with the increase in varieties that belong to the same brand rather than varieties of other brands. This is referred to as within-brand cannibalization effect. Let q_{ij} be the total demand for variety i of brand j across all agents. With identical agents, each agent k demands $q_{ij}^k = \frac{q_{ij}}{L}$. Total demand for variety i of brand j is then $q_{ij} = \frac{L}{\delta}[\alpha - p_{ij} - \frac{\gamma q_j}{L} - \frac{\eta Q}{L}]$, where $q_j = Lq_j^k$ and $Q = LQ^k$.

Firms. In a differentiated industry, firms enter the market by paying a fixed cost f. After paying the entry cost, firms produce products at a unit cost $c = \mu p_s^p$, where p_s^p is the price of services for production purposes or a variable cost, and μ is the degree of service usage intensity for production. μ ranges between 0 and 1, with $\mu = 0$ indicating that the production process does not depend on service inputs. For simplicity, I abstain from material inputs. Firms have perfect information on the unit cost before paying the entry cost. Having paid entry costs, firms have two choices: what quantity of product i to produce (q_{ij}) and how many products to supply (h_j). A firm chooses the quantity faced with the inverse demand $p_{ij} = a - \delta q_{ij} - \gamma q_j$, where $a = \alpha - \eta Q^k$ is the intercept which summarizes market demand condition which firms take as given. Firm j can produce multiple products. Thus, it chooses the range of products, h_j, by investing in product R&D at a rate $r_h \times p_s^r$ per product, where p_s^r is the price of service inputs for research and development, or the fixed cost of product innovation.

The distinction between service prices for production and R&D is supported by existing literature indicating that service costs differ depending on their use for product innovation or production processes. Benfratello et al. (2008) demonstrate that the development of local credit markets impacts process and product innovation differently, because product innovation is riskier and therefore banks are less willing to lend or charge higher interest rates (Caggese, 2019; Bertrand et al., 2007; Caggese, 2012). Similarly, Fernandes and Paunov (2013) show that transport costs drive product quality upgrading while having no effect on product innovation. Viscusi and Moore (1993) and Galasso and Luo (2022) document that high levels of product liability insurance costs decrease product innovation. This suggests that it is reasonable to assume that the price of services for production and R&D purposes may be different, which in turn would differentially affect a firm's cost of product and process innovation.

Putting this together, firm j decides on the quantity of variety i to produce, q_{ij}, and

the range of products, h_j to maximize the following profit function:

$$\max_{q_{ij},h_j} \Pi = \int_0^{h_j} \{[p_{ij} - \mu p_s^p]q_{ij} - r_h \times p_s^r\} di - f \tag{5}$$

With symmetric costs, the firm chooses the same quantity for each product supplied and hence the firm-product subscripts can be suppressed. The firm's problem can then be rewritten as: $\Pi = h\{[p - \mu p_s^p]q - r_h \times p_s^r\} - f \equiv h\pi - f$.

Solving the profit maximization problem of a firm, we can derive the optimal quantity in equilibrium: $q^{\text{opt}} = \left(\frac{Lr_h \times p_s^r}{\delta}\right)^{\frac{1}{2}}$. The optimal quantity increases with market size L, and decreases as varieties become more differentiated δ. If the cost of product R&D, r_h, increases, firms choose to produce more quantity of existing products rather than expand their product range. Now, we can solve for the optimal range $h^{opt} = \frac{1}{2\gamma}\left(\frac{L\delta}{r_h p_s^r}\right)^{\frac{1}{2}}(a - \mu p_s^p) - \frac{\delta}{\gamma}$. The optimal range rises with market size L and decreases with a degree of cannibalization, γ. Substituting the optimal quantity and range into the inverse demand function we get the optimal price: $p^{opt} = \frac{1}{2}(a + \mu p_s^p)$. Having determined the equilibrium values, I proceed with comparative statics to determine how optimal values react to a change in the price of services.

Proposition. Liberalization of the services sector decreases the cost of adding new products and increases the product range.

$$\frac{\partial h^{opt}}{\partial p_s^r} = -\frac{1}{2}\frac{1}{2\gamma}(a - \mu p_s^p)\left(\frac{L\delta}{r_h}\right)^{\frac{1}{2}}(p_s^r)^{-\frac{3}{2}} < 0, \tag{6}$$

where $L > 0$ is the market size, $a > 0$ is the market demand, $p_s^p > 0$ is the price of services for production, $\mu > 0$ is the intensity of service usage for production purposes, $p_s^r > 0$ is the price of services for R&D, $\delta > 0$ is the degree of differentiation across varieties, and $\gamma > 0$ captures brand differentiation. Intuitively, the model predicts that the cheaper the service inputs for R&D, the lower the fixed costs of product innovation and hence the higher the product variety. This could be explained by the fact that with increasing competition, banks are now more willing to lend to riskier innovation activities of firms, thus reducing the fixed cost of product innovation. The literature has shown that foreign-owned banks in particular take on more risks than their domestic counterparts (Chen et al., 2017) and that foreign banks base their pricing on internal credit ratings, while domestic banks price according to the length, depth, and breadth of their relationship with a firm, which makes it easier for a firm to overcome an information disadvantage (Beck et al., 2018). Enhanced telecommunications infrastructure allows firms to broaden their search of potential suppliers, thus increasing the variety of production inputs, and customers, which could result in the creation of a new production line tailored to a specific customer. Upgraded transport networks will allow firms to serve new international or domestic markets. Competitive insurance policies will decrease cargo insurance costs and costs associated with technology and equipment protection when setting up a new production line. These costs are more

likely to be non-recurring and will not change with the level of production, hence they can be classified as fixed costs of product innovation.[8]

5 Empirical strategy

The theoretical model suggests that services liberalization lowers the price of services for R&D, thereby expanding the product range of manufacturing firms. This section outlines the empirical strategy and addresses potential endogeneity concerns in identifying the treatment effect.

My identification strategy employs a shift-share research design that leverages time variation in the pace of the reforms and sectoral variation in service input intensity. Thus, weighted averages of the common set of shocks are constructed, where the weights are the service input shares for each manufacturing sector j, and the shock is the staggered introduction of the services reform. The underlying assumption is that some firms in the manufacturing sector j rely more on service inputs relative to firms in other sectors that are less service-intensive. This assumption is data-driven as is shown in Appendix Figure A.5, which documents substantial differences in the cost share of services across 2-digit industries. This creates heterogeneous exposure to the shock and more exposed firms are likely to be more affected by the services liberalization compared to less exposed firms. This methodology has been widely used in other applications, such as examining the impact of Chinese import competition on the local labor market (Autor et al., 2013), estimating the wage effect of offshoring (Hummels et al., 2014), or rural-urban migration effect on manufacturing firms (Imbert et al., 2022), among others.

To estimate the effect of services liberalization on the product scope of manufacturing firms, the following estimating equation is run on a panel of manufacturing firms over the period 1994 to 2004:

$$Y_{ijt} = \alpha + \beta Exp_{jt} + \gamma \mathcal{Z}_{jt-1} + \delta \sum_{s} \omega_{js} * \mathbb{1}(Year_t) + \theta_i + \tau_t + \xi_j + \epsilon_{jt} \tag{7}$$

The dependent variable Y_{ijt} is the log number of products of firm i in manufacturing sector j at time t. Exp_{jt} is a measure of treatment exposure specific to each manufacturing sector j, which is either a one-period lagged liberalization index, $\mathcal{L}_{jt-1}$, each of the reforms separately, $Transport_{jt-1}$, $Banking_{jt-1}$, $Insurance_{jt-1}$, and $Telecom_{jt-1}$, or the change in service prices, $\mathcal{P}_{jt=1994-2004}$. $\mathcal{Z}_{jt-1}$ are one-year lagged sector-level controls such as output and input tariffs. The coefficient of interest, β, indicates how does the product scope of firm i change with a one standard deviation change in the liberalization index. Following the predictions of the theoretical framework, the sign of β is expected to be positive.

[8] It is also interesting to see how the optimal price of the firm responds to the liberalization of services. When the price of services for production purposes falls, the optimal price charged by the firm falls ($\frac{\partial p^{opt}}{\partial p_s^p} = \frac{1}{2}\mu > 0$). In my empirical analysis, I do not observe any statistically significant effect of services liberalization on the price of incumbent products or the total sales of incumbent products, which may potentially be explained by the fact that μ is very low, i.e. the production process uses very few service inputs.

Recent literature on shift-share design argues that with panel data and incomplete shares, where the sum of exposure shares varies across observations and does not add up to one, it is important to control for the sum of exposure shares interacted with period fixed effects, $\sum_s \omega_{js} * \mathbb{1}(Year_t)$ (Borusyak et al., 2022). θ_i are firm fixed effects that control for time-invariant, firm-specific characteristics. τ_t are time fixed effects that control for time trends that are common to all firms. Since 11% of the firms in my sample switch industries during the study period, I separately control for industry fixed effects, ξ_j, which absorb time-invariant differences across industries.[9] In the robustness check I show that the results are unchanged when fixing the industry to the initial period and omitting industry fixed effects. Standard errors are clustered at the level of exposure - industry-year level.

Exogeneity - Recent literature has examined the identification assumptions necessary for valid inference in shift-share research designs (Adao et al., 2019; Goldsmith-Pinkham et al., 2020; Borusyak et al., 2022). According to Goldsmith-Pinkham et al. (2020), consistency of the estimator is ensured when the exposure shares are exogenous. In my study, the intensity of service inputs, used as shares, is fixed to the pre-treatment period, which reduces endogeneity concerns. However, this assumes that these shares remain constant over time.[10] If firms' input decisions were influenced by expectations about their future product portfolios, the exogeneity assumption could be violated. Alternatively, Borusyak et al. (2022) argue that the key condition for validity in shift-share designs is that shocks are orthogonal to unobserved residuals, allowing exposure shares to be endogenous. My design assumes that services sector reforms are quasi-randomly allocated across manufacturing sectors, based on pre-existing industry characteristics, which are absorbed by industry fixed effects. Additionally, identifying the causal effect rests on the assumption that services liberalization occurred unexpectedly, hence there is no anticipation effect or no pre-trends.

Hoekman et al. (2007) argue that the pace and pattern of policy reforms in the services sector were primarily influenced by political factors within the sector itself, rather than by the needs of the downstream manufacturing sector. For example, Chari and Gupta (2008) demonstrate that more concentrated service industries and those with significant state involvement were better able to resist foreign entry and competitive pressures compared to sectors dominated by private firms. Additionally, reforms were slower in service sectors where privatization would lead to significant job losses or reduce access to services for poorer and rural communities. Lobbying by state-owned banks and enterprises likely played a key role in delaying the liberalization process and excluding certain reforms from the 1991 general trade liberalization. As such, it is unlikely that manufacturing firms actively lobbied for services liberalization; instead, these reforms were externally imposed on India

[9] Prowess defines the industry according to the share of products in total revenue. The main product is the product with the highest sales share.

[10] Figure A.7 in the Appendix shows the percent of service inputs for each of the four service sectors in total inputs using 1993 and 1998 Input-Output tables. The patterns across manufacturing sectors are broadly constant over time. The Pearson correlation for finance is 0.06, for insurance - 0.37, for telecommunications - 0.94, and for transportation - 0.85.

and were not anticipated by manufacturing firms.

To provide supporting evidence of the exogeneity of the policy reform, I conduct a pre-trends check where pre-reform changes in manufacturing outcomes are regressed on future changes in services liberalization. The estimation equation is as follows:

$$\Delta Y_{ijt=1989-1993} = \beta \Delta \mathcal{L}_{jt=1994-2004} + \delta \sum_{s} \omega_{js} + \epsilon_{jt} \tag{8}$$

where the outcome variable $\Delta Y_{ijt=1989-1993}$ is the stack of first difference of the log number of products for a manufacturing firm i in industry j between 1993 and 1989, the first year of the Prowess dataset. $\Delta \mathcal{L}_{jt=1994-2004}$ is the difference in the services liberalization index between the last and the first years. This approach is similar to a falsification exercise in Autor et al. (2013), Imbert et al. (2022), and Bräuer and Kersting (2024). Finding no significant correlation would alleviate the concern of reverse causality.

Falsification tests - Another threat to the identification can be the presence of unobserved shocks, such as demand or productivity shocks, that are perfectly correlated with liberalization and which could simultaneously impact the treated firms in a similar way as services reforms. I conduct two placebo tests to show that there is a direct relationship between liberalization and a firm's own cost. First, I create placebo dates by moving the real date of liberalization seven periods forward.[11] Second, I use three other service sectors that were not liberalized during that time period, namely construction, water, and electricity. Finding no significant effect from these placebo checks will validate the result that there are no other unobserved shocks that could drive the result.

6 Results

6.1 Baseline results

Baseline estimation results of the effect of services liberalization on product innovation of manufacturing firms are presented in Table 3. Column (1) shows that the services liberalization has a significant and positive effect on the product scope of manufacturing firms. A one standard deviation change in the aggregate liberalization index increases the product scope of manufacturing firms by 2.1%, on average. The scope is measured in log terms, however, the number of products is a step function, which means that this effect translates into the addition of a new product by an average firm. This result is in line with the predictions of the model, documenting that services liberalization reduces the price of services for R&D and, hence, the fixed cost of product innovation. This, in turn, enables firms to expand their product scope. The magnitude of the effect is also comparable to previous findings by Goldberg et al. (2010a), who show that a 10 percentage point decline

[11] The choice of moving the date 7 years forward is done according to the consideration that most of the reforms are already implemented 7 years after the first introduction of the reforms. Choosing an earlier year would violate this given the staggered introduction of the reforms.

in input tariffs resulted in a 3.2% expansion of a firm's product scope. The difference lies in the fact that services account for only 10% of a firm's total costs, yet despite their small share, they have a significant impact on product innovation. Table B.2 in Appendix shows that the results are robust when using the number of products instead of its log transformation, indicating that the benefits spread not only to firms producing at least one product.

Table 3: Baseline estimation results on product innovation.

	(1) Scope	(2) Scope	(3) Scope	(4) Scope	(5) Scope	(6) Scope
$\mathcal{L}_{jt-1}$	0.021***					
	(0.005)					
Transport_{jt-1}		0.042***				0.026***
		(0.010)				(0.009)
Banking_{jt-1}			0.019***			0.016***
			(0.005)			(0.006)
Insurance_{jt-1}				-0.010*		-0.010
				(0.006)		(0.006)
Telecom_{jt-1}					-0.024***	-0.007
					(0.009)	(0.009)
Tariff_{jt-1}	0.010**	0.007**	0.009**	0.004	0.003	0.005
	(0.004)	(0.004)	(0.004)	(0.005)	(0.004)	(0.004)
$\text{Input tariff}_{jt-1}$	-0.003	0.000	-0.002	-0.003	-0.004	0.007
	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)
N	23054	23054	23054	23054	23054	23054
R-squared	0.889	0.889	0.889	0.888	0.888	0.889
i, j, t	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table.

The aggregate index may mask substantial heterogeneities as four service sectors may have differential effects on product scope. In Columns (2-6), I decompose the aggregate index and regress each of the reform indicators on product scope separately. Column (2) shows that reforms in the transportation sector have a significant and positive impact on product innovation, with a one standard deviation increase in the transportation index leading to a 4.2% rise in product scope. Similarly, Column (3) shows that a one standard deviation increase in the banking index results in a 2% increase in product range. Columns (4) and (5) show that reforms in the insurance and telecom sectors had a negative effect. These regressions, however, may suffer from omitted variable bias as they do not control for reforms in other sectors. To address this, Column (6) includes all four reform indices in the regression simultaneously. The results indicate that, after controlling for all other reforms, the liberalization of the transportation and banking sectors is most crucial for product innovation of manufacturing firms. Intuitively, liberalization of the transport sector could incentivize firms to expand into new markets with diversified products, as transport costs become cheaper or decrease the supplier search costs. Liberalization of the banking sector

could relax financial constraints and allow firms to borrow at a lower interest rate to invest in product innovation.

6.2 Validity and robustness tests

The causal interpretation of the results relies on the assumption that services reforms happen unexpectedly and are orthogonal to simultaneous shocks affecting product innovation of manufacturing firms in a similar way. To provide evidence of no anticipation effect or no pre-trends, I regress past manufacturing outcomes on future changes in policy reform, as specified in Equation (8). The results in Column (1) of Table 4 show no statistically significant relationship between the changes in pre-treatment log number of products and the future changes in the services liberalization index. The number of observations has decreased because I use stacked first difference of pre-treatment changes. In Column (2), the date of the liberalization is moved 7 periods forward. In Column (3), three other service sectors that were not liberalized are used to construct the liberalization index. There is no significant effect when using falsified date or non-liberalized sectors, indicating that the effect is not driven by unobserved demand or productivity shocks.

Table 4: Pre-trends and placebo checks.

	(1) $\Delta\mathcal{L}_{jt=1994-2004}$	(2) *Placebo date t+7*	(3) *Placebo sectors*
$\Delta\text{Scope}_{ijt=1989-1993}$	-0.131		
	(0.206)		
Scope		0.004	0.010
		(0.015)	(0.008)
N	365	23054	23054
R-squared	0.001	0.888	0.888

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: In Column (1), the pre-reform 1989-1993 changes in firm-level log number of products is regressed on the change in the services liberalization index between 1994 and 2004. In Columns (2) and (3), the dependent variable is the log number of products as in baseline specification. Placebo sectors are construction, water and electricity. All regressions control for the sum of exposure shares. Standard errors are clustered at the industry level in Column (1) and at the industry-year level in Columns (2) and (3).

Another potential concern is that my baseline results may be confounded by other factors that may influence the decision of a firm to expand its product portfolio. Further, clustering at the industry-year level assumes that observations are independent if they are in the same industry but in different years. In addition, as discussed above, the liberalization index imposes a linearity assumption and could potentially suffer from measurement error. This section addresses the above-mentioned concerns and verifies that the baseline results are robust to alternative specifications. I present three main robustness tests here and refer the reader to Appendix B.2 for additional robustness checks.

The expansion of the product scope may be driven by increased investments into the manufacturing sector rather than the services sector. To account for that, I control for the amount of FDI received at the 2-digit manufacturing sector. The data on FDI are taken

from publicly available FDI newsletters from the Department for Promotion of Industry and Internal Trade.[12] The results presented in the first two columns of Table 5 remain highly statistically significant but slightly smaller in magnitude. Unfortunately, the data on FDI at the industry level are available only from 1998, which decreases the sample size. However, the baseline results hold when running the estimations on the sub-sample for which the FDI data are available.[13] Column (2) shows that when decomposing the aggregate index the results hold: the liberalization of the transport and banking sectors plays the most important role in product innovation of manufacturing firms.

Table 5: Robustness checks.

	Controlling for FDI		Multi-way clustering		Change in prices	
	(1) Scope	(2) Scope	(3) Scope	(4) Scope	(5) Scope	(6) Scope
$\mathcal{L}_{jt-1}$	0.012**		0.021**			
	(0.006)		(0.007)			
$\ln(\text{FDI})_{jt-1}$	-0.002	-0.002				
	(0.008)	(0.008)				
Transport_{jt-1}		0.024*		0.026**		
		(0.013)		(0.010)		
Banking_{jt-1}		0.011**		0.016*		
		(0.005)		(0.008)		
Insurance_{jt-1}		-0.013**		-0.010		
		(0.006)		(0.008)		
Telecom_{jt-1}		0.005		-0.007		
		(0.010)		(0.009)		
$\mathcal{P}_{jt=1994-2004}$					-0.023***	
					(0.004)	
Transport $\mathcal{P}_{jt=1994-2004}$						0.002
						(0.015)
Banking $\mathcal{P}_{jt=1994-2004}$						-0.021***
						(0.004)
Telecom $\mathcal{P}_{jt=1994-2004}$						0.015
						(0.010)
Tariff_{jt-1}	0.011***	0.007*	0.010	0.005	0.006	0.006
	(0.003)	(0.003)	(0.008)	(0.006)	(0.004)	(0.004)
$\text{Input tariff}_{jt-1}$	-0.046**	-0.020	-0.003	0.007	-0.005	-0.006
	(0.018)	(0.019)	(0.017)	(0.015)	(0.011)	(0.011)
N	15523	15523	23054	23054	23054	23054
R-squared	0.916	0.916	0.889	0.889	0.888	0.888

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table.

In the baseline specification, standard errors are clustered at the industry-year level which assumes that observations are independent if they are in the same industry but in different years. In Columns (3-4) I relax this assumption and allow for multi-way clustering. However, multi-way clustering is most appropriate when the number of clusters is large in each dimension (Cameron and Miller, 2015). In my case, the sample consists of 21 industries and 10 years which may be relatively few. Nevertheless, the results on product

[12] The data are available under: https://dpiit.gov.in/publications/si-news-letters Accessed on May 2, 2024.

[13] The results are available upon request.

scope presented in Columns (3-4) remain robust and statistically significant at 5%.

As discussed above, the construction of the index necessarily involves subjective judgment about the relative importance of the reforms and is prone to bias. Hence, I use an alternative measure of the exposure which is the change in the price of services. The β coefficient is expected to be negative, opposite to the main results, because price change is the difference between 2004 and 1994 price. Results presented in Column (5) of Table 5 show that a one percentage point decrease in service prices from 1994 to 2004 resulted in a 2.3% increase in product scope. The magnitude of the effect is similar to Table 3. The price change may be endogenous, hence in Appendix Table B.3, I perform an Instrumental Variable (IV) approach where the change in the price of services is instrumented with the lagged measure of services liberalization. The results of the first stage indicate that the change in service prices is strongly correlated with the liberalization, conditional on other industry covariates. The results from the second stage are in line with the previous findings, the decline in the price of services resulted in an increase in product scope. Column (6) shows that the change in the price of the banking sector was driving the effect.

In Appendix B.2, I present further robustness checks, where I: (i) control for firm-level time-varying characteristics, (ii) relax the linearity assumption by creating binary indicator variables, (iii) instrument the liberalization index with similar services reforms in China, (iv) drop firms that produce only one product in the first two years, (v) drop few service products, (vi) hold the firm's industry constant, and (vii) use ASI from 1999-2004.

6.3 Mechanisms

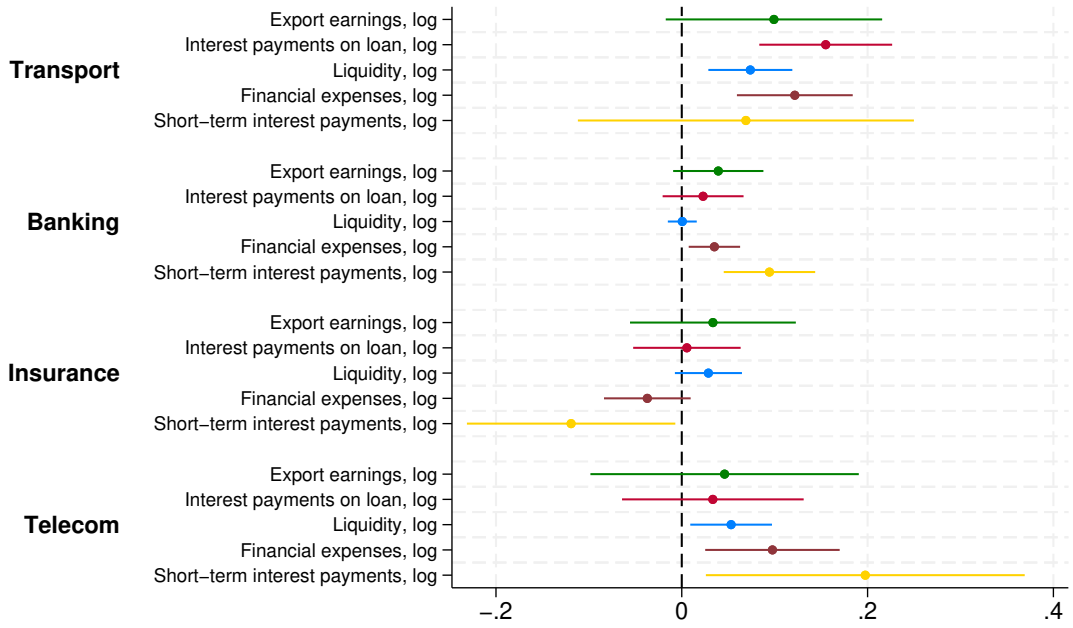
I have established so far that the liberalization of the services sector increases the product scope of manufacturing firms, with reforms in the transport and banking sectors playing the most crucial role for product innovation. Having verified the robustness of the results, this section proceeds with identifying the mechanisms that underline the baseline result.

Intuitively, liberalization of the transport sector could incentivize firms to expand into new markets with diversified products, as transport costs become cheaper. Product diversification, in turn, will increase the product range. Indeed, Figure 5 shows that liberalization in the transport sector increases earnings from exporting (significant at 10%), conditional on reforms in other sectors. Further, transport reforms significantly increase interest payments on loans, firm's liquidity position, and total payments on financial expenses. Unfortunately, the data neither allow me to test if a new product is exported or serves a new domestic market nor the creation of new supplier linkages.

Liberalization of the banking sector could relax financial constraints and allow firms to borrow at a lower interest rate to invest in product innovation. Figure 5 shows that liberalization of the banking sector has significantly increased the amount of interest payments on short-term loans, conditional on all other reforms. Further, the total amount of financial expenses has increased significantly. All these indicate that firms take up more loans, as conditions become more favorable, allowing them to diversify their product portfolio.

To shed light on the type of regulations in these two service sectors, which play crucial

Figure 5: The effect of reforms on exports and financial performance.



Note: This figure plots the coefficient estimates from Equation 7 with 95% confidence intervals for each services sector. Standard errors are clustered at the industry-year level. The estimation equation is as follows: $Y_{ijt} = \alpha + \beta_1 Transport_{jt} + \beta_2 Banking_{jt} + \beta_3 Insurance_{jt} + \beta_4 Telecom_{jt} + \gamma \mathcal{Z}_{jt-1} + \delta \sum_s \omega_{js} * \mathbb{1}(Year_t) + \theta_i + \tau_t + \xi_j + \epsilon_{jt}$

role for manufacturing firms, I create dummy indicators for each of the reforms separately. For transportation, there are two binary indicators: (1) before and after 1994, which marked the liberalization of prices in maritime freight, and (2) before and after 1998, when the government allowed FDI up to 40% in air transport and majority FDI in port construction. For banking, there are four major reforms: (1) in 1994, when FDI up to 20% are allowed, (2) in 2001, when entry barriers are lowered, (3) in 2002, when interest rates are deregulated and banks are allowed to set prices freely, and (4) in 2003, when foreign participation is made easier with the automatic approval up to 49% of FDI and majority ownership is allowed subject to approval. These binary indicators are then interacted with exposure shares as before.

In Column (1) of Table 6, the product scope is regressed on two binary indicators for transport reforms interacted with exposure shares when controlling for liberalization in the other three sectors. Transportation reforms in 1994 and 1998 have no discernible effect on product scope, once the reforms in the banking sector are controlled for. In Column (2), the scope is regressed on four indicators of banking reforms. The results show that banking reforms in 1994 and 2003 had a positive and significant impact on product innovation, after controlling for reforms in the transport, insurance and telecom sectors. This shows that allowing foreign participation in the banking sector was the most important policy. Column (3) documents that the results are robust to controlling for transportation reforms in 1994 and 1998. Intuitively, the literature has shown that foreign banks, in particular, take on more risks relative to domestic banks and decrease information disadvantage for firms by

basing their pricing on internal credit ratings rather than the history of a relationship with a firm (Chen et al., 2017; Beck et al., 2018). This relaxes firm's financial constraints, allowing them to invest in riskier innovation activities.

Table 6: Decomposing reforms in the banking and transportation sectors.

	(1) Scope	(2) Scope	(3) Scope
Transport 1994_{jt-1}	-0.008		-0.002
	(0.015)		(0.015)
Transport 1998_{jt-1}	-0.003		-0.002
	(0.008)		(0.009)
Banking 1994_{jt-1}		0.023***	0.028***
		(0.008)	(0.007)
Banking 2001_{jt-1}		0.005	0.005
		(0.005)	(0.005)
Banking 2002_{jt-1}		-0.005	-0.005
		(0.004)	(0.004)
Banking 2003_{jt-1}		0.007***	0.007***
		(0.002)	(0.002)
Banking_{jt-1}	0.021***		
	(0.006)		
Transport_{jt-1}		0.016	
		(0.010)	
Insurance_{jt-1}	-0.013**	-0.011	-0.013*
	(0.006)	(0.007)	(0.007)
Telecom_{jt-1}	-0.008	-0.005	-0.004
	(0.010)	(0.010)	(0.010)
N	23054	23054	23054
R-squared	0.889	0.889	0.889
i, j, t	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table.

6.4 Which type of products do firms add?

A natural question that arises is: which products do firms choose to add? Using detailed product-level data, I create a binary indicator variable that takes the value of one if a newly added product belongs to the same 3-digit industry as the firm's core or best-performing product. These data are complemented with measures of product differentiation from Rauch (1999) and Kugler and Verhoogen (2012), and product quality from Khandelwal (2010).[14] Since the used measures of product quality are time-invariant, I compute at the firm-year level the number of products classified as high quality using the quality ladder

[14] Rauch (1999) categorizes 4-digit SITC Rev. 2 products into three groups: (1) homogeneous goods traded on organized exchanges, (2) goods not traded on organized exchanges but with a reference price, and (3) differentiated goods without a quoted price. Using the conservative

from Khandelwal (2010), the number of differentiated products using the Rauch (1999) measure, and the number of high R&D intensive products using Kugler and Verhoogen (2012). These measures are then regressed on the liberalization index as in Equation 7.

Table 7: Characteristics of added products and quality effect.

	Product-level	Firm-level		
	(1) Same 3-dig NIC	(2) # high quality	(3) # differentiated	(4) # RnD intensive
$\mathcal{L}_{jt-1}$	0.017*	0.023	0.011	0.028**
	(0.010)	(0.025)	(0.025)	(0.014)
Tariff_{jt-1}	0.010	0.038*	0.012	0.028**
	(0.009)	(0.023)	(0.017)	(0.011)
Input Tariff_{jt-1}	0.035	-0.011	-0.056	-0.028
	(0.022)	(0.035)	(0.040)	(0.030)
N	8039	15705	19605	17412
R-squared	0.356	0.913	0.930	0.907
i, j, t	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed. Column (2) uses the quality ladder of Khandelwal (2010) to calculate the number of high quality products, Column (3) uses the measure of product differentiation by Rauch (1999) to calculate the number of differentiated products, and Column (4) computes the number of high R&D intensive products using the measure by Kugler and Verhoogen (2012).

The results in Column (1) of Table 7 indicate that firms are more likely to add products within the same 3-digit industry as their core product. This is consistent with the idea that firms diversify into input-similar industries, which allows them to gain comparative advantage in industries that use the same set of inputs (Boehm et al., 2022). Appendix Table B.4 shows that this effect is driven solely by the reforms in the banking sector.

Results in Columns (2-4) reveal that services liberalization does not significantly affect the number of high-quality or differentiated products. However, the number of high R&D-intensive products increases significantly following liberalization, suggesting that firms upgrade their product quality. This effect is also solely driven by banking sector reforms.

Extensive theoretical literature has studied the effects of trade shocks on product range adjustment of multi-product firms (Eckel and Neary, 2010; Dhingra, 2013). When new varieties are introduced, consumers re-optimize their consumption bundle by adjusting expenses on all other products, including products produced by the same firm. Because multi-product firms internalize the demand linkages across varieties produced, an introduction of new products leads to changes in the distribution of sales across products within the firm. I test this theoretical prediction using the Theil index as a measure of sales distribution (Mayer et al., 2014, 2021; Flach et al., 2021). This is an index of inequality for

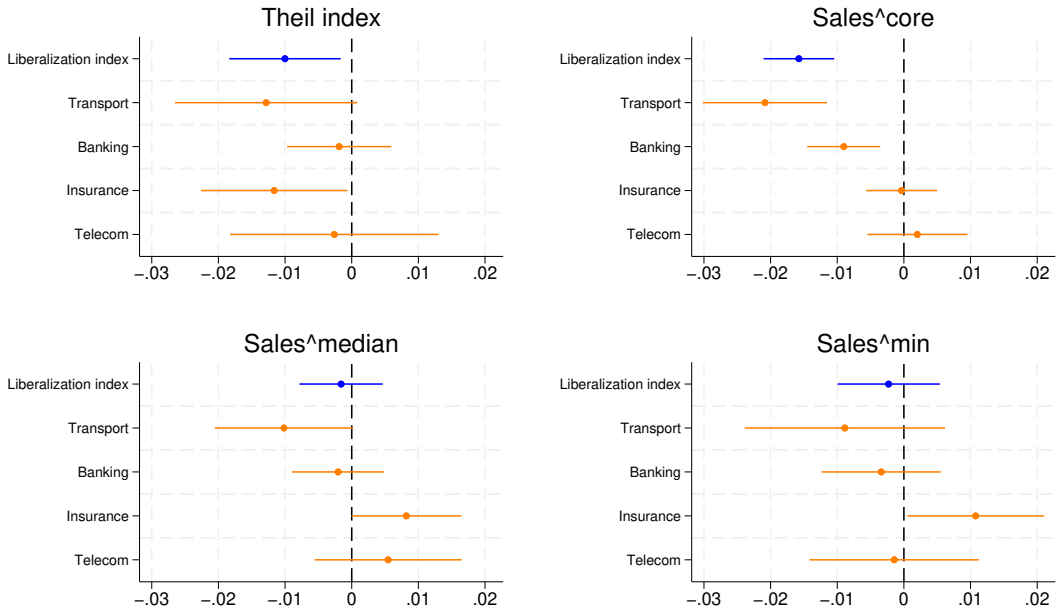
classification by Rauch (1999), I aggregate these products to the 6-digit HS level and convert them to ISIC Rev. 3.1 following the methodology of Piveteau and Smagghue (2019). Homogeneous goods are grouped, and a binary indicator for product differentiation is created. Khandelwal (2010) derives product quality from a nested logit demand system, where quality reflects the mean valuation of US consumers to an imported product. Products with higher market share, conditional on price, are assigned higher quality. I employ a 4-digit SIC Rev. 1987 industry-level quality ladder, defined as the weighted average of initial product ladders, and convert it to ISIC Rev. 3.1 using the concordance table provided by Schott (available at: `https://faculty.som.yale.edu/peterschott/international-trade-data/`).

the distribution of product sales within the firm. The Theil index is calculated as follows:

$$Theil_{ijt} = \frac{1}{N} \sum_{p} \left(\frac{s_p}{\bar{s}} \right) ln \left(\frac{s_p}{\bar{s}} \right) \tag{9}$$

where N is the number of products, s_p is the sales of product p, and $\bar{s}$ is the mean sales across all products of firm i at time t. The higher the Theil index, the greater the concentration of sales. Second, following Chan et al. (2022), I investigate how services liberalization affects sales across the entire range of products, from the best-performing to the median and the worst-performing product in terms of total sales. Thus, I look at the sales share of the best-performing or core product, $Sales^{Core}$, the sales share of the product at the median of the sales distribution, $Sales^{Median}$, and the sales share of the worst-performing products, $Sales^{Min}$, defined as the ratio of core, median, and minimum product sales to total sales of firm i at time t.

Figure 6: Baseline results on the distribution of sales.



Note: This figure plots regression coefficients from Equation 7. Blue dots represent regression coefficients with the aggregate services liberalization index. The orange dots are regression coefficients from a simultaneous regression when all the reforms are controlled for.

Results presented in Figure 6 show that sales become less concentrated after services liberalization, on average, as measured by the Theil index. Decomposition reveals that reforms in the transportation and insurance sectors drive the effect. Looking at the sales of the specific products across the entire range of sales distribution, I document that the sales share of the core product decline significantly following the liberalization. A one standard deviation change in the services liberalization index decreases the sales share of the core product, on average, by 0.02 percentage points. This effect is driven by the liberalization of the transport and banking sectors, whereas reforms in insurance and telecom have no

significant impact. On the other hand, the sales share of the product at the median of the sales distribution and the sales share of the worst-performing product did not experience any significant change. This suggests that the decreased concentration of sales is primarily driven by the decline in the sales of the core product, which is attributed to the fact that added products are close substitutes to the core product, hence, consumers re-optimize their consumption behaviour by switching from the core to the newly added product.[15]

Why would a firm expand its product portfolio if it internalizes the demand linkages across products and a change in demand for newly added products has a negative effect on revenues from the core product? Appendix Table B.6 decomposes sales into the sales from added products in total sales, and the growth rate of total firm's sales. Adding new products is profitable for the firm as the sales share of added products increases after the services liberalization. The level of total sales does not change, but the growth rate of the firm's total sales increases significantly, indicating that diversifying product portfolio, in expectation, results in higher sales growth of firms.

6.5 Other channels

In addition to lowering the fixed costs of product innovation, services liberalization may influence manufacturing firms through other channels, such as: (1) altering variable costs, (2) reducing entry barriers for firms, and (3) increasing demand for manufacturing products. This section provides evidence to rule out these alternative explanations.

Variable cost. Services liberalization can decrease not only the fixed cost of product innovation but also the variable cost of manufacturing firms, denoted in the theoretical model as p_s^p. If services are variable inputs in the production process, liberalization of the services would reduce the marginal cost, which could be reflected either in lower prices or increased output of incumbent products. My theoretical model shows that the decreased price of services will decrease the optimal price charged by the firm. To test the variable cost channel, I look at the prices of incumbent products and the intensive margin sales - the sum of sales of incumbent products that are produced in both $t-1$ and in t.

Column (1) in Appendix Table B.7 shows that there is no discernible effect on the intensive margin sales.[16] Column (2) indicates that prices of incumbent products also do not change following the liberalization. This shows that firms do not pass on the reduced cost effect to final consumers. Overall, the results indicate that service reforms affect the fixed cost of product innovation, but has no significant effect on the variable cost.

Firm entry. Another potential channel through which services liberalization may affect manufacturing firms is firm entry through decreased entry barriers. Unfortunately,

[15] To address the concern that the decline in the sales share may potentially be driven by changes in the denominator, in Appendix Table B.5 I look at the levels of sales for each product type. Analogously, there is a clear and statistically significant decline in the level of sales of the core product. Values are not log-transformed to keep the number of observations constant.

[16] Intensive margin sales include not only the core product (there are only 25% of incumbent products that are also core products), but also sales of other incumbent products, which means that it does not necessarily have to decline due to the presence of demand linkages.

the Prowess data do not allow me to check firm entry and exit because firms are not legally required to report to the collecting agency. Using ASI data allows checking firm entry, but given that the panel data starts in 1999 and the reforms in 1994, it may lead to omitting new entrants during the earlier stages of the reform. Nevertheless, firm entry does not seem to be an important margin of adjustment following services liberalization. Appendix Figure A.8 plots the number of newly registered firms using data from the Ministry of Corporate Affairs. The number of entrants has fallen dramatically since 1995 from 60,000 in 1995 to slightly more than 20,000 in 2001. Appendix Figure A.9 depicts the growth rate of the number of companies over time. Whereas there is an increasing trend since 1960, the growth rate of firms has declined dramatically during the study period, suggesting that firm entry is potentially not an important margin of adjustment after services liberalization.

Demand linkages. The entry of new service providers and increased competition may drive up the demand for manufacturing goods used as inputs in liberalized service sectors. This heightened demand could prompt firms to expand their product range, potentially confounding the results. To account for backward linkages and to focus only on the supply rather than the demand side of services liberalization, I follow Nguyen et al. (2022) and construct a measure of demand linkages as follows:

$$\text{Demand linkage}_{jt} = \sum_{s} \eta_{js} reform_{st} \tag{10}$$

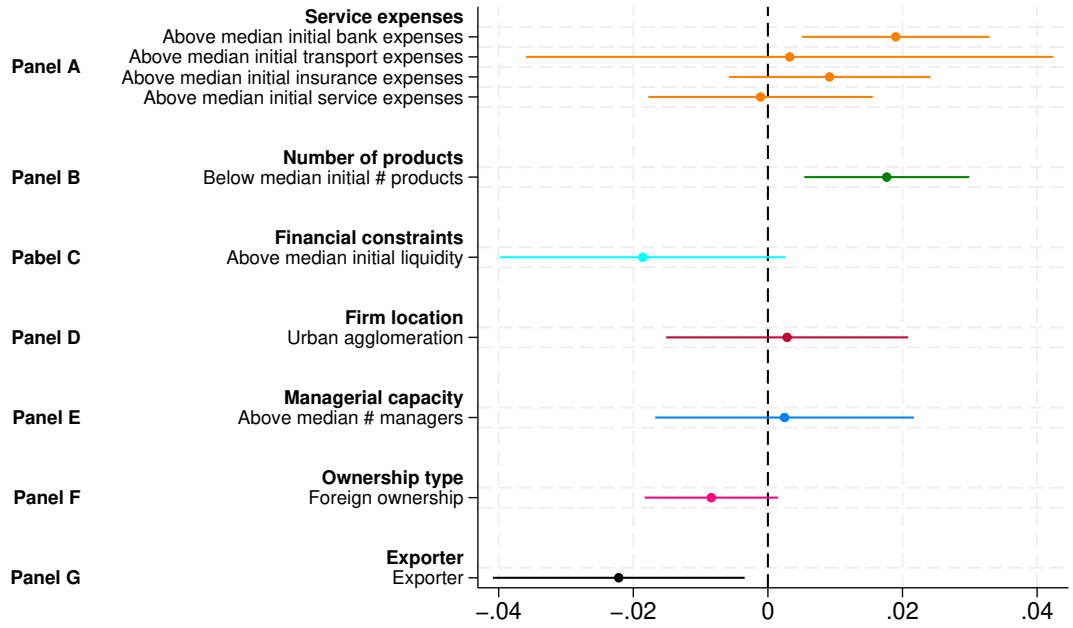
where η_{js} is the share of manufacturing input j in total intermediate inputs of each services sector s. The input share is taken from the 1993 Input-Output table. The results presented in Appendix Table B.8 show that controlling for the demand linkages does not alter the baseline results neither in terms of the magnitude nor the statistical significance. The coefficient on the demand linkages itself is not statistically significant, indicating that there is no significant relationship between the demand for manufacturing goods by service sectors and the product scope of manufacturing firms.

6.6 Heterogeneous effects

This section presents a heterogeneity analysis to explore how different types of firms may benefit from services liberalization. Factors such as initial service expenditures, product range, credit constraints, firm location, number of managers, and ownership status could lead to heterogeneous effects, as firms may respond differently to services liberalization based on these characteristics.

In the sample, 24% of firms report expenses on banking, transportation, insurance, and total service expenses. I calculate the share of each expense category in total firm expenses and create dummy variables for firms with an expense share above the median in the first year. Panel A of Figure 7 presents the results. Firms with a higher initial share of banking expenses benefit significantly more from services liberalization than those with a lower share. However, no differential effect is observed for firms with higher transport or insurance expenses. Additionally, firms with a higher share of total service expenses do

Figure 7: Heterogeneity analysis.



Note: This figure plots the coefficient estimates from Equation 7 with 95% confidence intervals interacted with dummies. Standard errors are clustered at the industry-year level.

not experience differential effects compared to those with a lower share. This suggests no reverse causality, as firms more reliant on services initially do not benefit disproportionately from liberalization. The baseline results remain robust when considering the smaller sample used in the heterogeneity analysis (see Appendix Table B.9).

Hottman et al. (2016) shows that larger firms offer more products than smaller firms. Panel B of Figure 7 examines whether firms with initially smaller product portfolios benefit differently from services liberalization. A dummy variable is assigned a value of one if a firm produces fewer than the median log number of products in the first two years of the sample. The results indicate that firms with fewer initial products benefit significantly more from liberalization compared to firms with broader product portfolios at the outset.

Minetti and Zhu (2011), Amiti and Weinstein (2011), and Manova (2013) have demonstrated that credit constraints limit firms' export activities, including product variety, sales, and the number of destinations. Panel C of Figure 7 examines this relationship by plotting the regression coefficient for the interaction between services liberalization and a binary indicator for firms with an above-median liquidity position in the first year of the sample. The results reveal that firms less financially constrained before the reform benefit less than those initially constrained. This finding suggests that services liberalization effectively reduced credit constraints for manufacturing firms.

Prior research has shown that more productive firms tend to sort into large cities (Gaubert, 2018), and infrastructure developments boost firm productivity (Holl, 2016; Gibbons et al., 2019). In Panel D, I analyze the heterogeneous effects of services liberalization based on firm location. The results indicate no significant difference in the impact

of liberalization between firms located in urban agglomerations and those in rural areas.

Previous studies suggest a positive relationship between product quality, prices, and a firm's managerial capabilities (Manova and Yu, 2017; Bloom et al., 2021; Berlingieri and Pisch, 2022). In Panel E, I examine the role of managerial complexity but find no evidence of a differential effect based on the number of managers. Firms with more than the median number of managers (seven in my sample) are not significantly more affected by services liberalization than firms with fewer managers.

Arnold et al. (2016) find that there is a differential effect of services liberalization based on firm ownership. In Panel F of Figure 7, I interact the liberalization index with a dummy variable for foreign ownership. Contrary to their findings, I do not find strong evidence that foreign firms benefit more from liberalization. If anything, there is weak evidence (significant at the 10% level) suggesting that foreign-owned firms are slightly less likely to add products. Lastly, Panel G of Figure 7 shows that exporting firms are less likely to add products, supporting our evidence that initially smaller, domestic firms are the main beneficiaries of the policy.

7 Conclusion

In this paper, I investigate how services liberalization affects product diversification of downstream manufacturing firms in India. By linking the panel data of firms to the liberalization measure, I am able to track the within-firm adjustments in the extensive margin and attribute the effect to a plausibly exogenous change in the services policy.

The analysis yields that the liberalization in the services sector decreases firms' fixed cost of product innovation, leading manufacturing firms to diversify. The opening of the financial sector to foreign participation seems to have the most pronounced effect on product innovation of downstream manufacturing firms because foreign banks are more risk-tolerant and are more likely to fund riskier innovation activities. Looking at the characteristics of added products, I document that firms are more likely to add products that are close substitutes for their core product. This changes the distribution of sales across products and reduces the sales share of the core product, as consumers switch away from the core product to the newly added product.

These findings have important policy implications. Service inputs are crucial to the production processes, yet, they remain highly regulated, especially in developing countries. Liberalizing the services sector and opening it up to domestic and foreign competition would make these services more widely available to downstream manufacturing firms, which, in turn, would introduce new products to the market. This paper shows that reforms in India's services sector benefit not only the service providers themselves, but also the manufacturing firms that rely on these services. This provides a useful paradigm for other countries seeking to remove barriers and deregulate their services sectors.

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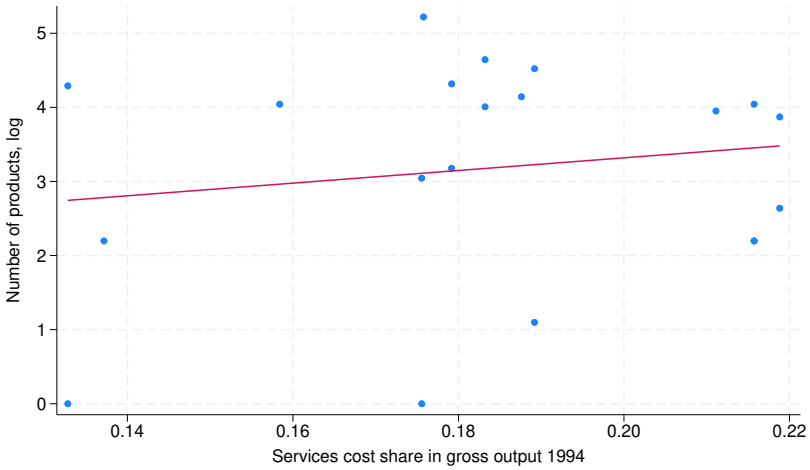
A Appendix

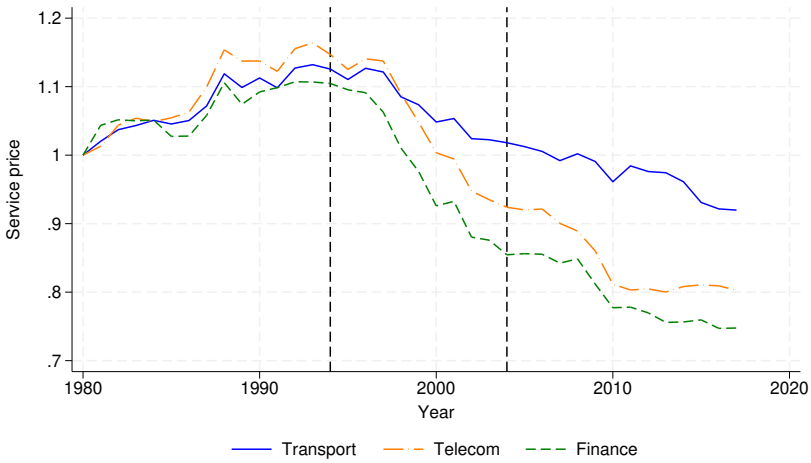
A.1 Appendix Figures

Figure A.1: Correlation between the number of products and service expenses.



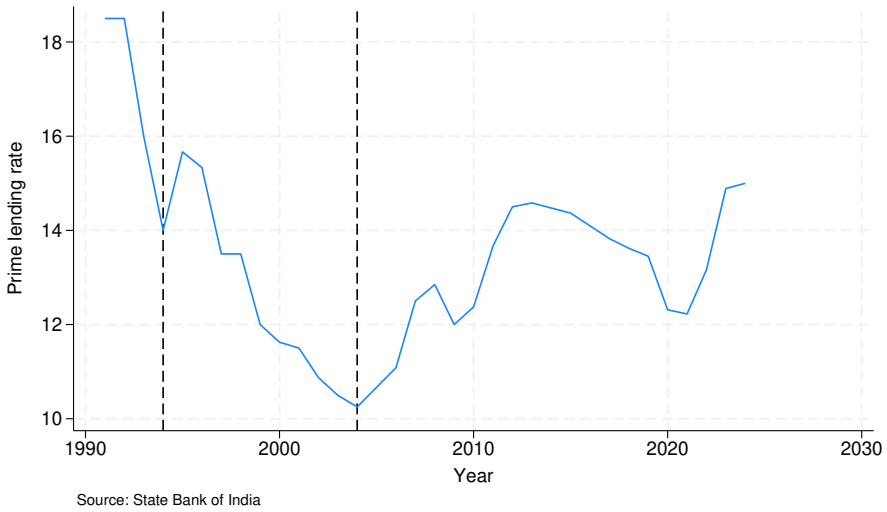
Note: The figure plots the log number of products and the services cost share in total output for the initial pre-treatment 1994 year at the 2-digit manufacturing industry level, when the outlier industry "Coke & refined petroleum products" with low service cost share and high number of products is dropped. Source: KLEMS database, Reserve Bank of India.

Figure A.2: The evolution of service prices from 1980 to 2017.



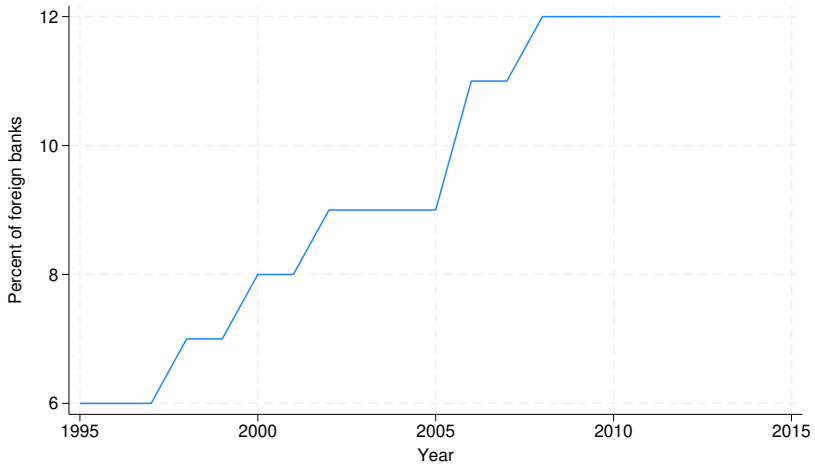
Note: Price is measured as services deflator relative to the GDP deflator. Base year is 1980. Data are taken from KLEMS database provided by the Reserve Bank of India.

Figure A.3: The evolution of the prime lending rate.



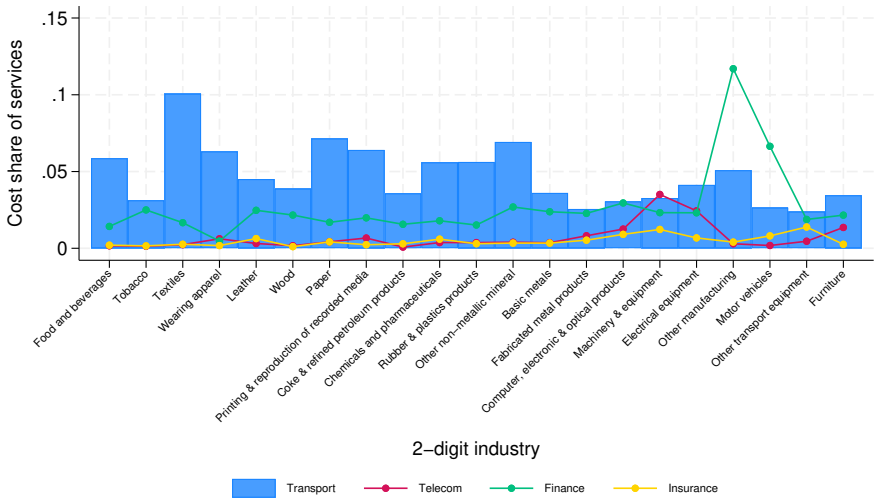
Note: The data on the benchmark prime lending rate are taken from the State Bank of India.

Figure A.4: Percentage of foreign banks to the total amount of banks.



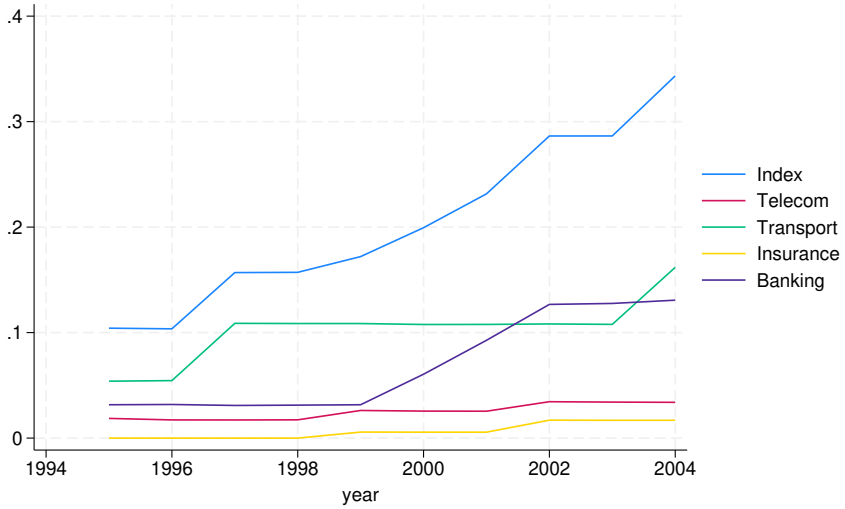
Source: World Bank, Percentage of Foreign Banks Among Total Banks for India, retrieved from FRED, Federal Reserve Bank of St. Louis.

Figure A.5: The cost share of each of the service inputs in total input cost at the 2-digit industry level.



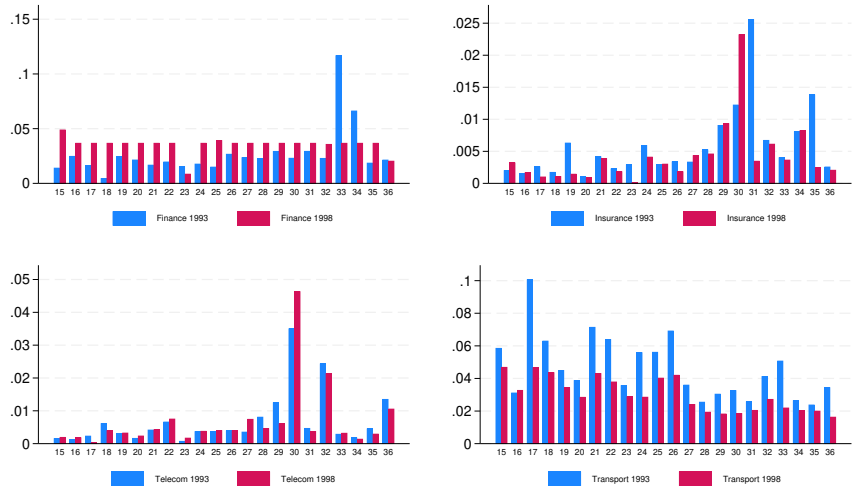
Note: The data on the cost share of each of the service inputs is taken from the 1993 Input-Output Table provided by the Ministry of Statistics and Program Implementation, Government of India.

Figure A.6: The development of the liberalization index for each services sector.



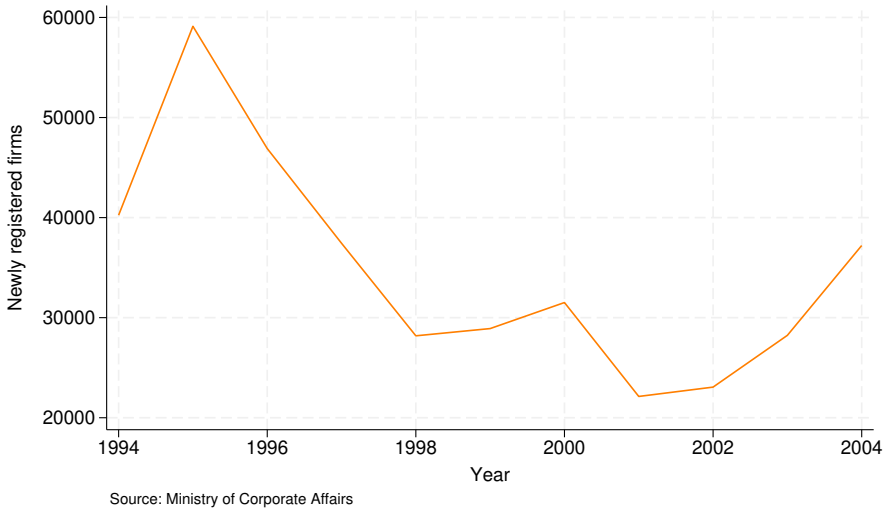
Note: This figure depicts the development of the services liberalization index over time.

Figure A.7: The evolution of service inputs using Input-Output tables in 1993 and 1998.



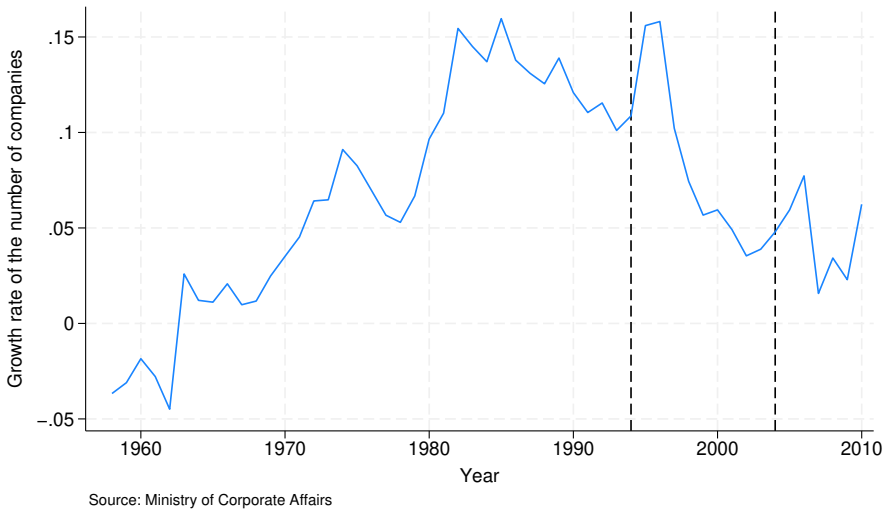
Note: This figure depicts the cost share of each of the services at the 2-digit manufacturing industry using 1993 and 1998 Input-Output tables. The data come from the Ministry of Statistics and Program Implementation, Government of India.

Figure A.8: The evolution of the number of newly registered companies.



Note: The data on the number of newly registered companies are taken from the Ministry of Corporate Affairs.

Figure A.9: The growth rate of the number of companies over time.



Note: This figure depicts the growth rate of the number of companies from 1957 to 2010. The data come from the Ministry of Corporate Affairs.

B Online Appendix

B.1 Appendix Tables

Table B.1: Timeline of services reforms.

Value	Banking	Insurance	Telecom	Transport
0	Public sector plays the dominant role	Public sector plays the dominant role	Public sector plays the dominant role	Public sector is the sole provider of all infrastructure
1	1993/4: FDI up to 20% but foreign banks are banned	1999/00: Foreign participation up to 26%	1993/4: First private networks put in operation	1993/4: Monopoly in domestic air services is abolished. Liberalization of prices in maritime freight
2	2000/1: Barriers to entry are lowered. State intents to withdraw from the sector	-	1994/5: FDI up to 49%	1997/8: Up to 40% FDI in air transport is allowed. First private sector participation in road infrastructure
3	2001/2: Interest rate deregulation allows banks to set prices freely	2002/3: 12 new private providers entered the market	1999/00: New Telecom Policy aims to open national long distance market	2004/5: Private airlines are permitted in international routes
4	2002/3: Foreign participation up to 49% without approval, the majority is subject to approval	-	2002/3: Public monopoly in international gateways abolished. No restrictions on the number of operators in national long distance market	-
5	-	-	-	-

Source: Arnold et al. (2016), technical appendix.

Table B.2: Baseline results using the number of products.

	(1) # products	(2) # products	(3) # products	(4) # products	(5) # products	(6) # products
$\mathcal{L}_{jt-1}$	0.076***					
	(0.029)					
Transport_{jt-1}		0.134***				0.065
		(0.050)				(0.047)
Banking_{jt-1}			0.076***			0.059**
			(0.025)			(0.028)
Insurance_{jt-1}				-0.034		-0.006
				(0.026)		(0.029)
Telecom_{jt-1}					-0.120***	-0.091*
					(0.042)	(0.053)
Tariff_{jt-1}	0.048**	0.038*	0.044**	0.025	0.015	0.027
	(0.022)	(0.020)	(0.021)	(0.020)	(0.019)	(0.019)
$\text{Input tariff}_{jt-1}$	-0.050	-0.042	-0.043	-0.052	-0.049	-0.021
	(0.049)	(0.046)	(0.048)	(0.050)	(0.048)	(0.046)
N	23054	23054	23054	23054	23054	23054
R-squared	0.928	0.928	0.928	0.928	0.928	0.928

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The outcome variable is the number of products. All regressions control for output and input tariffs and firm and year fixed effects. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed. Robust standard errors reported in parenthesis.

Table B.3: IV: Instrumenting change in prices with services liberalization.

	(1) Scope
Second stage	
$\mathcal{P}_{jt=1994-2004}$	-0.286***
	(0.091)
Tariff_{jt-1}	0.009**
	(0.004)
$\text{Input tariff}_{jt-1}$	0.033**
	(0.015)
Observations	23054
R-squared	-0.18
F-statistics	12.96
First stage. Dep var.: $\mathcal{P}_{jt=1994-2004}$	
$\mathcal{L}_{jt-1}$	-0.080***
	(0.022)
Tariff_{jt-1}	-0.001
	(0.008)
$\text{Input tariff}_{jt-1}$	0.129***
	(0.031)
Observations	23054

Note: All regressions control for output and input tariffs and firm and year fixed effects. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed. Robust standard errors reported in parenthesis.

Table B.4: Characteristics of added products and quality effect.

	Product-level	Firm-level		
	(1) Same 3-dig NIC	(2) # high quality	(3) # differentiated	(4) # RnD intensive
Transport$_{jt-1}$	-0.025	0.042	0.055	0.015
	(0.019)	(0.029)	(0.040)	(0.026)
Banking$_{jt-1}$	0.021**	0.017	-0.003	0.021*
	(0.009)	(0.023)	(0.028)	(0.012)
Insurance$_{jt-1}$	0.013	-0.019	0.017	0.011
	(0.013)	(0.019)	(0.029)	(0.021)
Telecom$_{jt-1}$	0.029	-0.015	-0.118***	-0.071**
	(0.019)	(0.033)	(0.044)	(0.034)
Tariff$_{jt-1}$	0.019**	0.028	-0.006	0.017*
	(0.009)	(0.021)	(0.013)	(0.010)
Input tariffs$_{jt-1}$	0.020	0.008	-0.036	-0.020
	(0.024)	(0.033)	(0.039)	(0.030)
N	8039	15705	19605	17412
R-squared	0.357	0.913	0.930	0.907
i, j, t	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed. Column (2) uses the quality ladder of Khandelwal (2010) to calculate the number of high quality products, Column (3) uses the measure of product differentiation by Rauch (1999) to calculate the number of differentiated products, and Column (4) computes the number of high R&D intensive products using the measure by Kugler and Verhoogen (2012).

Table B.5: Level of sales of core, median and worst performing product.

	(1) Core sales	(2) Median sales	(3) Least sales
$\mathcal{L}_{jt-1}$	-219.815**	11.178*	0.433
	(111.145)	(6.095)	(5.713)
Tariff$_{jt-1}$	42.789	-6.286	-5.251
	(94.372)	(5.680)	(3.736)
Input tariff$_{jt-1}$	-829.928*	21.886	-5.961
	(467.151)	(28.912)	(22.542)
N	23054	23054	23054
R-squared	0.913	0.690	0.630
i, j, t	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed.

Table B.6: Sales decomposition.

	(1) Added products sales share	(2) Total sales, log	(3) Total sales growth, log
$\mathcal{L}_{jt-1}$	0.017**	0.016	0.069**
	(0.007)	(0.015)	(0.033)
Tariff_{jt-1}	0.010***	-0.014	-0.019
	(0.004)	(0.012)	(0.044)
$\text{Input tariff}_{jt-1}$	0.005	0.081***	0.116*
	(0.009)	(0.023)	(0.064)
N	4445	23054	13199
R-squared	0.455	0.917	0.739
i, j, t	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Standard errors are clustered at the industry-year level. All regressions control for output and input tariffs. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed. Added products sales share is the share of sales of added products in total sales.

Table B.7: Other channels: Variable cost.

	Firm-level	Product-level
	(1) Intensive margin	(2) Incumbent products price, log
$\mathcal{L}_{jt-1}$	0.002	-0.046
	(0.016)	(0.121)
Tariff_{jt-1}	0.006	0.001
	(0.014)	(0.001)
$\text{Input tariffs}_{jt-1}$	0.057**	-0.015***
	(0.023)	(0.005)
N	22560	56132
R-squared	0.917	0.739
i	✓	✓
t	✓	✓
j	✓	
p		✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed. Intensive margin is defined as the log of the sum of sales of products that are produced both in period $t-1$ and t.

Table B.8: Accounting for the demand linkages for manufacturing firms.

	(1) Scope	(2) Scope	(3) $\text{Sales}^{\text{Core}}$	(4) $\text{Sales}^{\text{Core}}$
$\mathcal{L}_{jt-1}$	0.021***		-0.016***	
	(0.005)		(0.003)	
Demand linkage$_{jt-1}$	0.001	0.009	0.009***	0.007***
	(0.006)	(0.006)	(0.002)	(0.003)
Transport$_{jt-1}$		0.026***		-0.021***
		(0.009)		(0.005)
Banking$_{jt-1}$		0.015***		-0.009***
		(0.005)		(0.003)
Insurance$_{jt-1}$		-0.010		-0.000
		(0.006)		(0.003)
Telecom$_{jt-1}$		-0.010		-0.000
		(0.009)		(0.004)
Tariff$_{jt-1}$	0.010**	0.005	-0.005***	-0.004***
	(0.004)	(0.004)	(0.002)	(0.002)
Input tariff$_{jt-1}$	-0.003	0.007	0.017***	0.014***
	(0.010)	(0.010)	(0.004)	(0.004)
N	23054	23054	23054	23054
R-squared	0.889	0.889	0.834	0.834
i, j, t	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Demand linkage is constructed as specified in Equation 10. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed.

Table B.9: Robustness check of the baseline results for the sub-sample of firms reporting service expenses.

	(1) Scope	(2) Scope	(3) Scope	(4) Scope	(5) Scope
$\mathcal{L}_{jt-1}$	0.026***	0.041**	0.023***	0.028***	0.036***
	(0.007)	(0.016)	(0.007)	(0.008)	(0.012)
Tariff_{jt-1}	0.016***	0.016	0.015***	0.017***	0.029***
	(0.006)	(0.012)	(0.006)	(0.006)	(0.008)
$\text{Input tariff}_{jt-1}$	-0.002	-0.007	-0.001	-0.000	-0.029
	(0.013)	(0.025)	(0.013)	(0.013)	(0.019)
N	13980	2748	12368	14318	6212
R-squared	0.886	0.893	0.889	0.886	0.908
i, j, t	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Column (1) includes the sample for which information on the banking expenses is available. Column (2) includes the sample for which information on the transportation expenses is available. Column (3) includes the sample for which information on the insurance expenses is available. Column (4) includes the sample for which information on the total service expenses is available. Column (5) includes the sample for which information on the managers is available. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Common sample is imposed.

B.2 Robustness checks

In this section I present further robustness checks, where I: (i) control for firm-level time-varying characteristics, (ii) relax the linearity assumption by creating binary indicator variables, (iii) instrument the liberalization index with similar services reforms in China, (iv) drop firms that produce only one product in the first two years, (v) drop few service products, (vi) hold the firm's industry constant, and (vii) use ASI from 1999-2004.

Table B.10: Robustness check controlling for firm-level characteristics.

	(1) Scope	(2) Scope
$\mathcal{L}_{jt-1}$	0.021***	
	(0.007)	
Assets, log	0.078***	0.079***
	(0.011)	(0.011)
Services expenses, log	0.026***	0.026***
	(0.007)	(0.007)
Exporter	0.040***	0.041***
	(0.013)	(0.013)
Transport_{jt-1}		0.033***
		(0.012)
Banking_{jt-1}		0.017***
		(0.006)
Insurance_{jt-1}		-0.018**
		(0.008)
Telecom_{jt-1}		0.004
		(0.012)
Tariff_{jt-1}	0.016***	0.010*
	(0.006)	(0.005)
$\text{Input tariff}_{jt-1}$	-0.011	0.002
	(0.013)	(0.012)
N	14949	14949
R-squared	0.890	0.890

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table.

First, I control for firm-specific characteristics that may impact the decision of a firm to invest in product innovation. I include a log of assets as a proxy for size as bigger firms are more likely to diversify. Given that cheaper service inputs is the primary mechanism for how manufacturing firms could benefit from services liberalization, I control for log services expenditure to shut down this channel. Lastly, I include a binary variable indicating whether a firm is an exporter as exporters tend to be bigger firms with a higher likelihood of producing multiple products. Results in Appendix Table B.10 indicate that the findings remain practically unchanged both in terms of the magnitude and statistical significance when controlling for additional firm-level covariates even when it significantly reduces the

sample size due to data availability.

Second, the construction of the index is based on the linearity assumption. Here, I relax this assumption and construct binary indicators for before and after the main transformation in the sector took place, which I call structural breaks. The main reforms in the transportation sector were implemented in 1997, in the banking sector in 2001, and in the telecommunications and insurance sectors in 2002. These pre- and post-reform indicator variables are then interacted with the exposure weights as before and normalized with mean 0 and a standard deviation of 1. The results in Appendix Table B.11 show that a structural change in the transportation and banking sectors had a significant and positive effect on product innovation. A one standard deviation change in the transportation and banking indexes increases the product scope by 2.6% and 0.9%, respectively (summary statistics for additional variables is provided in Appendix Table B.12).

Table B.11: Regressions from structural break.

	(1) Scope
Transport break$_{jt-1}$	0.026***
	(0.009)
Banking break$_{jt-1}$	0.009**
	(0.003)
Insurance break$_{jt-1}$	-0.001
	(0.006)
Telecom break$_{jt-1}$	-0.007
	(0.004)
Tariff$_{jt-1}$	0.006*
	(0.004)
Input tariff$_{jt-1}$	-0.005
	(0.010)
N	23054
R-squared	0.889
i, j, t	✓
Standard errors in parentheses	
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$	

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. The structural break in the transportation sector was in 1997, for banking - 2001, for telecommunications and insurance - in 2002.

Another concern that could bias the results is reverse causality. In addition to the evidence provided above, I employ an instrumental variable strategy here by instrumenting the services liberalization index with a similar services reform index for China, following Arnold et al. (2016) and Bas (2020). The underlying assumption is that given the

Table B.12: Summary statistics of additional variables.

	N.obs.	Mean	Std. dev.	Min	Max
Transport break lagged	23054	0.000	1.000	-1.545	2.062
Banking break lagged	23054	0.000	1.000	-0.412	6.306
Insurance break lagged	23054	0.000	1.000	-0.417	4.932
Telecom break lagged	23054	0.000	1.000	-0.278	5.916

close development of India and China, it is likely that reforms in China influenced India's policy reforms, which makes it a suitable instrument, while at the same time, it is unlikely to assume that manufacturing firms in India lobbied for reforms in China, fulfilling the exogeneity assumption. Rather, the negotiations to liberalize China's services sector were implemented during its accession to the WTO. The results reported in Appendix Table B.13 confirm previous findings. The instruments are highly relevant, as is seen from the first-stage regressions and high F-statistics, showing that liberalization in the banking sector plays the most crucial role for product innovation.

Table B.13: Robustness check instrumenting reforms in each of the sectors with the reforms for China.

	(1) Scope			
Second stage				
Transport_{jt-1}	-0.082*			
	(0.042)			
Banking_{jt-1}	0.035***			
	(0.009)			
Insurance_{jt-1}	-0.028*			
	(0.014)			
Telecom_{jt-1}	0.001			
	(0.023)			
Tariff_{jt-1}	0.000			
	(0.005)			
$\text{Input tariff}_{jt-1}$	-0.002			
	(0.011)			
Observations	23054			
R-squared	0.03			
F-statistics	113.43			
	(1) Transport_{jt-1}	(2) Banking_{jt-1}	(3) Insurance_{jt-1}	(4) Telecom_{jt-1}
First stage				
China transportation	12.563***	-5.211***	-6.317***	-4.179***
	(0.613)	(1.271)	(0.794)	(0.334)
China banking	0.207	24.639***	1.254***	0.810**
	(0.364)	(1.278)	(0.482)	(0.393)
China insurance	7.916*	46.177***	209.484***	-25.677***
	(4.690)	(10.286)	(8.288)	(3.132)
China telecom	-1.203	-7.506***	5.892***	38.888***
	(1.022)	(2.144)	(2.039)	(1.042)
Tariff_{jt-1}	0.000	-0.069***	-0.144***	-0.104***
	(0.005)	(0.010)	(0.005)	(0.004)
$\text{Input tariff}_{jt-1}$	-0.194***	-0.431***	0.219***	0.097***
	(0.016)	(0.025)	(0.009)	(0.009)
Observations	23054	23054	23054	23054

Note: All regressions control for output and input tariffs and firm and year fixed effects. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Robust standard errors reported in parenthesis.

Further, I look at all firms that produce strictly more than one product. In Columns (1) and (2) of Table B.14, all firms that produce exactly one product in the first two years in the sample are dropped. The number of observations has declined only slightly, indicating that the majority of firms produce multiple products already at the beginning of the sample. The results remain robust. In Columns (3) and (4), I drop the relatively few service products produced by manufacturing firms and the result remains unchanged.

Because 11% of firms switch their industry, in Columns (5) and (6) I perform a robustness test holding the industry constant from the first year in the panel. Industry fixed effects are then dropped from the regression. The results remain practically unchanged.

Prowess contains mostly large, exporting firms that may have the capacity to expand. To verify that the results are not driven by a specific subsample of firms, I use the universe of all manufacturing establishments from the ASI. The main caveat of the ASI is that the panel identifier is only available from 1999 onwards, which is well after the start of the services reforms. Taking this into account, the results presented in Columns (7-8) of Table B.14 show that the reforms have had a positive impact on all manufacturing establishments. Product scope has increased significantly, with a one standard deviation change in the liberalization index increasing the product scope by 1%. Decomposing the index shows that reforms in the banking sector have a significant and positive effect, while reforms in the transportation, insurance and telecom sectors have no discernible effect. This may be attributed to the fact that the most important reforms in the transportation sector were in 1997, whereas in the banking sector - in 2001.

Table B.14: Additional robustness checks.

	Drop single-product firms		Manufacturing products only		Constant industry		ASI	
	(1) Scope	(2) Scope	(3) Scope	(4) Scope	(5) Scope	(6) Scope	(7) Scope	(8) Scope
$\mathcal{L}_{jt-1}$	0.022***		0.019***		0.021***		0.010**	
	(0.006)		(0.006)		(0.005)		(0.005)	
Transport_{jt-1}		0.029***		0.023**		0.024**		-0.003
		(0.010)		(0.009)		(0.010)		(0.017)
Banking_{jt-1}		0.014**		0.014**		0.017***		0.008**
		(0.006)		(0.006)		(0.006)		(0.004)
Insurance_{jt-1}		-0.005		-0.006		-0.011		0.001
		(0.007)		(0.006)		(0.007)		(0.002)
Telecom_{jt-1}		-0.009		-0.012		-0.007		0.002
		(0.009)		(0.009)		(0.009)		(0.007)
N	18010	18010	23262	22992	23054	23054	42548	42551
R-squared	0.861	0.861	0.889	0.890	0.888	0.888	0.862	0.862
i, j, t	✓	✓	✓	✓	✓	✓	✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: Scope is defined as the log number of products. Standard errors are clustered at the industry-year level. All regressions control for the sum of exposure share interacted with year dummies and input and output tariffs. Input tariffs are defined as the weighted output tariffs, where weights are taken from the 1993 input-output table. Singe-product is the firm that produces exactly one product in the first two years in the sample. The industry is fixed to the industry in the initial period of the sample.