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# INDUSTRIAL POLICY AND THE DOMESTIC CONTENT OF MEXICO'S MAQUILA EXPORTS: A LONG-RUN PERSPECTIVE

DEPARTMENT OF POLICY, RESEARCH AND STATISTICS

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**Industrial policy and the domestic content of Mexico's  
maquila exports: A long-run perspective**

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## **Abstract**

This paper studies the domestic value added content of exports in a developing country, namely Mexico's maquiladoras (export-processing firms) during the period 1981 to 2006. Initially, the government viewed maquiladoras as mere providers of employment. This view and subsequent industrial policies shifted with the increasing outward orientation of Mexico in the late 1980s. The government began promoting the sourcing of intermediates from Mexican firms and technological upgrading within maquiladora firms. We combine a recently released input-output table for maquiladora industries with detailed longitudinal data to study whether observed patterns are related to changes in industrial policy. Over time, productivity and the share of skilled workers in maquiladoras increased only modestly. A long-run decline in aggregate domestic value added embodied in maquila exports, from 27 per cent in 1981 to 13 per cent in 2006, is largely explained by the falling domestic content within electronics manufacturing. Changes in the domestic content of exports appear mainly related to internal and external shocks and not to changes in the regulatory environment.

*JEL Codes:* C67, L6

*Keywords:* Domestic content, Industrial policy, Export processing, Mexico

## 1. Introduction

Mexico's export-processing firms belong to one of the oldest and largest international production networks in the world. The first export-processing firms (officially known as *maquiladoras de exportación*) were established during the 1960s. *Maquiladoras* were allowed to import material and equipment without paying tariffs. In combination with low wages, it was very attractive for multinational enterprises to set up an export-processing subsidiary in Mexico. Employment in *maquiladoras* increased from 0.12 million in 1980 to 1.2 million in 2006. *Maquiladoras* account for about 20 per cent of Mexican manufacturing value added and about half of the country's exports in 2006 (Bergin et al., 2009).

In the 1960s and 70s, many developing countries pursued a development strategy termed import substitution industrialization, which aimed at building a domestic industry behind high tariff walls. The emergence of export-processing firms in Mexico was not in line with this import substitution industrialization. However, the government saw *maquiladoras* as necessary providers of employment along its Northern border with the United States due to the end of the *bracero* guest-worker programme for temporary work of Mexicans in the US (mainly seasonal work in agriculture). Over time, policymakers increasingly realized that *maquiladoras* not only provide jobs, but are also important for generating foreign currency and for the development of domestic firms that deliver inputs to these *maquiladoras*. As a result, various policies were put in place during the 1990s to stimulate the technological development of *maquiladoras* and to increase incentives for sourcing inputs locally (SECOFI, 1994; SECOFI, 1998). These policies aimed to increase the domestic content of *maquila* production and the creation of good (skilled) jobs. Basically, it is a policy that many developing countries with export processing zones pursue today. Are these changes in industrial policy in Mexico related to changes in the domestic content of exports? Did productivity and the quality of jobs improve within *maquiladoras* over time?

This paper is the first to study long-term trends in the domestic content of Mexico's *maquila* exports. We combine a recently released input-output table for *maquiladora* industries with detailed longitudinal data on value added, gross exports, employment by skill type, and domestic and imported intermediate inputs to relate observed patterns to changes in industrial policy. *Maquiladoras* in Mexico predominantly export finished goods (Verhoogen, 2008). This compares to a 'typical' firm, which might produce intermediate inputs for use by other firms or sell goods in the local market (and sometimes also the foreign market). In contrast, a *maquila*

firm assembles a good and sells it in the US.<sup>1</sup> We study whether these maquiladoras upgraded their activities (reflected in an increasing skill content and/or rise in productivity), and increasingly sourced intermediate inputs locally, which could signal the success of industrial policies in stimulating the development of the domestic economy.

Despite various industrial policies, we find that the share of domestic value added in aggregate maquila exports fell from about 27 per cent in 1981 to around 13 per cent in 2006. However, the domestic content share varies substantially over time. The 1982 debt crisis and the 1994 tequila crisis together with the run-up and adoption of the North American Free Trade Agreement (NAFTA) in the early 1990s coincide with declines in the domestic content. The emergence of China, especially after its entry to the WTO in 2001, appears related to a gradual decline in the domestic value added of aggregate maquila exports. A decomposition analysis suggests that this is partly driven by the demise of textile manufacturing that has a relatively high domestic value added content. However, the overall long-run decline in aggregate domestic value added embodied in maquila exports is largely accounted for by the falling domestic content within electrical machinery product manufacturing.

Research on the export composition of Mexico typically finds that the technology composition of Mexico's exports increased substantially, because it transformed from one based on raw materials to one dominated by medium- and high-technology manufactured products during the past decades (Sturgeon and Gereffi, 2009). This suggests learning and industrial upgrading is taking place in Mexico. However, to assess whether the transformation is real and not just a shift towards other final assembly activities, one needs to know the value that is added by a country to production rather than the gross output value of its exports, which is the approach taken in this paper. So far, most analyses of the domestic content embodied in exports and technology upgrading within maquiladoras has been limited to surveys and case studies. These studies provide a rich characterization of maquila firms, but it is unclear whether these findings can be generalized. We aim to provide a macro perspective to these case studies. A clear limitation to this approach, however, is that we are unable to causally link industrial policy to the domestic content of exports. We will relate industrial policies to changes in domestic content, but more detailed and novel identification strategies are required to causally link policy and domestic content.

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<sup>1</sup> Most imports are from the US, and over 99.7 per cent of sales were in the US (Utar and Torres Ruiz, 2013).



Our paper is most closely related to de la Cruz et al. (2011, 2013).<sup>2</sup> De la Cruz et al. (2011, 2013) measure the domestic content of Mexico's exports for the period 2000 to 2006. Similar to this paper, they use the 2003 input-output table that distinguishes processing and non-processing activities. Their results for the domestic content share in maquiladora exports in 2003 are fairly similar. Compared to de la Cruz et al. (2011, 2013), changes during 2000-2006 in domestic content are only due to variation in the export composition. In contrast, in this paper we collect and use information on production and inputs. Hence, we allow domestic content to vary if input cost shares change over time, which is more accurate. The purpose of de la Cruz et al. (2011, 2013) is also different from ours. They aim to provide point estimates for the domestic content in Mexico's processing and non-processing exports and compare these to those for China. In comparison, this paper aims to relate changes in the domestic content of maquiladora exports to changes in industrial policy. We take a much longer time perspective, from 1981 to 2006. Industrial policies changed in important ways during the 1980s and 90s (as we will discuss in Section 2), so a long-run approach is necessary to relate changes in the domestic content of exports to changes in industrial policy. Changes in the domestic content of exports are one way to examine whether industrial upgrading is taking place. Typically, if activities shift to higher value adding stages of production (say, from assembly to product development), we also expect these shifts to be accompanied by an increase in skills and capital. In contrast to de la Cruz (2011, 2013), we therefore also examine the productivity performance of maquiladoras and explore changes in the share of non-production workers over time.

The remainder of the paper is organized as follows. In the next section, we provide an overview of industrial policies for the maquila industry from its inception in the 1960s until the merging of the programme in a broader framework in 2006. We argue that industrial policy changed considerably as time progressed, but there is little evidence to guide us whether these policies had their intended effects. In Section 3, we discuss the data and provide a descriptive analysis of changes in the use of domestic intermediate inputs by maquiladoras, as well as productivity growth and the use of skilled workers within maquiladoras. We also examine changes in industry composition from 1981 onwards. Section 4 discusses the estimation of time series input-output tables and describes the method to measure the domestic value added content of exports. Section 5 presents empirical results and it returns to a discussion of industrial policies related to changes in the share of domestic content in maquiladora exports. Section 6 provides concluding remarks.

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<sup>2</sup> See also Johnson and Noguera (2012) who separate the value added content of Mexico's maquila and non-maquila exports for the year 2004.

## **2. Industrial policy and Mexican maquiladoras: an overview**

The maquiladora programme was devised in the 1960s as an emergency programme to cope with rising unemployment observed in the northern part of Mexico. Mexicans were pushed out of the US due to the end of the *bracero* guest-worker programme in 1964. Initially, the maquila programme was restrictive (Contreras and Munguía, 2007). For example, firms were supposed to be located within 20 kilometres of the Mexican border; have a minimum national ownership of 51 per cent; and they were obliged to re-export their entire production. This restrictive legal framework was put in place, because the programme was not in line with the Import Substitution Industrialization (ISI) policies prevailing in Mexico at the time. Providing tariff exemptions to manufacturing firms that are partly foreign owned was simply a policy contrary to the strategy of ISI. As a consequence of this ISI, the government of Mexico hardly implemented policies related to firms operating under the maquiladora programme.

During the 1970s, several laws were passed that aimed to reduce unemployment by permitting the creation of maquiladoras in coastal areas (in 1971), and soon thereafter for the entire Mexican territory (in 1972). Yet most maquiladoras remain along the Northern border of Mexico to avoid higher transport costs. In 1977, a law was passed that allowed maquiladoras to be entirely foreign owned (Urias, 1978). Few attempts were made, however, to promote technological upgrading within maquilas and to increase the domestic content of production. To the contrary, regulations implemented by the Mexican Law on Foreign Investment in 1973 allowed the government to review and control the implementation of technologies in maquiladoras. Also, the government was able to prohibit any foreign firm or new plant from entry if it could harm the national industry (González, 1990). These policies limited the possibility of industrial upgrading as it posed restrictions to the implementation of foreign technologies.

In the mid-1980s, as many Latin American countries (including Mexico) struggled with the debt crisis, Mexico's policies became more outward-oriented and various market-oriented reforms were implemented. A key policy change was Mexico joining the General Agreement on Tariffs and Trade (GATT) in 1985, which served as an initial push for domestic and international trade reforms during the upcoming years. Once this new economic model was established, major changes were observed in the legal framework for maquiladoras. The government recognized the potential of maquila firms as one of the drivers of the new export-led development in Mexico. According to new regulations that were passed in 1989 (see Government of Mexico, 1989), the maquiladora industry was now supposed to meet the following objectives: (1) to provide higher levels of employment; (2) to increase manufacturing exports and levels of

foreign exchange; (3) to stimulate the development and transfer of knowledge, and (4) to promote investment in human capital through further integration with the local Mexican manufacturing industry.

Various researchers have studied the effects of these new government objectives, but so far this has been restricted to selected industries. For example, Wilson (1992) and Carrillo and Hualde (1997) study changes in the technology used in automotive and electronic manufacturing during the 1980s. They find that new technologies were typically introduced to obtain more precision, control and quality in labour-intensive activities. Hence, old machinery was replaced by technologically more sophisticated instruments that still needed a low qualified workforce to operate (Carrillo and Hualde, 1997). Also, more autonomous decision making was observed, but this remained restricted to issues such as recruitment and human resource management. Hardly ever did local managers participate in the selection of inputs or in the decision process of goods to be produced as most of the technical specifications came from abroad. Along the same lines, local management had little influence on investment, finance or production technology decisions (Wilson, 1992).

Output and employment expanded rapidly during the 1990s. And as we will describe below, the composition of output increasingly shifted towards the production of electronic and transport equipment goods. This growth was underpinned by legal changes that were in line with the liberalization of the economy. For instance, the new Law on Foreign Investment of 1990 represented a major relaxation of policies towards foreign direct investment relative to that of 1973, because it reduced uncertainty and allowed for long-term planning of operations. This new regulation was thought to induce a change in current corporate strategies of foreign firms under the maquila programme so that they could develop progressively more technologically complex activities in the country, moving away from labour-intensive ones (Carrillo, 2007). Along the same lines, import licensing continued to decline in importance, and easier and faster administrative procedures were implemented.<sup>3</sup>

In 1994, the removal of trade and investment barriers in the North American Free Trade Agreement (NAFTA) gave rise to another output boost for the maquila industry. The NAFTA agreement increased preferential access of maquiladoras to the US market relative to firms

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<sup>3</sup> At the same time, other export promoting programmes for the manufacturing industry were implemented. In 1990, the “Programas de Importación Temporal para Producir Artículos de Exportación” (PITEX) came into effect with the intention of permitting firms to import intermediate inputs and machinery free of duty as long as 30 per cent of their total sales were exported. The difference between the firms under PITEX and the maquiladora programme lies in the fact that the industries under the latter programme were exempt from a larger amount of taxes. Similarly, unlike maquiladoras, PITEX firms were mainly located in the interior of Mexico as most of their production was destined for domestic consumption (de la Cruz et al., 2011).

outside the NAFTA area due to the execution of the principles of national treatment and ‘most-favored-nation’ (NAFTA Article 102). Non-NAFTA originated inputs had to pay Mexico’s Most Favored Nation (MFN) tax, around 35 per cent in 1994, while the intermediate goods originating in the NAFTA region could be imported free of duty. Hence, these new regulations created an important incentive for the production of parts and components in maquiladoras because the inputs eligible for tariff exemption were not only those including pure NAFTA content, but also those from other regions that have been previously processed in Mexico.<sup>4</sup> In addition, with the NAFTA agreement, the benefits to maquila firms were extended to companies that supplied them goods and services, thereby increasing the incentive for domestic firms to supply maquiladoras.

As a result of this changing economic environment in Mexico, maquiladoras started to introduce more technologically complex procedures. Buitelaar and Padilla (2000) argue that modern management systems were more commonly seen in maquiladoras, such as total quality control, just in time delivery, elaborate operation manuals as well as norms regarding organizational culture and labour discipline. In addition, they find that more skilled workers were employed and they observe an increase in local R&D centres. However, these results are based on a case study and it remains to be seen whether technological upgrading is a general pattern.

A large contraction of output and employment in the maquiladora industry occurred during the early 2000s. This was in part due to the 2001 recession of the US economy with the collapse of the dot-com bubble, and in part due to the industrial emergence of China and its entry to the WTO in 2001. China’s emergence has had a profound negative effect on maquiladoras. The reason for this negative effect is often sought in the similarity of the composition of US imports from Chinese and Mexican producers (Dussel Peters, 2005; Gallagher et al., 2008).

In light of increasing competition, the Government of Mexico implemented more changes in the legal framework that aimed to induce an increasing number of maquiladoras to exit low-tech, labour-intensive industries and evolve toward higher value added, technology-intensive industries (Sargent and Mathews, 2008). During the early 2000s, the government provided substantial tax incentives to maquiladora firms that engaged in research and development activities (R&D) and created a fund to promote Mexico’s software industry (Ruiz Durán et al., 2005). State governments, industry chambers, and universities were also involved in the upgrading efforts. The branch of Mexico’s largest private university system in Guadalajara

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<sup>4</sup> As of 2001, only North American inputs were exempted from tariffs. In order not to lose competitiveness, policy makers implemented a new program called “Sectoral Programmes” (PROSECs) that provided tax exemption to the import of a specific percentage of inputs not produced in North America across selected industries.

established institutes designed to accelerate the development of design engineering centres, software development firms, and technology intensive start-ups in the city's cluster of electronics firms. The government in Mexico was especially interested in attracting new companies engaged in applied research, product and process development, product testing, and high-tech manufacturing in five industries; biotechnology, mechatronics, information technology, health, and nanotechnology (Sargent and Mathews, 2008).

In a nutshell, Mexico's industrial policy towards maquiladoras gradually shifted from viewing them as mere providers of employment towards promoting the sourcing of intermediates from upstream domestic firms and technological upgrading within maquiladora firms. In the next section we discuss the dataset to that will be used to analyse whether these policy changes had their intended effects.

### **3. Database construction and descriptive statistics for maquila industries**

The dataset for detailed maquiladora manufacturing industries consists of longitudinal information on output (gross output and value added), gross exports as well as intermediate inputs and employment distinguished by production and non-production workers. This data is derived from various publications of the statistical office (INEGI 1991, 2001, 2005). The data presented in these publications are based on monthly statistical surveys of the maquiladora industry as well as the five-year economic census. The monthly sample survey of the maquiladora industry collects detailed information on the business operations of maquilas. The setup of the survey did not change much during the period analysed, and the economic census is a full census of economic activity that underpins this monthly survey. Data from 1990 to 2006 can be readily obtained from the national statistical office's website ([www.inegi.org.mx](http://www.inegi.org.mx)), but to trace the development further back and to obtain more industry detail, we collected and digitized hard copies of various reports (notably INEGI 1991, 2001). Detailed industry data following Mexico's industry classification is matched to two-digit industries in the International Standard Industrial Classification 3.1.<sup>5</sup>

After 2006, the maquiladora programme was merged with another programme that offers duty relief for temporary imports, the PITEEX programme (Programas de Importación Temporal para Producir Artículos de Exportación). As a result, the statistical office no longer updates information for maquiladoras. Information that includes maquiladoras and other firms is reported in the monthly statistical report of the IMMEX programme from 2006 onwards

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<sup>5</sup> Our analysis starts in 1981 as we were unable to obtain industry level data further back. The maquiladora programme started in the 1960s, but it only started to boom with the increasing outward orientation of Mexico during the late 1980s (Feenstra and Hanson, 1996). We believe the time period included in this paper captures the most important periods in the history of the maquiladora programme.

(Industria Manufacturera, Maquiladora, y de Servicio de Exportación). Our time series stop in 2006, because it is no longer possible to distinguish maquiladora firms in these reports. Also, policies specific to maquiladoras are no longer present from 2006 onwards. Thus, we focus on the domestic content of maquila exports in the period from 1981 to 2006.

Columns (1) – (4) of Table 1 show gross output shares by industry for 1981, 1990, 2000 and 2006. Note that gross output equals exports for maquiladoras since we assume that everything produced is subsequently exported (this is further discussed in Section 4). Changes in gross output shares reflect changes in industry composition. Textile products, electronics and transport equipment account for the majority of gross output, with the assembly of electronic goods by itself accounting for over half of the gross production value.<sup>6</sup>

During the 1980s, transport equipment and miscellaneous manufacturing (including furniture, jewellery, musical instruments, sports goods and toy production) grew substantially faster as compared to other sectors such as textiles and electronics. The opposite pattern is observed for the 1990s. After 2000, we observe a sharp drop in the relative importance of textile manufacturing. This drop might be related to the entry of China to the WTO in 2001 and the end of the Multi-Fiber Agreement in 2004 that eliminated import quotas for textile products. Mexican textile firms faced relatively tough competition from Chinese firms thereafter. These import competition effects in the US market are likely to differ across industries, for example, due to quality differences and transport costs, but also firm size within industries (Iacovone et al., 2013).

Changes in the relative size of industries carry important implications for the composition of maquila exports and subsequently also for the domestic value added content of exports. In Column (5) we report the share of domestic intermediate inputs in total intermediate inputs in 2006. The share of domestic intermediates varies substantially across industries. Food processing manufacturing sources a lot of inputs domestically (37.9 per cent in 2006) as fresh produce typically requires immediate processing. However, most inputs in the more technologically advanced electronics manufacturing sector are sourced from abroad. The domestic share was only 6.8 per cent in 2006. The share of domestic inputs directly used in production reflects the direct domestic content of maquila exports. Hence, the relative decline of textile manufacturing with a high share of domestically produced intermediates and the relative expansion of electronics and transport equipment manufacturing with a low domestic content

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<sup>6</sup>“Business services” includes activities such as “professional services”, “leisure services” and “other services”. These services are provided by some maquiladoras (INEGI, 2010).

after 2000 suggests that the domestic content in aggregate exports declined. We will examine this in more detail in Section 5.

**Table 1 Descriptive statistics, size and domestic input use maquiladora industries**

	Gross output shares				Domestic intermediate use shares
	1981	1990	2000	2006	2006
	(1)	(2)	(3)	(4)	(5)
Food, Beverages and Tobacco	1.9	1.1	0.4	0.8	37.9
Textiles and Textile Products	15.5	7.4	12.0	7.4	16.0
Leather, Leather and Footwear	1.0	1.0	0.6	0.3	16.0
Pulp, Paper, Printing and Publishing	1.5	3.6	2.0	1.9	17.7
Chemicals and Chemical Products	-	0.3	0.2	0.2	35.1
Rubber and Plastics	2.3	1.6	2.2	3.1	22.9
Other Non-Metallic Minerals	0.4	0.6	0.7	1.9	10.5
Basic Metals and Fabricated Metal	2.4	3.1	3.1	3.2	21.4
Machinery	1.8	2.0	1.8	2.3	17.3
Electronics	55.3	45.9	52.9	53.0	6.8
Transport Equipment	11.4	22.5	16.5	17.2	14.2
Miscellaneous manufacturing	2.3	9.7	6.1	6.9	10.1
Business services	4.2	1.3	1.5	1.8	24.5
Total	100.0	100.0	100.0	100.0	10.9

*Notes:* Columns (1) – (4) show gross output shares in current prices by industry. Column (5) shows the share of domestic intermediate inputs in total intermediate inputs. Total refers to total maquila industries. Wood and Products of Wood and Cork are included in Pulp, Paper, Printing and Publishing manufacturing. *Sources:* INEGI (1991, 2001, 2005) and others, see text.

Figure 1 shows various indicators of technological development within maquila manufacturing industries. The top panel shows productivity growth for total manufacturing and the three largest sectors (textile, electronics and transport equipment manufacturing). We divided real value added by hours worked to measure labour productivity. Based on growth rates of labour productivity an index is constructed, which equals 1 in 1981. The overall trend suggests that productivity hardly improved during the period considered. In 1997, there is a substantial drop in labour productivity, which arises from a substantial increase in hours worked between 1996 and 1997. This change is related to an expansion in the average working hours per week from

34.4 hours to 37.6 hours in 1997.<sup>7</sup> From the late 1990s onwards, productivity improved modestly.

The dataset we constructed distinguishes between production workers and non-production workers. Production workers primarily undertake manual tasks, whereas non-production workers mainly carry out managerial and administrative tasks. The bottom panel of Figure 1 shows the share of non-production workers in total persons engaged, which proxies for the quality of jobs. The figure reveals that more technology-intensive industries such as electronics and transport equipment manufacturing have a higher share of non-production workers compared to less technology-intensive industries such as textile manufacturing. A slightly upward trend, though from low initial levels, can be observed.

Overall, however, the modest positive trend in labour productivity and the small increase in non-production workers suggest that technological development in the maquiladora industry has not advanced at a fast pace. In the next sections, we will study whether the domestic content of exports has increased. We first outline the input-output table and the method to measure the domestic content of exports before turning to the empirical analysis.

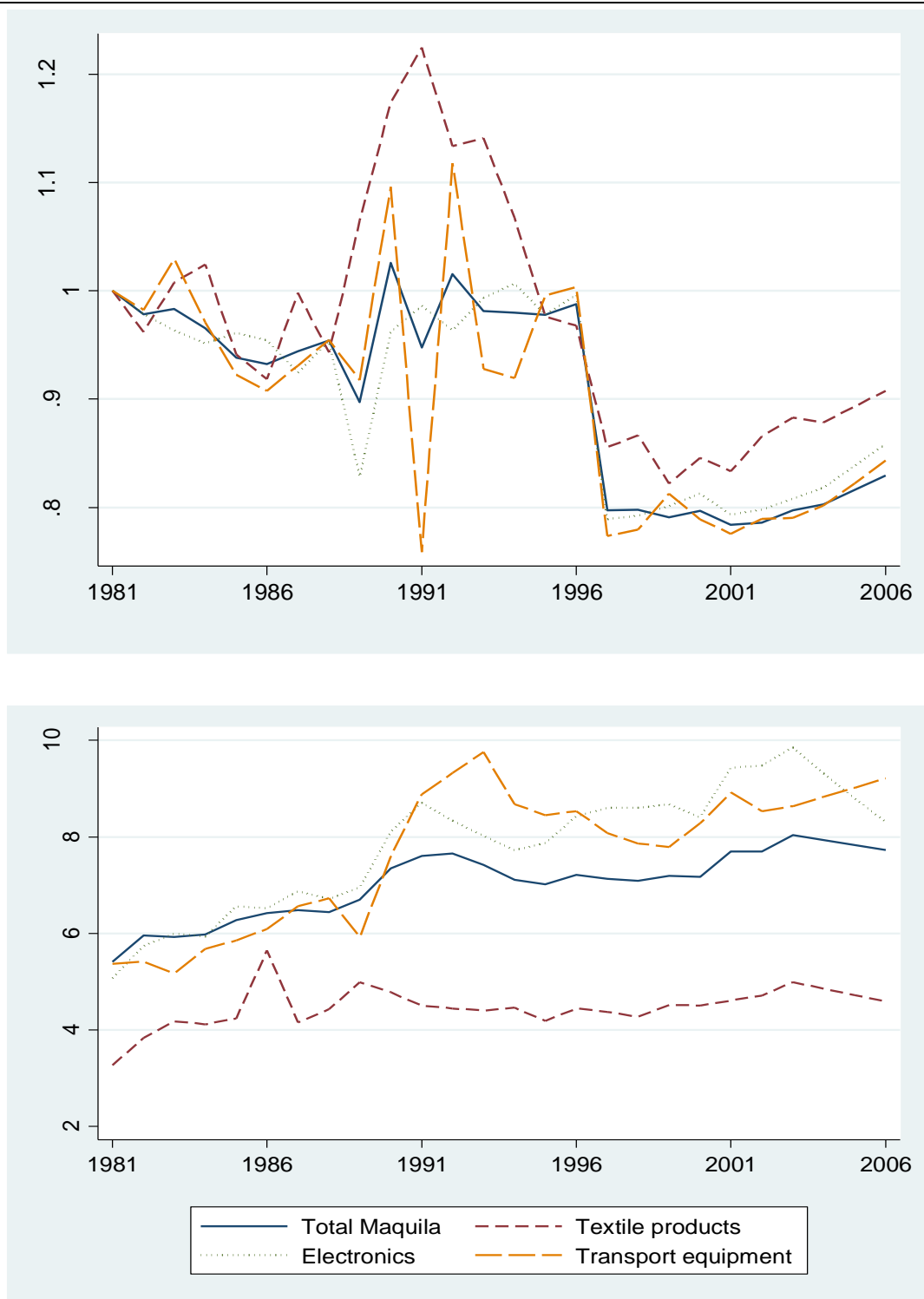
Our preferred method (explained in the next section) to measure the direct and indirect domestic input content embodied in maquila exports requires an input-output table. INEGI recently released such a table for the maquila industry for the year 2003 (INEGI, 2010). Although total economy input-output tables are available for Mexico as well, the use of such tables would introduce a bias in the measured domestic content if the sourcing structure differs across maquiladora and non-maquiladora exporting firms. Dietzenbacher et al. (2012) show how this sourcing structure differs between processing and non-processing firms in China.

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<sup>7</sup> <http://web.mit.edu/course/21/21f.707/Maquilayempleo.html>



**Figure 1 Productivity growth and share of non-production workers, 1981-2006**



*Notes:* The first panel shows productivity growth, which is based on the growth in real value added divided by persons engaged (the index equals 1 in 1981). The second panel shows the percentage share of non-production (white-collar) workers in total persons engaged. *Sources:* INEGI (1991, 2001, 2005) and others, see text.

The maquiladora input-output table is constructed on the basis of a Supply and Use Table (SUT) at basic prices and additional assumptions concerning technology. To transform the SUT in an industry by industry Input-Output Table (IOT), we use the so-called “fixed product-sales structure” assumption stating that each product has its own specific sales structure, irrespective of the industry where it is produced. The sales structure assumption refers to the proportions of the output of the product in which it is sold to the respective intermediate and final users. This assumption is most widely used to transform SUTs into IOTs, not only because it is more realistic than its alternatives, but also because it requires a relative simple mechanical procedure. Furthermore, it does not generate any negatives in the IOT that would require manual rebalancing (see Miller and Blair (2009) for further discussion).

In constructing the maquila SUT, INEGI relies on various internal and externally available statistical sources. The main source for production data is the Monthly Statistical Report for the Maquiladora Industry undertaken by INEGI. This information is combined with the Foreign Trade Database prepared by the Central Bank of Mexico, which contains information on imported intermediate consumption. Trade margins (the difference between products valued at producer and purchasers’ prices) are estimated from the 2004 Commercial Census. Gross value-added is the sum of the wage bill, net taxes on subsidies from production and the gross operating surplus. The “National Survey of Employment for 2003” prepared by INEGI in conjunction with the Monthly Statistical Report was the underlying source of information for these data. For further details on the methods and sources, see INEGI (2010).

#### **4. Methodology to measure the domestic content of exports over time**

This section is divided in two parts. First, we outline the method to measure the domestic content of maquila exports. Second, we discuss the (G)RAS procedure to estimate time series input-output tables for Mexico.

##### **4.1 Measuring the domestic content of maquila exports**

We use the approach from Los, Timmer, and de Vries (2015) to measure Mexican value added embodied in maquila exports. There is a big debate in the literature about how to measure domestic value added in gross exports in global or inter-regional input-output tables, and various methods are proposed (see e.g. Daudin et al. 2011; Johnson and Noguera, 2012; Foster-McGregor and Stehrer, 2013). In an influential article, Koopman, Wang, and Wei (2014) provide a complete decomposition of the gross exports value of a country into nine terms, based on an input-output representation of the world economy. However, their accounting approach is mathematically tedious. And a key issue in that paper concerns what to do with the so-called

‘pure double counted’ terms in measuring the domestic content of exports. When there is two-way trade in intermediates, meaning that country A needs inputs from country B to produce inputs for B, it is typically difficult to establish the origin of these pure double counted terms. Conceptually, tables can be constructed that trace this two-way trade, but empirical input-output tables will never have the required level of detail and it is hard to imagine they ever will, given the amount of information that would be needed. It implies that *all* tasks in *all* supply chains in the world should be represented as separate industries.

Los et al. (2015) introduce an elegant and intuitive method to measure domestic value added in gross exports. They extract all export flows from a country and calculate how much value added would be generated in that hypothetical situation. Domestic value added in exports is defined as the difference between actual and hypothetical GDP in that country. They show their measure is equal to the first five terms in the key equation (36) of Koopman et al. (2014). These five terms in Koopman et al. (2014) do not include any pure double counted terms. In addition, Los et al. (2015) show that their and Koopman et al. (2014) measure of domestic value added in exports is equal to one minus Vertical Specialization (VS), with VS as originally suggested by Hummels, Ishii and Yi (2001). In what follows we explain formally how we measure Mexican value added in maquiladora exports.

Consider  $n$  industries and let the matrix  $\mathbf{Z}$  denote domestic inter-industry flows from industry  $i$  to industry  $j$ . The vector of exports is denoted by  $\mathbf{e}$ , the final demand vector by  $\mathbf{f}$ , the vector of value added by  $\mathbf{v}$ , the vector of industry gross outputs by  $\mathbf{x}$ , and let  $\mathbf{M}$  denote the import use matrix with a typical element  $m_{ij}$  the imports of industry  $i$  by industry  $j$ .

The domestic and imported intermediate input flows for both domestic and maquila industries can be depicted in an adaptation of the ordinary input-output table (see Table 2). The framework is similar to an inter-regional input-output table, with two regions. In this table, the matrix  $\mathbf{Z}^{\text{DD}}$  gives domestic industry deliveries to other domestic industries, whereas  $\mathbf{Z}^{\text{DP}}$  gives domestic inter-industry flows to maquila industries. Likewise, the vector  $\mathbf{v}^{\text{D}}$  gives value added generated in domestic industries whereas  $\mathbf{v}^{\text{P}}$  gives value added in maquila (export-processing) industries.

Note that maquila firms in the final use block are assumed not to deliver output for final demand ( $\mathbf{f}^{\text{P}} = 0$ , see Table 2). INEGI (the national statistical office of Mexico) regularly carries out surveys, and consistently finds that maquiladoras sell less than 5 per cent of their output domestically (Verhoogen, 2008). Some of these domestic sales of maquiladoras may end up as intermediate inputs for domestic firms (which would be in the matrix  $\mathbf{Z}^{\text{PD}}$ , here set to zero). We are unable to take these intermediate transactions into account and this will result in a bias in

our estimates. However, given the typically low value of these transactions we presume this bias will not be large. We also assume  $\mathbf{Z}^{PP}$  is zero, hence no intermediate deliveries amongst maquiladoras, but below discuss an approach to infer the bias from this assumption.

We assume that maquila output is exported, so gross output of maquila firms equals gross exports. This is consistent with procedures at the statistical office INEGI, who give the estimates for the maquiladora industries that are compatible with the Mexican Balance of Payments. In the Mexican BOP, gross output equals gross exports and imported intermediate inputs equals the total value of maquila imports such that the difference is the maquiladora trade balance.

**Table 2 Expanded input-output table for Mexico**

	Intermediate use		Final use		
	<i>D</i>	<i>P</i>	<i>FD</i>	<i>EXP</i>	
<i>D</i>	$\mathbf{Z}^{DD}$	$\mathbf{Z}^{DP}$	$\mathbf{f}^D$	$\mathbf{e}^D$	$\mathbf{x}^D$
<i>P</i>	0	0	0	$\mathbf{e}^P$	$\mathbf{x}^P$
<i>IMP</i>	$\mathbf{M}^D$	$\mathbf{M}^P$	$\mathbf{f}^M$	0	$\mathbf{x}^M$
<i>VA</i>	$(\mathbf{v}^D)'$	$(\mathbf{v}^P)'$			
<i>TOT</i>	$(\mathbf{x}^D)'$	$(\mathbf{x}^P)'$			

*Notes:* D = industries producing for domestic use; P = maquila industries (export processing); FD = final demand; EXP = exports; TOT = gross industry outputs (and total imports in the column TOT); IMP = imports; and VA = value added.

The direct requirements for domestic input  $i$  per unit of output  $j$  are given by

$$\mathbf{A}^{DD} = \mathbf{Z}^{DD} (\widehat{\mathbf{x}^D})^{-1} \text{ for domestic industries (with typical element } a_{ij}^{DD} = z_{ij}^{DD} / x_j^D \text{) and}$$

$$\mathbf{A}^{DP} = \mathbf{Z}^{DP} (\widehat{\mathbf{x}^P})^{-1} \text{ for maquila industries.}^8$$

Production typically requires domestic and imported inputs. However, these inputs in turn also require domestic and imported inputs. The latter effects are indirect effects. The size of these indirect effects depends on the interrelatedness of production across industries and countries. To include both direct and indirect effects in an analysis of the domestic content of exports, we

<sup>8</sup> The circumflex indicates a diagonal matrix, in this case with the vector  $\mathbf{x}$  on the main diagonal.

calculate the total effect using the Leontief inverse  $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ , where  $\mathbf{I}$  is the identity matrix, a diagonal matrix of ones.

The total domestic content of aggregate maquila exports is one minus VS as in Hummels et al. (2001), which is given by

$$DCE = (\mathbf{v}^P)'(\mathbf{I} - \mathbf{A}^{DP})^{-1}\mathbf{e}^P / (\mathbf{u}'\mathbf{e}^P), \quad (1)$$

where  $\mathbf{u}$  is a summation vector consisting of ones, and a prime (e.g.  $\mathbf{u}'$ ) indicates transposition. We will use equation (1) to calculate the Domestic Content of maquila Exports (DCE).

Our framework assumes that maquiladoras do not deliver intermediates to each other. This is a common assumption in the literature; see e.g. de la Cruz (2011, 2013) and Yang et al. (2015). However, the measured domestic content of maquila exports by sector will be biased if there are inter-industry flows among maquiladoras. In particular, if the use of each other's inputs has become more pervasive over time, changes in the domestic content may be overstated for some sectors and understated for others. In a robustness analysis, we examine the sensitive of our results to this assumption.

In the absence of information on intermediate maquiladora deliveries ( $\mathbf{Z}^{PP}$ ), we assume it is equal to ( $\mathbf{Z}^{DP}$ ) and use that to explore the bias in our estimates. The partitioned form of the Leontief inverse is written as

$$\mathbf{L} = \left( \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ \mathbf{0} & \mathbf{I} \end{bmatrix} - \begin{bmatrix} \mathbf{A}^{DD} & \mathbf{A}^{DP} \\ \mathbf{0} & \mathbf{A}^{PP} \end{bmatrix} \right)^{-1} = \begin{bmatrix} \mathbf{L}^{DD} & \mathbf{L}^{DP} \\ \mathbf{0} & \mathbf{L}^{PP} \end{bmatrix}.$$

We use  $\tilde{\mathbf{A}}$  by appropriately summing over the industries in  $\mathbf{L}^{DP}$  and  $\mathbf{L}^{PP}$  ( $\tilde{\mathbf{A}} = \mathbf{I} * \mathbf{L}^{DP} + \mathbf{I} * \mathbf{L}^{PP}$ ) and  $\tilde{\mathbf{e}}^P$  excludes the intermediate deliveries  $\mathbf{Z}^{PP}$ .<sup>9</sup> Our alternative estimate of the domestic content of maquila exports is then given by

$$\widetilde{DCE} = (\mathbf{v}^P)'(\mathbf{I} - \tilde{\mathbf{A}})^{-1}\tilde{\mathbf{e}}^P / (\mathbf{u}'\tilde{\mathbf{e}}^P). \quad (2)$$

In order to measure the domestic content of exports annually from 1981 to 2006, we need a time series of the expanded input-output table as shown in Table 2.

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<sup>9</sup> These intermediate deliveries are the obtained by summing over  $\mathbf{Z}^{DP}$ .

## 4.2. Construction of time series IOTs

For the purposes of this paper we extrapolate the 2003 maquila input-output table. To do so, the literature offers a wide pallet of methods to project IOTs for non-benchmark years. Temurshoev et al. (2011) provide an overview and asses the performance of various projection methods. They find that (G)RAS gives one of the most reliable projections of the data. We use the iterative algorithm of (G)RAS proposed by Lenzen et al. (2007). Basically, the G-RAS procedure requires a benchmark input-output table - the domestic and maquila table for 2003 in our case - and row and columns sums for all years for which we would like to estimate IOTs. (G)RAS estimates new IO matrices for all years as close as possible to the benchmark table under the external constraints of the row and column sums. We implement this approach for the domestic intermediate use block of the maquila table ( $\mathbf{Z}^{DP}$ ) for the period from 1981 to 2006.

While this approach allows us to project IOTs for non-benchmark years, an important limitation that we face is the absence of benchmark tables for earlier years. Our approach takes into account differences in the overall structure of the maquila and domestic industries, but if intermediates sourcing structures change substantially over time, these changes are not necessarily well accounted for. Temurshoev et al. (2011) assess the bias in projecting supply and use tables (the building blocks for IOTs) for Spain and the Netherlands. That is, they project a table to a particular year, say 2000 and compare the projected table with the officially published table from 2000. A five-year projection of the use table (projecting for 2000 using a 1995 benchmark table) results on average in about a 9 per cent margin of error for any particular element in the use table.<sup>10</sup> A ten-year projection of the use table gives an almost 18 per cent margin of error, almost twice as large. If this carries over to our context, our projection for the earliest year in our sample, 1981, based on the 2003 benchmark table may have a 40 per cent margin of error. This is a substantial error margin and it might be even larger in our projections considering the more volatile development path in Mexico compared to Spain and the Netherlands on which the estimates by Temurshoev et al. (2011) are based. It is a serious limitation of the analysis presented here, and we will get back to this when discussing the results, in particular for the early 1980s. However, our approach is not uncommon in the literature. See, e.g., Johnson and Noguera (2014) who estimate global input-output tables backwards for four decades. Also, one reason why we presented measures of upgrading such as productivity growth rates and the share of non-production workers in Section 3 was to back up our key finding, namely that the domestic content of maquiladora exports has been in a long-

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<sup>10</sup> This is based on a weighted absolute percentage error, which weights each percentage deviation of a cell element in the use table from the true element by the relative size of the corresponding true element in the overall sum of the actual elements. We discuss the weighted absolute percentage error for its simplicity in interpretation but note that a more sophisticated measure, the psi statistic, produces essentially the same results.

term decline. In addition, in the next section we seek to relate several sector-specific findings to sector-specific policies to be more certain that we are capturing something real and not just measurement error.

## **5. The domestic content of maquila exports**

In this section we describe the evolution of Mexico's value added share in maquila exports for the period from 1981 to 2006. In Section 5.1 we document aggregate and industry trends. Subsequently we examine whether changes in the aggregate trend are driven by changes within industries or by changes in the industry composition in Section 5.2.

### **5.1 The domestic content of maquila exports: aggregate and industry trends**

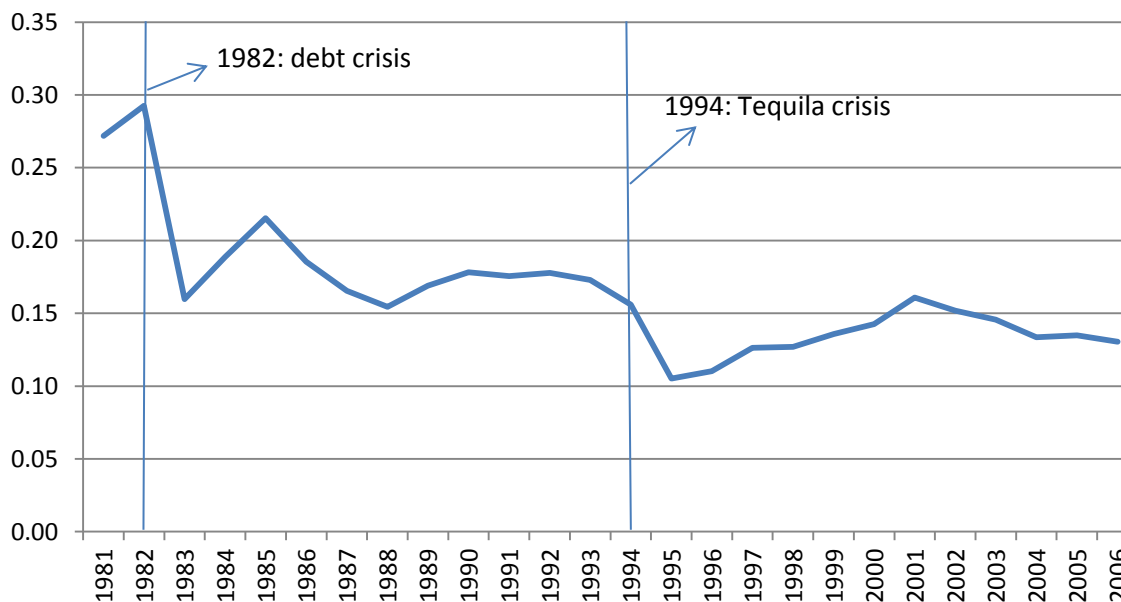
The share of domestic content in aggregate exports is shown in figure 2. We use the extended input-output tables and equation (1) to calculate domestic content for the period from 1981 to 2006. The figure reports the total domestic content, which incorporates indirect effects, because for the production of domestic intermediates also imported inputs are used. In 1981, the domestic content share in Mexico's maquila exports is about 27 per cent. In 2006 this share has fallen to about 13 per cent. Even if we ignore the turbulent early 1980s, our findings suggest that the domestic content was between 15 per cent and 20 per cent. This suggests the domestic content of maquila exports has declined substantially.

Buitelaar and Perez (2000) use detailed firm-level studies to explain why local firms supply so few inputs to maquiladoras. They argue that part of the low domestic content embodied in maquila exports relates to the regulatory environment that did not stimulate the development of a local supplier network until the increasing outward orientation in the late 1980s. Other factors are at work that relate to persistent low domestic content, even after the policy changes that started to stimulate local sourcing. These other factors include transnational corporate strategies that do not consider local procurement to be important, and US import tariffs on Mexican intermediates embodied in maquila exports. Supply side constraints also affect the domestic content of exports. For example, local firms have to pass very strict and time-consuming processes of certification and quality control before they can provide multi-national firms with inputs, which appears in particular an obstacle to potential suppliers to electronics maquiladoras. In addition, the quality and technology of inputs demanded by maquiladoras is typically quite high and often subject to change. Maquiladoras demand low prices for their inputs, and they demand predictable delivery times.

The domestic content varied substantially over time. In particular, the 1982 debt crisis and the 1994 Tequila crisis coincide with a substantial drop in domestic value added embodied in

maquila output.<sup>11</sup> After the 1982 debt crisis there does not seem to be a recovery, but after the 1994 crisis the domestic content recovered to levels observed before the crisis. The increasing value added content during the second half of the 1990s is consistent with case study findings presented by Buitelaar and Perez (2000). Indeed, the abolition of US duties on Mexican intermediate inputs with the 1994 NAFTA agreements might have had a positive effect on domestic sourcing by maquiladoras, although the 1985 GATT agreement appears unrelated to a substantial change in domestic value added. After 2001, we observe that the domestic content share decreases again. These results suggest that aggregate patterns appear mainly related to internal and external shocks, such as the 1982 and 1994 crisis, and not so much to changes in the regulatory environment.

**Figure 2** The domestic content of aggregate maquila exports



*Notes:* Domestic content as a share in aggregate maquila exports. Authors' calculations using time series estimates and equation (1).

In Table 3 we further explore the domestic content of exports at the industry level. These results are obtained by replacing the export vector  $e^P$  in equation (1) by a diagonal matrix with the vector  $e^P$  on the main diagonal. The findings suggest that the domestic content differs substantially across sectors. In particular, the domestic content is low in electronics

<sup>11</sup> These findings seem at odds with currency devaluation, which one would expect to result in a decrease of imported intermediates. However, other effects may dominate. For example, credit constraints or increased uncertainty may affect domestic sources, and changes in industry composition of exports may also affect these outcomes. If industries with lower domestic value added content expand, the overall effect is a decrease in domestic content of aggregate maquila exports, further discussed in Section 5.2.



manufacturing (9 per cent in 2006) as compared to textiles manufacturing (21 per cent). The findings tend to suggest that the domestic content is lower in technology-intensive sectors.<sup>12</sup>

The time series results from 1981 to 2006 suggest that in some industries the domestic content was relatively stable, for example, in textiles at about 21 per cent. However, in most industries the share fell, even if we ignore the results for the early 1980s, although the decline then becomes less pronounced. For example, in the non-metallic minerals industry, the domestic content declined substantially from 38 per cent in 1981 to 10 per cent in 2006. This sector experienced a considerable change in its sourcing pattern, in particular after the implementation of NAFTA, which removed tariff imports of glass, gypsum and cement. The domestic content of leather and footwear maquila manufacturing declined during the 1990s, after the opening up of the market in 1988, when tariffs on imports were cut and all import licenses were eliminated. Mexican shoe manufacturers were initially ill-equipped to compete with imports on price, quality and fashion content (Rabellotti, 1999). It also brought more pressures to domestic suppliers in the footwear industry since there were great difficulties in the supply of raw materials and particularly in the supply of bovine leather (Ortiz and Martinez, 2000). Thus, many producers substituted domestic supplies with cheaper and higher quality imported supplies (Woodruff, 1998).

The pulp, paper, printing and publishing sector experienced a gradual decline in domestic content after 2000. Here Mexican firms face stiff competition from forestry firms in Canada and the United States who leverage their technology and scale of production to supply forestry products of high quality and low price. The biggest change for machinery manufacturing appears to have occurred in the 1980s. In its “Plan Nacional de Desarrollo Industrial: 1979-1982” the government began promoting the production of capital goods. The government was expected to purchase 40 per cent from the total production of machinery and equipment. Furthermore, the domestic production of machinery and equipment was to be purchased by the government with a price 15 per cent higher than the one established by the market. The government also offered to pay the transportation costs. Following the same stream of ideas, the government also offered fiscal credits (25 per cent for new investments) and preferential prices for electricity, fuel oil, natural gas and basic petrochemical goods (Bancomext, 1979). Nonetheless, the government decided to stop this whole programme due to the debt crisis faced by Mexico in 1982. After that, imports of machinery products became increasingly important. In business services the domestic content also fell, especially during the 1990s from 42 per cent in 1990 to 25 per cent in 2000. The maquiladora business services sector mainly consists of the

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<sup>12</sup> de la Cruz et al. (2011, 2013) find similar differences across sectors.

provision of specific services to maquiladoras such as renting of industrial units, transportation, customs tariff advice, legal advice, services for the hiring and provision of labour and they supply services aimed at facilitating maquiladora exports. A Maquiladora decree in 1989 (and a follow up in 1998) gave services firms much more freedom in importing equipment and other inputs free of duty (González-Aréchiga et al. 1991, which might be related to the drop in domestic content after 1990.

The food sector experienced an increase in domestic content during the 1980s and a decline after the 1990s. Initially, in the early 1980s, the food sector was characterized by a high level of foreign content. Most of the multinationals in the food industry were of US origin. These firms used abundant and cheap agricultural products from the US, such as wheat, soy, sorghum and milk, because they were highly subsidized by the US government. In contrast the multinational firms did not process much of Mexico's main food staples such as corn, beans, and rice (Rama, 1984). In order to increase the domestic content in the food industry, the Mexican government imposed several restrictions on agricultural imports when the GATT was signed (GATT, 1986). Amongst others, these import restrictions included a 45 per cent tariff on imports of condensed milk, 50 per cent on butter, 10 per cent on sorghum, 40 per cent on corn, wheat, soy, beer, wine (GATT, 1986). Our findings suggest that these restrictions are related to an increase in domestic content during the 1980s, suggesting a switch to more domestic inputs following the GATT provisions. However, in line with the implementation of NAFTA, the restrictions for the imports of sorghum were removed in 1994, those for wheat, milk and soy in 2003 and those for corn in 2008 (Schwentenius Rindermann and Gómez-Cruz, 2001). The maquiladora decree of 2002 also allowed tariff exemptions on the imports from milk (powder), eggs, corn (powder), and sugar. After 1990 we again observe a decline in the domestic content of the food industry.

For the largest maquiladora sector, 'maquiladora electrónica' or electronics maquiladoras, we also find a decline in the domestic content, from 23 per cent in 1981 to 9 per cent in 2006. During the 1980s, as electronic production expanded, more complex technologies were introduced such as microelectronic machinery (Brown and Dominguez, 1989). These technologies were intended to better control the productive process and reduce labour costs. Besides reducing on direct labour inputs, local suppliers also faced difficulties in expanding their supply of intermediates. For example, local suppliers experienced difficulties in obtaining quality certificates; had continuous changes in the design of electronic products; and faced formidable foreign competition. In 2001, a critical year for the electronic industry with the dot.com crisis in the US and the entry of China to the WTO, the Mexican government unilaterally implemented the 'Information Technology Agreement (ITA)' (Olliver-Fiero, 2007).

The ITA eliminated tariffs on electronics imported into Mexico, including tariffs on subassemblies and raw materials used for electronics production. These policies helped to strengthen the position of maquiladora producers in the electronics industry, but they did not promote the production of subassemblies and components by Mexican firms. Most inputs provided by local suppliers are those used in the last stage of manufacturing production, such as corrugated fibreboard, accessories for metal casting, instruction manuals, wooden pallets, polyethylene, foam, uniforms, packaging and so forth (Carrillo and Zarate-Cornejo 2003).

**Table 3 Domestic content of maquila exports, industry results**

	1981	1990	2000	2006
Food, Beverages and Tobacco	0.22	0.27	0.25	0.18
Textiles and Textile Products	0.22	0.21	0.21	0.21
Leather, Leather and Footwear	0.31	0.28	0.19	0.18
Pulp, Paper, Printing and Publishing	0.24	0.20	0.23	0.19
Chemicals and Chemical Products	-	0.18	0.20	0.24
Rubber and Plastics	0.31	0.23	0.22	0.20
Other Non-Metallic Minerals	0.38	0.28	0.19	0.10
Basic Metals and Fabricated Metal	0.24	0.15	0.19	0.15
Machinery	0.34	0.17	0.16	0.13
Electronics	0.23	0.15	0.11	0.09
Transport Equipment	0.24	0.19	0.16	0.17
Miscellaneous manufacturing	0.31	0.21	0.17	0.19
Business services	0.56	0.42	0.25	0.25

*Notes:* Authors' calculations using time series estimates and equation (1) where  $e^P$  is put on the main diagonal of a matrix of equal dimension as the number of industries.

In Appendix Table 1 we show that the trends discussed above are very similar to what we observe if we account for inter-industry flows among maquiladoras (proxied by  $\mathbf{Z}^{DP}$ ). The differences are small, mainly because these inter-industry flows are only accounted for as second- and higher-order effects. This suggests that the estimates are probably not substantially biased if inter-industry flows are omitted. In the next section, we combine changes in the domestic content with changes in export to examine whether the aggregate patterns observed in Figure 2 are related to changes within industries or a result of changes in the product composition.

## 5.2 The domestic content of maquila exports: a disaggregation analysis

To disaggregate the aggregate change in domestic export content, we apply a ‘within’ and ‘between’ analysis, which can be written in the current context as follows

$$DCE_{t+1} - DCE_t = \sum_i \left( \left( (DCE_{i,t+1} - DCE_{i,t}) \left( \frac{\omega_{i,t+1} + \omega_{i,t}}{2} \right) \right) + \left( (\omega_{i,t+1} - \omega_{i,t}) \left( \frac{DCE_{i,t+1} + DCE_{i,t}}{2} \right) \right) \right), \quad (3)$$

where  $DCE_{i,t}$  is the domestic content of exports by industry  $i$  in year  $t$ , and  $\omega_{i,t}$  is industry  $i$ 's share in total exports at time  $t$ . The industry contribution in equation (3) is split into two terms. The first term gives the industry contribution due to changes in the industry level DCE share (within), and the second term gives the contribution due to changes in the industry-level export share (between).

The results from this decomposition are given in Table 4 for the period from 1981 to 2006. Contributions from the three most important maquila industries (based on export shares) are shown, namely textiles and textile products, electronics and transport equipment. The other industries are grouped. The decomposition suggests that changes in the aggregate domestic content are mainly accounted for by changes within industries. The substantial drop in the domestic content of electronics manufacturing accounts for almost two-thirds of the aggregate change in domestic content.

**Table 4 Sources of change in domestic value added of maquila exports, 1981 to 2006**

	Share of domestic content in exports		Contribution of (in per cent):		
	1981	2006	Change in industry DCE intensity	Change in industry share in overall exports	Total
<b>Total maquiladora</b>	<b>0,27</b>	<b>0,13</b>			
Textiles and Textile Products	0,22	0,21	0,8	14,5	
Electronics	0,23	0,09	64,3	3,0	
Transport Equipment	0,24	0,17	8,1	-9,8	
Other			25,4	-6,4	
			98,6	1,4	100

*Notes:* authors' calculations using equation (3).

The dominance of within-industry effects is confirmed from decompositions using different time periods. In Table 5, we do the same decomposition, but for the period from 2001 to 2006. This period coincides with the demise of textile maquiladora activities due to the strong competition from China after its entry to the WTO in 2001 and the end of the Multi-Fibre Arrangements in 2004 (Utar, 2013). The effect of the shrinking share of textile manufacturing output (it fell from 13 per cent in 2001 to 7 per cent of gross output in 2006) is clearly borne out by the decomposition results. About one third of the fall in the domestic content between 2001 and 2006 is accounted for by textile manufacturing. Interestingly, changes within industry still explain most of the change in the domestic content of exports. The 'within' explanation of changes in the aggregate content is the dominant explanation, also if we consider different time periods. Again, electronic manufacturing accounts for the majority of the within-industry decline in the domestic content of exports.

**Table 5 Sources of change in domestic value added of maquila exports, 2001 to 2006**

	Share of domestic content in exports		Contribution of (in per cent):		
	2001	2006	Change in industry DCE intensity	Change in industry share in overall exports	Total
<b>Total maquiladora</b>	<b>0,16</b>	<b>0,13</b>			
Textiles and Textile Products	0,24	0,21	9,5	35,4	
Electronics	0,12	0,09	53,5	-5,4	
Transport Equipment	0,17	0,17	2,8	-2,3	
Other			23,2	-16,8	
			89,0	11,0	100

*Notes:* authors' calculations using equation (3).

## 6. Concluding remarks

This paper studied the domestic content of maquila industries. It took a long-run macro perspective in order to relate changes in industrial policies to changes in the domestic content of maquila exports. Initially the government viewed maquiladoras as mere providers of jobs. This view and subsequent industrial policies shifted with the increasing outward orientation of Mexico in the late 1980s. We combined a recently released input-output table for maquiladora industries with detailed longitudinal data on output and inputs to study whether observed patterns are related to changes in industrial policy. We find substantial differences in the domestic value added content of exports across industries and over time. The domestic content is typically higher in labour-intensive goods manufacturers, such as textiles, compared to more capital-intensive industries such as transport and electronic goods manufacturing. Over time, productivity and the share of skilled workers in maquiladoras improved only modestly. A long-run decline in aggregate domestic value added embodied in maquila exports, from 27 per cent in 1981 to 13 per cent in 2006, is largely accounted for by the falling domestic content in electrical machinery product manufacturing. Overall, our findings suggest that even if industrial policies

had their intended effects for specific sectors at specific moments in time, these effects are not observed in the aggregate as the domestic content fell.

This paper is the first to study long-term trends in the domestic content of Mexico's maquila exports. So far, most analysis of domestic content and technology upgrading within maquiladoras are limited to case studies. We provide a macro perspective to these case studies. A clear limitation in this approach is that we are unable to causally link industrial policy to the domestic content of exports. Typically, detailed micro studies are better able to isolate effects of particular policies. However, our findings show the overall picture, which suggests that even if some detailed micro studies may find that industry-specific policies have been successful (Jordaan, 2011), overall these policies are not visible as productivity levels and the use of skilled workers in maquila industries hardly improved. Also, we do not find a systematic tendency of increased domestic sourcing of inputs. This carries important implications for other developing countries that try to start a process of technological upgrading after entering global value chains via final assembly activities.

Various policy measures might be considered to increase the local content of maquiladoras production. We discuss some here, but refer the interested reader to Brannon et al. (1994) and Verhoogen (2012) for further discussion. In particular, the government might seek to strengthen engineering and design capacities by means of active education and technology acquisition policies. Typically these high-skilled activities generate much higher value added compared to the provision of standard inputs such as boxes and packaging materials. Also, the Mexican government might stimulate decentralized decision making at maquiladora establishments and engaging them with local suppliers. If maquiladoras source inputs locally, they have a strong incentive to improve the quality of these goods sourced, which stimulates productivity growth of suppliers (Brannon et al., 1994). Also, government officials might actively encourage joint ventures to increase technology spillovers.

Although our analysis is for Mexico's maquiladoras, we believe the analysis presented here has wider appeal. In particular, the analysis has wider relevance for other developing countries that are characterized by low domestic value added content of exports as our analysis seeks to relate industrial policies to changes in the domestic content of exports. Many other Central-American countries, but also developing Asian and African countries have export processing firms and low domestic content (Koopman et al., 2014). Which nations and firms have been successful and why? Future research may seek to extent this type of long-term analysis of industrial upgrading to other developing countries to get a tighter grip on policies that kick start technological upgrading.

## References

- Banco Nacional de Comercio Exterior (1979), "Sección Nacional", *Comercio Exterior*, Vol. 29, No.5, pp. 521-534.
- Bergin, P. R., R. Feenstra, G. H. Hanson (2009), "Offshoring and Volatility: Evidence from Mexico's Maquiladora Industry", *American Economic Review* Vol. 99, No. 4. pp. 1664-1671.
- Brannon, J. T., D. D. James, G. W. Lucker (1994), "Generating and Sustaining Backward Linkages Between Maquiladoras and Local Suppliers in Northern Mexico. *World Development* 22(12), pp. 1933-1945.
- Brown, F., and L. Domínguez (1989), "Nuevas Tecnologías en la Industria Maquiladora de Exportación", *Comercio Exterior*, vol. 39, No. 3, México, pp. 215-223.
- Buitelaar, R.M. and R. Padilla Pérez (2000), "Maquila, Economic Reform and Corporate Strategies", *World Development* Vol. 28, No. 9, pp. 1627-1642.
- Carrillo, J. and A. Hualde (1997) "Maquiladoras de Tercera Generación. El caso de Delphi-General Motors", *El Colegio de la Frontera Norte (COLEF)*, México.
- Carrillo J. and R. Zárate-Cornejo (2003), "Limitaciones de los Proveedores Mexicanos de la Electrónica frente a los Extranjeros", *Región y Sociedad*, Vol. XV, no. 28, pp. 161-191.
- Carrillo, J. (2007), "La Industria Maquiladora en México: ¿Evolución o Agotamiento?", *Comercio Exterior*, Vol. 57, No. 8.
- Contreras, O. F. and L. F. Munguía (2007), "Evolución de las Maquiladoras en México. Política Industrial y Aprendizaje Tecnológico", *Region y Sociedad*, vol. XIX, pp. 72-87.
- Daudin, G., C. Riffart, and D. Schweisguth (2011), "Who Produces for Whom in the World Economy?" *Canadian Journal of Economics*, 44 (4), 1403-1437.
- De La Cruz J., R. Koopman, Z. Wang. and S. Wei. (2011), "Estimating Foreign Value Added in Mexico's Manufacturing Sector", *mimeo United States International Trade Commission*.
- De La Cruz J., R. Koopman, Z.Wang, and S. Wei (2013), "Foreign and Domestic Content in Mexico's Manufacturing Exports", in Mattoo, A., Z. Wang, and S. Wei, (eds.) (2013), *Trade in Value Added: Developing New Measures of Cross-Border Trade*, The International Bank for Reconstruction and Development/The World Bank, USA, pp. 135-160.
- Dietzenbacher, E., J. Pei, C. Yang (2012), "Trade, Production Fragmentation, and China's Carbon Emissions," *Journal of Environmental Economics and Management*, vol. 64, pp. 88-101.
- Dussel Peters, E. (2005), "Economic Opportunities and Challenges Posed By China for Mexico and Central America", *German Development Institute (DIE), Studies Series, Bonn*.
- Feenstra, Robert and Gordon Hanson, "Foreign Investment, Outsourcing and Relative Wages," in *Political Economy of Trade Policy: Essays in Honor of Jagdish Bhagwati*, ed. by R. Feenstra and G. Grossman (Cambridge MA: MIT Press, 1996).



- Foster-McGregor, N., and R. Stehrer (2013), "Value added content of trade: A comprehensive approach", *Economics Letters*, Vol. 120, Issue 2, pp. 354–357.
- Gallagher, K. and Shafaeddin, M. (2010), "Policies for industrial learning in China and Mexico", *Technology in Society*, Vol. 32, Issue 2, pp. 81-99.
- GATT (1986), Protocolo de Adhesión de México al Acuerdo General sobre Aranceles Aduaneros y Comercio, Ginebra, Julio 17.
- González, A. (1990), *El Desarrollo de la Inversión Extranjera en México. SEGUMEX: Reseña anual de la industria maquiladora*, Thomas Madison, México DF.
- González-Aréchiga, B., J.C Ramírez, and F. Aguas Gómez (1991), "Los Servicios en la Industria Maquiladora y las Negociaciones de un Tratado de Libre Comercio con Estados Unidos y Canadá", *Revista Mexicana de Sociología*, Vol. 53, No. 3, El Tratado de Libre Comercio y la Frontera Norte, pp. 201-219.
- Government of Mexico (1989). Decreto para el fomento y la operación de la industria maquiladora de exportación. Diario Oficial de la Federación, December 22.
- Hummels, D., J. Ishii and K.M. Yi (2001), "The Nature and Growth of Vertical Specialization in World Trade", *Journal of International Economics*, vol. 54, pp. 75-96.
- Iacovone, Leonardo, Rauch, Ferdinand and Winters, L Alan (2013) Trade as an engine of creative destruction: Mexican experience with Chinese competition. *Journal of International Economics*, vol. 89 (2). pp. 379-392.
- INEGI (1991), Estadística de la Industria Maquiladora de Exportación, 1979-1989, Instituto Nacional de Estadística, Geografía e Informática. México p.1-53.
- \_\_\_\_\_ (2001), "La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación; Total Nacional (1988-2000)", *Sistema de Cuentas Nacionales de México*, Instituto Nacional de Estadística e Informática, México, pp. 1-115.
- \_\_\_\_\_ (2005), "La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación; Total Nacional (1999-2004)", *Sistema de Cuentas Nacionales de México*, Instituto Nacional de Estadística e Informática, México, pp. 1-109.
- \_\_\_\_\_ (2010), "La Producción, Salarios, Empleo y Productividad de la Industria Maquiladora de Exportación, Total Nacional; Metodología", *Sistema de Cuentas Nacionales de México*, Instituto Nacional de Estadística e Informática, México, pp. 1-7.
- Johnson, R. C., and G. Noguera (2012). "Accounting for Intermediates: Production Sharing and Trade in Value Added." *Journal of International Economics*, vol. 86(2): 224-236.
- Johnson, R. C., and G. Noguera (2014). "A Portrait of Trade in Value Added Over Four Decades." Mimeo Dartmouth college.
- Jordaan, J. A. (2011), "FDI, Local Sourcing, and Supportive Linkages with Domestic Suppliers: The Case of Monterrey, Mexico. *World Development*, 39(4), pp. 620-631.
- Koopman, R., Z. Wang, and S.J. Wei (2014), "Tracing Value-Added and Double Counting in Gross Exports", *American Economic Review*, 104(2): 459-94.

- Lenzen, M., R. Wood, B. Gallego (2007), "Some Comments on the GRAS method" *Economic Systems Research*, vol. 19 (4), pp. 461-465.
- Los, B., M. Timmer, and G. de Vries (2015), "Tracing Value-Added and Double Counting in Gross Exports: Comment. A Comment on Koopman, Wang and Wei." Mimeo Groningen Growth and Development Centre, University of Groningen.
- Miller, R.E. and P.D. Blair (2009) *Input-Output Analysis: Foundations and Extensions*, 2nd edition (Cambridge UK: Cambridge University Press).
- Ollivier-Fierro J.O. (2007), "Proveeduría Nacional a la Industria Maquiladora en México: Un reto Tecnológico", *Frontera Norte*, Vol. 19, No. 38, pp. 191-218.
- Ortiz, A. and Martínez, A. (2000), "Factores de Competitividad, Situación Nacional y Cadena Productiva de la Industria del Calzado en León, Guanajuato", *Economía, Sociedad y Territorio*, Vol. II, No. 7, pp. 533-68.
- Rabellotti, R. (1999), "Recovery of a Mexican Cluster: Devaluation Bonanza or Collective Efficiency?", *World Development*, Vol. 27, No. 9, pp. 1571-1585
- Rama, R. (1984), "El Papel de las Empresas Transnacionales en la Agricultura Mexicana", *Comercio Exterior*, vol. 34, No. 11, México, pp. 1083-1095.
- Ruiz Durán, C., M. Piore, and A. Schrank (2005), "Los Retos para el Desarrollo de la Industria del Software", *Comercio Exterior*, Vol. 55, No. 9, pp. 743-755
- Temurshoev, U., C. Webb, and N. Yamano (2011) "Projection of Supply and Use Tables: Methods and their Empirical Assessment", *Economic Systems Research*, Vol. 23, No. 1, pp. 91-123. Sargent, J. and L. Mathews (2008), "Capital Intensity, Technology Intensity, and Skill Development in Post China/WTO Maquiladoras", *World Development*, Vol. 36, Issue 4, April 2008, Pages 541–559. Schwentesius Rindermann, R., and M.Á. Gómez-Cruz (2001), "El TLCAN y el sector agroalimentario de México", *Comercio Exterior*, Vol. 51, No. 6, pp. 545-554.
- Secretaría de Comercio y Fomento Industrial (SECOFI, 1994), Decreto que promueve la creación de empresas comercializadoras de insumos para la industria maquiladora de exportación, Diario Oficial de la Federación, México, 3 de agosto de 1994.
- Secretaría de Comercio y Fomento Industrial (SECOFI, 1998), Decreto para el Fomento y Operación de la Industria Maquiladora de Exportación, México, Diario Oficial de la Federación 1 de Junio de 1998.
- Sturgeon, T.J., and G. Gereffi (2009), "Measuring success in the global economy: international trade, industrial upgrading, and business function outsourcing in global value chains", *Transnational Corporations*, 18(2).
- Urias, H. (1978), "La Industria Maquiladora: Evolución Reciente y Perspectivas." *Comercio Exterior* 28 (4).

- Utar, H., and L. B. Torres Ruiz (2013), "International Competition and Industrial Evolution: Evidence from the Impact of Chinese Competition on Mexican Maquiladoras," *Journal of Development Economics*, Vol. 105, pp. 267–287.
- Verhoogen, E. A. (2008), "Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector," *Quarterly Journal of Economics*, 123(2). Verhoogen, E. A. (2012), "Industrial Structure and Innovation: Notes Toward a New Strategy for Industrial Development in Mexico," Forthcoming, *Boletín Informativo Techint*.
- Wilson, P.A. (1992), *Exports and Local Development: Mexico's New Maquiladora*, University of Texas Press, pp. 161.
- Woodruff, C. (1998), "Contract Enforcement and Trade Liberalization in Mexico's Footwear Industry", *World Development*, vol. 26 No. 6, pp. 979-91.
- Yang, C., E. Dietzenbacher, J. Pei, X. Chen, K. Zhu and Z. Tang (2015), "Processing Trade Biases The Measurement of Vertical Specialization in China", *Economic Systems Research*, Vol. 27, No. 1, 60–76.

**Appendix Table 1 Domestic content of maquila exports, industry results, robustness test**

	1981	1990	2000	2006
Food, Beverages and Tobacco	0.23	0.31	0.30	0.21
Textiles and Textile Products	0.22	0.21	0.22	0.22
Leather, Leather and Footwear	0.33	0.29	0.20	0.19
Pulp, Paper, Printing and Publishing	0.28	0.20	0.24	0.20
Chemicals and Chemical Products	-	0.21	0.23	0.26
Rubber and Plastics	0.32	0.24	0.23	0.21
Other Non-Metallic Minerals	0.40	0.30	0.21	0.11
Basic Metals and Fabricated Metal	0.25	0.16	0.20	0.16
Machinery	0.34	0.17	0.17	0.13
Electronics	0.23	0.15	0.11	0.09
Transport Equipment	0.25	0.20	0.16	0.18
Miscellaneous manufacturing	0.32	0.22	0.18	0.19
Business services	0.59	0.42	0.26	0.26

*Notes:* Authors' calculations using time series estimates and equation (2) where  $\widehat{e^P}$  is put on the main diagonal of a matrix of equal dimension as the number of industries.



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