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Foreign exports, net interregional spillovers and Chinese regional supply chains*

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Abstract. This study develops a method to decompose total national indirect value added effects (induced by final demand) into intraregional effects and interregional spillovers. The decomposition is applied to China's 2002 and 2007 interregional input–output tables with foreign-owned processing exports separated from normal exports. First, we find that interregional spillovers account for one quarter to one half of the total national indirect value added multipliers in 2007, with the largest spillovers occurring for the coastal regions. This finding is important when explaining regional value added generation and thus has real implications for regional policy programmes. Second, we develop a new measure, namely, ‘net interregional value added spillovers’ to position China's individual regions in the global production chains. This measure shows that upstream regions in the Centre, Northwest and Southwest of China are net recipients of interregional value added spillovers generated by foreign exports in coastal regions. Over time, this observation becomes more pronounced.

JEL classification: R15, C67, F14

Key words: Foreign exports, interregional input–output table, interregional spillovers, production chains, China

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1 Introduction

Income inequality between regions has been a major concern to the central government in China for long.¹ An approach that has been used in the past to reduce regional inequality was the ‘stepladder strategy’ towards development. The idea was that fast-growing coastal regions would spillover growth to interior regions through interregional trade and technological transfers (Ying 2000; Brun et al. 2002; Fu 2004; Groenewold et al. 2007). In 2013, however, gross regional product (GRP) ranged from 80.7 billion Renminbi (RMB) in Tibet to 6.2 trillion RMB in Guangdong Province. The differences in GRP *per capita* were also huge, ranging from 22,900 RMB in Guizhou Province to 97,600 RMB in Tianjin.

The ‘stepladder approach’ is partly based on the following reasoning. Consider a stimulus, for example, an increase in the exports of chemical products from Shandong province. Clearly this will generate extra value added in Shandong simply because the last stage of production takes place there. These are direct value added effects. However, for this last stage of production, the chemical industry in Shandong requires inputs from other industries, some of which are located in other provinces, some of which are located in Shandong. Hence, value added will be generated in other provinces and (additional) value added will be generated in Shandong. In producing these inputs, further inputs are required which needs further value added and so forth. Altogether, these are the indirect value added effects of the stimulus. The parts of them generated in other provinces are labelled interregional value added spillover effects and the parts of them generated in Shandong province are labelled intraregional indirect value added effects).

For regional development, it is important to focus on the indirect value added effects. The direct effects always take place in the region or province where the stimulus is located. The indirect effects and, in particular, the split between interregional spillover effects and intraregional indirect effects determine to what extent other regions also benefit from the stimulus. The first research question in this paper is: How much of the indirect value added effects spill over to other regions, given a stimulus in a specific industry in one province?

To answer this question, three main categories of approaches can be employed following the literature, namely, the econometrics method, multi-regional computable general equilibrium (CGE) model and the interregional input–output model. For the econometrics approach, vector-autoregressive (VAR) models may be applied (e.g., Groenewold et al. 2007). Alternatively, in order to factor out provincial spillover effects, regressions with provincial variables are specified (e.g., Brun et al. 2002). The basic conclusion drawn from the regressions analysis is that interregional spillovers are important. Multiregional CGE models, which are typically based on data from interregional input–output (IRIO) tables, are used to evaluate alternative policies and/or external shocks. For instance, the impact of investment expenditures on regional economic growth and income disparity (Kim and Kim 2003); the unevenly distributed effects of MFA quota elimination upon China’s WTO accession (Li and Zhai 2002); and the regional economic impacts of the construction of the Chongqing–Lichuan rail link (Horridge and Wittwer 2008).

The IRIO tables themselves, however, have been frequently used for the direct accounting of interregional spillovers, both in terms of magnitude and direction. Specifically, we use the IRIO model (Isard 1951; Oosterhaven 1981; Miller and Blair 2009), with China grouped into eight regions, which is able to examine interregional interindustry interdependencies (i.e., to distinguish intraregional effects from interregional spillovers at the level of individual

¹ See discussions in Jian et al. (1996), Raiser (1998) and Zhang (2001).

industries; Oosterhaven et al. 2001; Zhang and Zhao 2005).² This complements to the econometrics method and CGE models (e.g., Brun et al. 2002; Li and Zhai 2002; Groenewold et al. 2007) in a way that interregional interdependencies are explicitly explored both at aggregate level and detailed industry level.³

It is well known that foreign exports have been such a stimulus, which contributed greatly to China's tremendous economic growth (Akyüz 2011; Jarreau and Poncet 2012; Pei et al. 2012). China's coastal regions obviously benefited significantly from foreign exports, but what is not obvious is whether this also holds true for interior regions. This important dimension of foreign exports has not been investigated properly thus far. The second research question therefore is: which regions and to what extent, benefit from China's foreign exports?

We answer this question by examining the interregional value added spillovers caused by foreign exports. Our approach is related to the recent literature on global value chains (see e.g., Timmer et al. 2013, 2014; Los et al. 2015).⁴ Slicing up the production chain into ever smaller parts and outsourcing certain parts has induced international and interregional fragmentation and a boost to the trade of intermediate goods. Final products are made in the last stage of production which, from a production chain perspective, is located downstream. This requires that inputs are produced (which generates value added) in industries in other countries and regions which are located upstream.⁵ In this paper we focus on the interregional Chinese part of the global value chain. We find that interior regions in China are located upstream and, because of interregional intermediate product transactions, are intimately integrated with the downstream coastal regions. The position of each Chinese region in this value chain is indicated by a new measure, namely the net value added spillovers of foreign exports.

To address our research questions, this study employed China's 2002 and 2007 IRIO tables with foreign-owned processing exports separated. The distinction between normal exports and processing exports is of prime importance (Jarreau and Poncet 2012; Pei et al. 2012) and is made possible by incorporating detailed customs data. Studies that fail to make the distinction will exaggerate the backward effects of foreign exports on the Chinese economy

² In theory, interregional spillovers may run via markets and run outside markets. The interregional spillovers that run via markets will be tied to interregional transactions, such as the interregional products flows that are recorded in an input-output table which are the topic of this study. It is noted that there are also other interregional flows which relate to labour, capital (including foreign direct investment, FDI) and technology (either embodied in capital or labour, or disembodied). In theory, this type of interregional spillovers can be both beneficial and harmful to receiving regions. These channels may also contribute to regional disparity problem. We are grateful to the referee for offering this point.

³ See also the survey by Shoven and Whalley (1984) on the use of CGE modelling to issues of international trade and taxation. From this survey it is clear that CGE models are of particular use in counterfactual analyses, as was also pointed out by one of the referees. Our study, however, adopts an accounting point of view, where we focus on a given, actual situation. Total final demand equals domestic final demand plus foreign demand (i.e., exports) by definition. Using an IRIO framework, we calculate how much value added should be attributed to (or is embodied in) each of these two components.

⁴ It also relates to the international economics literature that focuses on measuring vertical specialization. For example, Hummels et al. (2001) propose different ways of measuring vertical specialization (VS), and Chen et al. (2005) discuss how the subset of imported intermediates used to produce final goods has increased in the US. In fact, VS measurement and domestic value added content in foreign exports (Lau et al. 2010) are complementary measures (i.e., total VS share equals one minus total 'domestic' value added generated per unit of export). The intuition is that, total value of exports can roughly be divided into two parts, the domestic value added and foreign value added. While VS measures the foreign (or imported) value added that is embodied in a country's exports, the domestic value added generated by (and embodied in) exports measures the counterpart. In this sense, they are essentially two sides of the same coin. We are grateful to a referee for pointing out this relation.

⁵ In line with Antràs et al. (2012), the upstream regions are those that have a relatively longer distance to final use in the production chain. Prior contributions (e.g., Dietzenbacher and Romero 2007) focusing on production chains have shed light on the importance of sequencing, using a different terminology, namely, average propagation lengths (APL; see also Oosterhaven and Bouwmeester 2013).

(Dietzenbacher et al. 2012; Yang et al. 2015). This novel dataset enables the investigation of the changing nature and significance of indirect value added effects in general and those due to foreign exports in particular.⁶

The rest of this paper is structured as follows. Section 2 presents the data and a preliminary analysis based on the data. Section 3 explains how the IRIO model is used to answer the two research questions. Section 4 empirically analyses the answers to the two research questions and the last section concludes and evaluates.

2 Data processing and preliminary analysis

First, we discuss the data problems and the solution (i.e., the modification of China's interregional IO table with foreign-owned processing exports separated). Second, we provide a very rough sketch of the direct interregional interdependencies in the intermediate input structures of China's eight regions. Finally, we present the spatial concentration of foreign exports in China's coastal regions.

2.1 China's interregional IO table with foreign-owned processing exports separated

The primary source data are China's IRIO tables constructed by the State Information Centre of China (SIC) in collaboration with the National Bureau of Statistics of China (NBS) for 2002 and 2007 (Zhang and Qi 2012).⁷ The IRIO tables include 17 sectors, covering eight regions (see Appendix A for both classifications).⁸ The exports in these IRIO tables are gross exports to the rest of the world (RoW) and consist of processing exports and normal exports, taken together.

Processing exports play an important role in China's foreign exports (e.g., the proportion of processing exports to total exports was 55% in 2002 and 51% in 2007; see NBS various years). Unlike normal exports, however, processing exports use few domestic intermediate inputs. Therefore, it is necessary to explicitly distinguish these two types of exports (Pei et al. 2012). Within processing exports, there are mainly two sub-categories: (i) domestically-owned processing exports, where domestic firms possess the ownership and buy processing imports (which enter the production process and are recorded in production statistics) and export the products after manufacturing; (ii) Foreign-owned processing exports, with ownership by foreign companies, who use processing imports that are shipped (tax free) to China and will be shipped back to the foreign counterparts after processing and assembling. Because the foreign ownership remains unchanged in the whole production process, the foreign-owned processing imports do not show up in China's production statistics. Only value added (e.g., a processing fee) is

⁶ The spatial concentration of exports and investment programmes also has implications for the regional disparity problem (Sun and Parikh 2001; Zhang 2001). Yang and Lahr (2008), He and Duchin (2009) and Jiang (2011) adopt a comparable input–output methodology to investigate China's regional disparity problem explicitly.

⁷ Note that they use the term multiregional input–output (MRIO) table, which differs from the IRIO table (Miller and Blair 2009). Only the IRIO table has full (albeit often estimated) information of the deliveries of industry i in region r to industry j in region s . It is worth stressing that there is a 1997 IRIO table for China, which is constructed by SIC and the Institute of Developing Economies (IDE-JETRO) in Japan. The reasons not to include it in this study are twofold. First, the compilation methods are not entirely comparable. And second, the 1997 IRIO table does not differentiate imports from domestic products.

⁸ We acknowledge that several institutions, both within and outside China, are constructing Chinese IRIO tables (e.g., the Development Research Centre of the State Council of China). Despite the different definition of regions, the methodologies are comparable according to the literature. However, one major advantage of the dataset that we use here is that it is semi-official and publicly accessible.

Table 1. Layout of China’s IRIO table with foreign-owned processing exports separated

	Intermediate deliveries				Domestic final use			STK	Other exports	FOP exports	TO
	$\mathbf{Z}^{11}$	$\mathbf{Z}^{12}$	...	$\mathbf{Z}^{1R}$	$\mathbf{F}^{11}$	...	$\mathbf{F}^{1R}$	Δ^1	$\mathbf{e}^1$	$\mathbf{e}^{fop1}$	$\mathbf{x}^1$
	$\mathbf{Z}^{21}$	$\mathbf{Z}^{22}$	...	$\mathbf{Z}^{2R}$	$\mathbf{F}^{21}$	...	$\mathbf{F}^{2R}$	Δ^2	$\mathbf{e}^2$	$\mathbf{e}^{fop2}$	$\mathbf{x}^2$
	...	...	...	...	...	...	...	...	...	...	...
	$\mathbf{Z}^{R1}$	$\mathbf{Z}^{R2}$	...	$\mathbf{Z}^{RR}$	$\mathbf{F}^{R1}$	...	$\mathbf{F}^{RR}$	Δ^R	$\mathbf{e}^R$	$\mathbf{e}^{fopR}$	$\mathbf{x}^R$
IM	$(\mathbf{m}^{Z1})'$	$(\mathbf{m}^{Z2})'$	...	$(\mathbf{m}^{ZR})'$	$(\mathbf{m}^1)'$	...	$(\mathbf{m}^R)'$	0	0	0	m
VA	$(\mathbf{v}^1)'$	$(\mathbf{v}^2)'$	...	$(\mathbf{v}^R)'$							
TI	$(\mathbf{x}^1)'$	$(\mathbf{x}^2)'$	...	$(\mathbf{x}^R)'$							

Notes: STK = changes in inventories; FOP exports = foreign-owned processing exports; TO = total output; IM = foreign imports; VA = value added; TI = total input.

recorded in this case (for a more detailed discussion, see Pei et al. 2011). As processing imports are exempted from tax, customs agencies keep track of the entire production process, which ensures the data availability. By linking detailed trade data with data on the trade regime, provincial information and a concordance table between input–output sectors and harmonized system (HS) codes, it is possible to obtain foreign-owned processing exports by sector and by province.

In the case of foreign-owned processing exports, the imports are not covered by production (and thus not by input–output) statistics. Yet, the foreign-owned processing exports are included in the gross exports. The input structure of gross exports thus only reflects how other exports (i.e., normal exports and domestically-owned exports) are produced. Therefore, the foreign-owned processing exports should be separated from gross exports before any analysis is conducted. We thus split the single column in the IRIO with gross exports into two columns: a column for foreign-owned processing exports and a column for other exports (consisting of normal exports and domestically-owned processing exports).⁹ The resulting framework for the 2002/07 IRIO for China is shown in Table 1.

The terms $\mathbf{x}^r$, $\mathbf{v}^r$, $\mathbf{m}^{Zr}$, $\mathbf{e}^r$, $\mathbf{e}^{fop}$ and Δ^r denote (for region r) the 17 element vectors of, respectively, total outputs/inputs, value added, imports from the rest of the world (RoW), other (gross) exports to the RoW, foreign-owned processing exports to the RoW and changes in inventories (including discrepancies). Superscripts r and s indicate region-specific values, with rs indicating a flow from region r to region s . Furthermore, $\mathbf{Z}^{rr}$ gives the 17×17 matrix of intraregional intermediate deliveries for region r and $\mathbf{Z}^{rs}$ is the 17×17 matrix of interregional intermediate exports from r to s . The term $\mathbf{F}^{rr}$ gives the 17×4 matrix of intraregional final demand, with the following four categories: rural household consumption, urban household consumption,

⁹ Ideally, the IRIO table should be partitioned into two parts, namely, ‘foreign-owned processing (FOP) exports’ and ‘others’, as is done in Pei et al. (2012) for a national IO table. However, not all necessary data are available at the regional level. Little information is available even for the FOP imports by region, let alone the value added data for that part of a sector that is involved in FOP exports. We thus need to keep in mind that the present split-up of FOP exports from gross exports is only a half-way treatment. The modified tables are believed to be better than the original ones, in particular when estimating the economy-wide impact of foreign exports. To test this assertion, we have estimated the total national value added generated by total exports (both FOP exports and other exports) for China in three alternative ways: First, using the partitioned national IO table (i.e., the 2007 partitioned IO table used in Pei et al. 2012) to calculate the total national value added generated by gross exports, which yields 6,034 billion RMB (which we take as the benchmark outcome). Second, using China’s official national IO table to calculate the total national value added generated by gross exports yields 7,380 billion RMB (which is a 22% overestimation). Third, using the same official national IO table to calculate the total national value added generated by other exports (i.e., gross exports less FOP exports) yields 6,943 billion RMB (which is a 15% overestimation). Thus, the results support our choice (i.e., at the national level, focusing on other exports yields better results than focusing on gross exports).

government expenditure and gross fixed capital formation. In addition, $\mathbf{F}^{rs}$ is the 17×4 matrix of interregional exports from region r to final demand in region s , with the same four categories as in $\mathbf{F}^{rr}$. Finally, $\mathbf{m}^{fr}$ is (for region r) the four-element vector with foreign imports for final demand purposes and the scalar m indicates total imports from the RoW.

2.2 A sketch of the interregional purchases by region

Table 2 summarizes the input structures by aggregating over the 17 sectors and provides information about the direct intraregional deliveries and the direct interregional spillovers. First, we observe in the row ‘Value added’ of the upper panel that the aggregate value added coefficients can be roughly grouped into two categories. The four coastal regions (North Coast, NC; East Coast, EC; South Coast, SC; and North Municipalities, NM) have relatively low aggregate value added coefficients in 2007, ranging from 28.2 per cent in EC to 31.4 per cent in NM. This reflects the downstream nature of these regions. Typically, downstream regions produce final products, which depend largely on intermediate inputs per unit of output. Because the value added coefficient equals one less the sum of intermediate input coefficients (including those for regional and foreign imports), the value added coefficients are relatively small. Upstream regions typically produce primary goods that require relatively few intermediate inputs but more value added. Large aggregate value added coefficients are an indication of production activities that occur in the early phase of the production chain.

Also, note that the aggregate value added coefficients in all regions decreased from 2002 to 2007. Smaller aggregate value added coefficients (associated with larger aggregate intermediate input coefficients) indicate more complicated (i.e., roundabout) production processes, which holds true for all China’s regions, regardless of whether they are coastal or interior regions.

Second, observe in the row ‘Rest of the world’ that there is a distinction in the dependence on foreign imports between three coastal regions (NM, EC and SC) and the other regions. Note that the distinction was larger in 2002 and that EC and SC had larger aggregate foreign import coefficients than aggregate interregional import coefficients in 2002 (see the row ‘Rest of China’, RoC). All regions except for EC and SC show an increase in their aggregate foreign import coefficients from 2002 to 2007. This indicates a convergence among China’s regions in terms of foreign import dependence (as reflected by the standard deviation of the aggregate foreign import coefficients per region that dropped from 5.4 in 2002 to 3.5 in 2007).

Table 2. Aggregate input coefficients (in %) for the business sector by region

Origin	NE	NM	NC	EC	SC	CR	NW	SW	Tot.
2007									
Own region	50.3	38.6	54.3	52.4	44.4	48.1	39.9	46.9	–
Rest of China	6.9	17.6	11.7	9.8	12.3	11.9	14.4	10.8	–
Total China	57.2	56.2	66.0	62.2	56.7	60.0	54.3	57.7	60.0
Rest of the World	7.6	12.4	4.3	9.6	12.0	4.1	5.4	4.5	7.5
Value added	35.2	31.4	29.6	28.2	31.3	35.9	40.2	37.8	32.5
2002									
Origin									
Own region	49.1	36.4	48.1	51.9	41.3	48.5	40.0	48.5	–
Rest of China	4.8	17.7	10.1	4.3	5.7	7.3	13.9	6.3	–
Total China	53.9	54.1	58.2	56.2	47.0	55.8	53.9	54.8	54.3
Rest of the World	4.3	9.5	3.0	10.2	16.2	1.4	2.3	1.4	6.8
Value added	41.8	36.4	38.8	33.7	36.8	42.8	43.9	43.8	38.9

Table 3. Regional shares in foreign exports per sector (in %) and industry shares in national exports (in %)

	NE	NM	NC	EC	SC	CR	NW	SW	Export share
2007									
4	4.5	2.4	10.6	60.6	15.9	3.3	1.1	1.7	11.9
7	6.9	2.8	11.1	22.7	41.8	7.3	3.7	3.6	11.6
9	7.9	4.8	11.7	36.5	19.7	7.7	8.4	3.4	10.0
12	1.7	10.8	0.9	57.9	26.7	0.6	0.4	0.9	26.7
16	4.4	16.0	21.8	21.2	23.6	5.4	6.2	1.3	7.4
Total	4.4	8.1	8.8	41.9	26.8	3.8	4.1	2.1	
2002									
4	2.8	3.2	11.2	49.5	26.9	3.6	1.3	1.4	20.2
7	7.4	6.5	10.8	27.9	32.8	7.9	2.3	4.4	8.3
10	2.7	1.6	4.2	20.4	67.5	1.4	0.8	1.4	7.3
12	3.0	10.0	2.6	34.5	47.3	0.7	0.3	1.6	26.6
16	5.4	5.4	5.1	26.7	49.6	3.8	2.8	1.2	7.2
Total	4.8	6.7	7.9	32.2	41.2	3.4	1.5	2.3	

Source: Authors' calculation based on China's 2002 and 2007 IRIO tables.

Notes: See Appendix Table A1 for the meaning of the industry numbers. (Here we present the five largest foreign exporting sectors.) The column 'Export share' gives the industry shares in the total national foreign exports (in %). Values per exporting industry are regional shares in foreign exports per industry (in each row the percentages of the eight regions add to 100).

Third, the size of the direct interregional spillovers for each region appears in the row 'Rest of China.' NM (with many national government institutions) has significant interregional spillovers, as its aggregate interregional import coefficient is the highest (i.e., 17.6% in 2007). This means that to produce one unit of typical output in NM, 17.6 per cent of intermediate inputs are sourced directly from the RoC. Furthermore, all regions increased their external dependency on the RoC (with an exception for NM) from 2002 to 2007. This leads to larger interregional spillovers of all kinds of regional impulses, such as investment or foreign exports.

2.3 Foreign exports are spatially concentrated in coastal regions

Table 3 provides the direct regional shares in the foreign exports for each of the five most important exporting industries.¹⁰ For example, in 2007, the entire textile and wearing apparel sector (industry 4) was responsible for 11.9 per cent of the foreign exports and 4.5 per cent of this industry's exports was by the North East (NE). Note that the five listed industries are responsible for almost 70 per cent of all foreign exports. From the bottom row (with 'Total') it follows that the exports are spatially concentrated in the coastal regions EC and SC. In almost all the large exporting sectors, EC and SC combined have a majority share. This is true, for example, for both the large traditional textile and wearing apparel industry (with EC and SC together producing 76.5% of China's textile exports) and the relatively sophisticated electronic products sector (industry 12 with EC and SC together producing 84.6% of China's electronic products exports) in 2007. It is found that EC and SC have a strong foreign exports focus and strongly depend on foreign imports (see Table 2). So these two regions are relatively open from an international perspective.

Observe that three of the four of China's coastal regions experienced an increase in their regional share of foreign exports, with EC overtaking SC in 2007 in terms of regional shares

¹⁰ Table 3 uses the other foreign exports data (i.e., foreign-owned exports are deducted from gross exports a priori). A similar pattern may emerge by using gross exports, however. Note that the other foreign exports data are used in all empirical analyses throughout this study, unless otherwise stated.

in foreign exports. Taking into account the 30 per cent average annual growth rate of foreign exports in China during this period (see NBS various years), it is clear that most coastal regions rely heavily on foreign markets. This is in line with the observations made in Table 2 regarding the relatively high foreign import dependence of the coastal regions.

The descriptive data analysis in this and the previous subsection provided a very rough sketch of the direct interregional interdependencies and the spatial export concentration. Our research questions, however, relate to the indirect effects (and the split into interregional spillover and intraregional indirect effects). For this, a full interregional input–output analysis is necessary.

3 The method

The fundamental input–output equation will serve as the starting point. It is based on the following assumptions: (i) supply follows demand (i.e., total output equals intermediate demand plus final demand, so $\mathbf{x} = \mathbf{Z}\mathbf{i} + \mathbf{y}$) and (ii) intermediate demand is determined by total output using fixed intermediate input coefficients (i.e., $\mathbf{Z}\mathbf{i} = \mathbf{A}\mathbf{x}$). Thus, we have:

$$\mathbf{x} = \mathbf{Z}\mathbf{i} + \mathbf{y} = \mathbf{A}\mathbf{x} + \mathbf{y}, \quad (1)$$

where $\mathbf{Z}$ is the matrix of domestic intermediate deliveries, $\mathbf{i}$ is the summation vector of appropriate length, $\mathbf{A}$ is the matrix of domestic input coefficients, $\mathbf{x}$ is the vector of gross output and $\mathbf{y}$ is the vector of final demand. In an IRIO framework with N sectors and R regions, the matrices and vectors can all be partitioned according to the earlier discussed Table 1. The dimensions of $\mathbf{A}$ and $\mathbf{Z}$ are then $NR \times NR$ and those of the vectors $\mathbf{x}$, $\mathbf{y}$, Δ , $\mathbf{e}$ and $\mathbf{e}^{fop}$ are NR -element. Thus:

$$\mathbf{A} = \begin{pmatrix} \mathbf{A}^{11} & \mathbf{A}^{12} & \mathbf{L} & \mathbf{A}^{1R} \\ \mathbf{A}^{21} & \mathbf{A}^{22} & \mathbf{L} & \mathbf{A}^{2R} \\ \mathbf{M} & \mathbf{M} & \mathbf{O} & \mathbf{M} \\ \mathbf{A}^{R1} & \mathbf{A}^{R2} & \mathbf{L} & \mathbf{A}^{RR} \end{pmatrix}, \mathbf{x} = \begin{pmatrix} \mathbf{x}^1 \\ \mathbf{x}^2 \\ \mathbf{M} \\ \mathbf{x}^R \end{pmatrix}, \mathbf{y} = \begin{pmatrix} \mathbf{F}^{11} + \mathbf{L} + \mathbf{F}^{1R} \\ \mathbf{F}^{21} + \mathbf{L} + \mathbf{F}^{2R} \\ \mathbf{M} \\ \mathbf{F}^{R1} + \mathbf{L} + \mathbf{F}^{RR} \end{pmatrix} \mathbf{i} + \begin{pmatrix} \Delta^1 \\ \Delta^2 \\ \mathbf{M} \\ \Delta^R \end{pmatrix} + \begin{pmatrix} \mathbf{e}^1 \\ \mathbf{e}^2 \\ \mathbf{M} \\ \mathbf{e}^R \end{pmatrix} + \begin{pmatrix} \mathbf{e}^{fop1} \\ \mathbf{e}^{fop2} \\ \mathbf{M} \\ \mathbf{e}^{fopR} \end{pmatrix},$$

where $\mathbf{A}^{rr}$ is the 17×17 matrix with intraregional input coefficients, with its typical elements computed as $a^{rr} = z_{ij}^{rr}/x_j^r$; $\mathbf{A}^{rs}$ is a 17×17 matrix with interregional input coefficients (with inputs from region r used per unit of output in region s , $r \neq s$), with its elements calculated as $a^{rs} = z_{ij}^{rs}/x_j^s$; $\mathbf{F}^{rr}$ and $\mathbf{F}^{rs}$ are the same 17×4 matrices defined previously, giving intraregional final demand and interregional imports for final demand, respectively; Δ^r gives the 17-element vector of changes in inventories in region r ; $\mathbf{e}^r$ is a 17-element vector with other foreign exports in region r ; and $\mathbf{e}^{fop}$ is a 17-element vector with FOP exports of region r .

Solving Equation (1) for $\mathbf{x}$ gives the following:

$$\mathbf{x} = (\mathbf{I} - \mathbf{A})^{-1} \mathbf{y}. \quad (2)$$

Let $\mathbf{v}$ denote the NR -element vector of value added and let $\mathbf{c}$ denote the NR -vector of value added coefficients, with its typical element calculated as $c_j^r = v_j^r/x_j^r$. The value added equation then reads as follows:¹¹

¹¹ Vectors are defined as column vectors, a hat indicates the transformation of a vector into a diagonal matrix with the vector on its main diagonal and zeros elsewhere, and a prime indicates the transformation of a column into a row.

$$\mathbf{v} = \hat{\mathbf{c}}\mathbf{x} = \hat{\mathbf{c}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} = \hat{\mathbf{c}}\mathbf{L}\mathbf{y}, \quad (3)$$

where $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ is the interregional Leontief-inverse.

For the first research question (How much of the indirect value added effects spill over to other regions, given a stimulus in a specific industry in one province?) it is also relevant to know whether the indirect effects are large (or small) when compared to the direct effects. Take a stimulus as represented by $\mathbf{y}$, the total value added effects are then given by $\mathbf{c}'\mathbf{L}\hat{\mathbf{y}}$. The direct effects yield $\mathbf{c}'\hat{\mathbf{y}}$ and the indirect effects therefore $\mathbf{c}'\mathbf{L}\hat{\mathbf{y}} - \mathbf{c}'\hat{\mathbf{y}} = \mathbf{c}'(\mathbf{L} - \mathbf{I})\hat{\mathbf{y}}$. The ratio of the indirect and the direct effects gives $\mathbf{c}'(\mathbf{L} - \mathbf{I})\hat{\mathbf{y}}(\hat{\mathbf{c}}\hat{\mathbf{y}})^{-1} = \mathbf{c}'\mathbf{L}\hat{\mathbf{c}}^{-1} - \mathbf{i}'$. This is a row vector. Suppose its j th element is 0.3. The interpretation then is that a stimulus of the j th final demand (e.g., an increase in exports or investments) directly generates value added in industry j (because this is where the last stage of production takes place) and additionally generates value added indirectly. The indirectly generated value added is then 30 per cent of the directly generated value added.

The indirect generation of value added can be anywhere and the ratios in $\mathbf{c}'\mathbf{L}\hat{\mathbf{c}}^{-1} - \mathbf{i}'$ focus on the total national outcome (i.e., in all regions and all industries). To answer our research question, we split the national ratios into two: an intraregional (i.e. within region) and an inter-regional part. Let the indirect value added induced by one unit of direct value added in region r be denoted by $\mathbf{c}_n^r$. It is decomposed into intraregional indirect value added effects and inter-regional value added spillover effects, all per industry of final demand:

$$(\mathbf{c}_n^r)' = \sum_s (\mathbf{c}^s)' \mathbf{L}^{sr} (\hat{\mathbf{c}}^r)^{-1} - \mathbf{i}' \text{ (total national indirect value added effects)} \quad (4)$$

$$= (\mathbf{c}^r)' \mathbf{L}^{rr} (\hat{\mathbf{c}}^r)^{-1} - \mathbf{i}' \text{ (intraregional indirect value added effects)} \quad (4a)$$

$$+ \sum_{s \neq r} (\mathbf{c}^s)' \mathbf{L}^{sr} (\hat{\mathbf{c}}^r)^{-1} \text{ (interregional value added spillover effects)}. \quad (4b)$$

For the second research question (Which regions and to what extent, benefit from China's foreign exports?), we are particularly interested in the actual value added effects generated by other foreign exports. The value added that is generated by other foreign exports is decomposed into: the direct value added effect from the own region's exports and the indirect value added effects, which are further split into intraregional indirect value added effects and interregional value added spillover effects. When final demand $\mathbf{y}$ in (3) is replaced with other foreign exports $\mathbf{e}$, the value added by industry generated in region r can be decomposed as follows:

$$\mathbf{v}_e^r = \hat{\mathbf{c}}^r \mathbf{L}^{rr} \mathbf{e}^r + \hat{\mathbf{c}}^r \sum_{s \neq r} \mathbf{L}^{rs} \mathbf{e}^s \quad (5)$$

and the decomposition is as follows:

$$\mathbf{v}_e^r = \hat{\mathbf{c}}^r \mathbf{e}^r \text{ (intraregional direct value added effects);} \quad (6a)$$

$$+ \hat{\mathbf{c}}^r (\mathbf{L}^{rr} - \mathbf{I}) \mathbf{e}^r \text{ (intraregional indirect value added effects);} \quad (6b)$$

$$+ \hat{\mathbf{c}}^r \sum_{s \neq r} \mathbf{L}^{rs} \mathbf{e}^s \text{ (interregional value added spillover effects).} \quad (6c)$$

4 The results

This section answers the two research questions. The first question has a clear policy implication and deals with any possible stimulus. It uses the ratios by industry in Equation (4) that are independent of final demand. It considers the national total indirect value added effect due to one unit of direct final use impulse in region r and examines how much the own region gains and how much spills over to other regions. The second research question deals with the other foreign exports as they occurred in 2002 and 2007. The total value added generated by these exports is split into direct value added in the exporting region, intraregional indirect value added and interregional value added spillovers.

Calculating a new measure called net interregional value added spillovers (due to foreign exports) allows us to examine the position of China's regions in the global value chain. Following Antràs et al. (2012) concept, upstreamness reflects the average distance of a region from final demand. We expect this to be larger for interior regions (which mainly supply natural resources and raw materials) than for coastal regions (which are closer to the final consumers and will thus be positioned downstream).

4.1 How much of the indirect value added effects spills over to other regions

Table 4 gives the average indirect value added effects, in which the average for each region is obtained by weighting the sectoral effects with sectoral total regional final demand.¹² In 2007, for example, a stimulus in NE that generates 100 RMB of direct value added, additionally generates 170 RMB of indirect value added. Of these 170 RMB, 130 RMB are generated in NE and 40 RMB spill over to other regions.

When comparing the results for 2002 and 2007, we see that the (weighted averages of the) total national indirect value added effects have increased for all regions. In 2007, the largest total national indirect value added effects are found in coastal regions, particularly in NC and EC (2.2 and 2.1, respectively, in row 'Total'). The largest growth in the total national indirect value added effect happened in SC (from 1.2 in 2002 to 1.8 in 2007) and the next largest change took place in EC (from 1.6 to 2.1). It is clear that coastal regions have become more important in terms of total national indirect value added generation. This means that production of final products requires more domestic upstream activities in 2007 than in 2002, which holds in particular for the coastal regions.

The decomposition of the total national indirect value added effects into intraregional indirect value added effects and interregional value added spillovers are given in Equation (4). Observe that, from 2002 to 2007, six of the eight regions experienced an increase in intraregional indirect value added effects (the CE and the SW are the exception). At the same time, the interregional spillovers also increased in all regions except the NW. The intraregional indirect effects were larger and remained larger than the interregional spillover effects (except in NM). Still, the interregional spillovers became more important as indicated by their share in the total national indirect value added effects (see row 4 in Table 4), which has, often considerably, increased (except for NM).

From a policy point of view, the results clearly show that it is important to take a full interregional perspective rather than just a regional focus. Taking only the intraregional indirect value added effects into account, the economy-wide indirect value added effects would be

¹² As shown in the derivation of formula (4), the normalization pertains to the income impulse incorporated in final demand, so weighting all sectoral effects by regional total final demand by industry gives a consistent average (Oosterhaven 1981).

Table 4. Decomposition of economy-wide indirect value added effects per unit of direct value added (weighted averages)

	NE	NM	NC	EC	SC	CR	NW	SW
2007								
Intra (1)	1.3	0.8	1.4	1.4	1.1	1.1	0.9	1.1
Inter (2)	0.4	0.9	0.7	0.8	0.7	0.5	0.6	0.6
Total (3)	1.7	1.7	2.2	2.1	1.8	1.7	1.6	1.7
Share (4)	23.7	54.5	34.5	35.6	39.5	32.5	41.8	32.8
2002								
Intra (1)	1.2	0.6	1.2	1.3	0.9	1.2	0.8	1.2
Inter (2)	0.2	0.8	0.5	0.3	0.3	0.3	0.6	0.3
Total (3)	1.5	1.4	1.8	1.6	1.2	1.5	1.4	1.5
Share (4)	16.0	56.5	30.1	17.9	21.7	20.2	40.6	19.4

Notes: The 'Intra' is intraregional indirect value added effects using equation (4.1); 'Inter' means interregional value added spillovers using equation (4.2); 'Total' is the sum of 'Intra' and 'Inter'; and 'Share' is the ratio of interregional value added spillovers to total national indirect value added multiplier (i.e., $\text{row}(4) = \text{row}(2)/\text{row}(3) \times 100$). The values of row (1) and row (2) are, respectively, averages of all sectoral intraregional indirect value added effects and interregional value added spillovers weighted by regional total final demand by industry. Results at industry level are available upon request.

underestimated by one quarter to one half in 2007. The growing importance of the interregional value added spillovers indicates that regional investment programmes may also have the potential to alleviate value added disparity across regions.

A similar analysis of the interregional value added spillovers was carried out at the industry level. Just as an example, every 100 RMB of extra direct value added (or value added) in NW due to extra final demand for transport equipment from NW induced in 2007 an interregional spillover on value added in the rest of China that was 200 RMB. Here we only provide a brief summary of the most important findings, details can be found in Pei (2012, Chapter 4). The interregional value added spillovers increased between 2002 and 2007, but generally remained smaller than the direct value added effect. Three coastal regions, however, showed many large spillover effects. For NM, 11 (out of 17) industries had interregional spillovers that were at least as large as the direct value added effect (which was the case in NC for 8 industries and in EC for 7). Some industries (such as agriculture, mining, trade and transport and services) exhibited very small interregional spillover effects, irrespective of the region.

4.2 Which regions and to what extent, benefit from China's foreign exports?

In this section we focus on the value added effects generated by actual exports abroad. The decomposition of total value added effects induced by foreign exports may help determine the regions that are located more upstream (i.e., with net inflowing interregional value added spillovers) or downstream (i.e., with net outflowing interregional value added spillovers) in production chains.

We investigate the regional value added generation due to the other foreign exports.¹³ Previous studies included foreign-owned processing exports in their analysis, partly because of the non-availability of data (Yang and Lahr 2008; He and Duchin 2009). However,

¹³ One of the reasons for this specific investigation is that the ability to export abroad is argued to indicate relatively high productivity due to the competition on foreign markets, the technologically advanced products demanded there, the technology transferred with foreign investments, and so forth (Melitz and Trefler 2012).

Table 5. Regional value added due to foreign exports: 2002 and 2007

	VA due to foreign exports	% of total VA	Direct (% VA)	Own Indirect (% VA)	Interregional value added spillovers from foreign exports in (% VA):							
					NE	NM	NC	EC	SC	CR	NW	SW
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
2007												
NE	384	17	25.2	33.5	–	5.3	5.5	14.2	11.7	2.1	1.7	0.9
NM	389	28	47.6	32.9	1.3	–	6.2	6.3	3.6	0.8	1.1	0.3
NC	642	17	30.2	39.9	1.6	7.9	–	9.8	6.2	2.0	2.0	0.4
EC	1734	32	37.1	55.3	0.2	0.7	0.7	–	4.6	0.8	0.4	0.2
SC	1088	28	43.3	45.2	0.6	1.3	1.1	6.0	–	0.8	0.8	0.8
CR	517	10	16.9	20.4	1.1	3.0	6.8	33.5	15.4	–	2.1	0.8
NW	414	22	30.2	24.7	1.8	3.3	5.3	19.1	12.0	2.4	–	1.2
SW	231	9	21.3	26.0	1.3	2.0	3.9	17.1	23.6	1.9	2.9	–
2002												
NE	119	10	38.9	43.1	–	5.3	3.5	3.2	4.1	0.6	0.8	0.5
NM	90	14	54.3	36.2	0.8	–	3.4	1.8	2.8	0.2	0.2	0.2
NC	172	10	35.0	46.9	0.9	7.7	–	4.5	3.2	0.9	0.7	0.2
EC	577	24	38.7	54.5	0.2	0.8	1.0	–	3.5	0.8	0.2	0.2
SC	521	28	49.7	44.3	0.3	0.8	0.6	3.0	–	0.4	0.3	0.5
CR	145	6	22.2	29.7	1.4	4.6	6.8	19.9	13.3	–	1.4	0.9
NW	46	6	31.0	31.3	2.9	4.3	4.8	13.9	8.2	2.4	–	1.3
SW	77	6	26.9	37.5	1.6	2.5	2.7	7.7	17.8	1.2	2.1	–

Notes: Value added is in billion RMB (current price), which is embodied in foreign exports. The effects, including direct effect (formula 6.1), indirect effect (formula 6.2) and seven interregional spillovers from foreign exports production in other regions (formula 6.3), are percentage contributions that add to 100 per cent.

Pei et al. (2012) argue that the processing exports should be left out to measure the true contribution of foreign exports to economic growth. This is supported by Yang et al. (2015) who find that the indirect effects due to processing exports are extremely small when compared to the total effects. For the imports in 2007, they report that 8 per cent is indirect if generated by processing exports and 45 per cent if generated by normal exports.

Table 5 presents the results for the value added generation due to foreign exports: columns (2) and (3) give the total value added generated by China's foreign exports, both in absolute and in percentage terms.¹⁴ The 384 billion RMB for NE, for example, gives the value added in NE that is generated by all of China's foreign exports (i.e., own foreign exports by NE and those by the RoC). This amounts to 17 per cent of the GRP in NE, which can thus be attributed to China's foreign exports. Out of the 384 billion RMB value added in NE generated by China's foreign exports, 25 per cent (column (4)) is directly generated by its own foreign exports and 33 per cent (column (5)) is indirectly generated by its own foreign exports. This implies that the remaining 42 per cent are indirect value added spillovers from foreign exports in the RoC, which is further split in columns (6)–(13) according to exporting regions.

In columns (3) and (4), we observe that three groups of regions may be distinguished in 2007. For the generation of value added (as percentage of GRP) in column (3), the EC (32%), NM (28%) and SC (28%) are at the high end. Medium ones are found for NW (22%), NE (17%) and NC (17%). Low ones are found for the inland regions: the CR and SW, with only

¹⁴ The detailed results at industry level are omitted because of space constraints but are available on request.

10 per cent and 9 per cent of their GRP generated by China's foreign exports. The same distinction applies to the direct effects in column (4).

The interregional value added spillovers due to foreign exports show that the foreign exports by EC and SC indirectly benefit the regions CR, NW and SW to a considerable extent. For example, the interregional value added spillovers to CR from foreign exports in EC and SC, respectively, yield 33.5 per cent and 15.4 per cent of the total value added generated in CR by China's foreign exports. This implies that when the global financial crisis hit EC and SC and their foreign export growth decreased, value added growth in CR contracted.

To provide another perspective, we also investigate the interregional value added spillovers due to foreign exports from a sending (vs. receiving) and a net (vs. gross) viewpoint. The second column in Table 6 gives the total of the direct and indirect own value added due to their own foreign exports in each region (i.e., the column 'Direct' plus the column 'Own Indirect' from Table 5, multiplied by the corresponding values of column 'VA'). Two coastal regions are outstanding, namely, EC and SC, which (directly and indirectly) realized 1,595 billion RMB and 957 billion RMB value added, respectively, due to their own foreign exports in 2007. The size difference of foreign exports is obvious for different regions (recall the regional shares in foreign exports in Table 4, in which EC and SC took more than two-thirds of total foreign exports in 2007) and partly drives our estimation of interregional value added spillovers due to foreign exports.

Not surprisingly, the foreign exports of EC and SC have strong interregional value added spillovers to the RoC. Imagine the production chain (or the global value chain; Antràs et al. 2012). The downstream regions are closer to final consumers in the RoW, while upstream ones provide raw material or natural resources residing at the other end in the production chain. Viewed in this way, the region's position in the production chain can be traced by using the absolute interregional value added spillovers due to foreign exports because they indicate the

Table 6. Net interregional value added spillovers to each region due to foreign exports

Local value added generation by own foreign exports (billion RMB)		Foreign exports–led net interregional value added spillovers to (billion RMB)								
		EC	SC	NM	NC	NE	SW	NW	CR	Total
2007										
EC	1595	–	–14.9	13.2	50.2	50.5	36.5	72.6	160.2	368.2
SC	957	14.9	–	–0.1	27.6	38.4	45.5	40.5	71.3	238.0
NM	315	–13.2	0.1	–	26.4	15.1	3.6	9.5	12.3	53.7
NC	449	–50.2	–27.6	–26.4	–	10.8	6.2	9.0	22.7	–55.5
NE	223	–50.5	–38.4	–15.1	–10.8	–	–0.4	0.8	–2.3	–116.5
SW	109	–36.5	–45.5	–3.6	–6.2	0.4	–	–1.5	–0.2	–93.0
NW	228	–72.6	–40.5	–9.5	–9.0	–0.8	1.5	–	0.9	–130.0
CR	191	–160.2	–71.3	–12.3	–22.7	2.3	0.2	–0.9	–	–264.9
2002										
EC	537	–	–4.5	–3.1	2.2	2.6	4.7	5.0	24.0	30.9
SC	490	4.5	–	–1.4	2.3	3.2	11.3	2.3	16.9	39.2
NM	81	3.1	1.4	–	10.2	5.5	1.8	1.8	6.4	30.2
NC	141	–2.2	–2.3	–10.2	–	2.6	1.7	1.1	8.3	–1.1
NE	98	–2.6	–3.2	–5.5	–2.6	–	0.6	0.4	1.2	–11.7
SW	50	–4.7	–11.3	–1.8	–1.7	–0.6	–	–1.0	0.4	–20.7
NW	29	–5.0	–2.3	–1.8	–1.1	–0.4	1.0	–	0.9	–8.7
CR	75	–24.0	–16.9	–6.4	–8.3	–1.2	–0.4	–0.9	–	–58.1

Notes: All figures in the Table are absolute values (billion RMB, current prices). A positive entry indicates net interregional value added spillovers from the region in a column to the region in a row; negative entries indicate the opposite (please see Appendix Table A2 for original values).

actual direct and indirect strengths of the supply chain. Given that interregional value added spillovers are two-way, the net interregional value added spillovers reflect the sum of each region's outflowing interregional value added spillovers less its inflowing ones at the bilateral (or bi-regional) level.

The foreign exports of EC and SC are extremely beneficial to the value added formation in the RoC. Partly because of the locational advantage of EC and SC, the RoC realized net inflowing interregional value added spillovers of 368 billion RMB from EC and 238 billion RMB from SC in 2007. CR benefits mainly from EC and SC, running a 265 billion RMB negative net interregional value added spillover (i.e., more inflowing interregional value added spillovers than outflowing ones). Thus, it is evident that, within China, SC and EC are the downstream regions in the production chain in terms of net interregional value added spillovers to other regions. In contrast, CR and NW, among others, are the upstream regions.

Moreover, the net interregional value added spillovers from foreign exports in EC and SC have contributed to growth in other regions (NM even changed from being a net outflowing region to EC in 2002 to being a net inflowing one from EC in 2007). That is, over time, value added formation in upstream regions relies more on foreign exports in downstream regions. The largest absolute change (in terms of net inflowing value added spillovers) occurs for CR, from -58 billion RMB in 2002 to -265 billion RMB in 2007. In addition, at least a threefold growth occurs in other upstream regions, which indicates the pronounced upstream nature of these regions. Thus, the regions' positions in the production chain have become more pronounced.

Figure 1 visualizes the *net* interregional value added spillovers due to foreign exports. The thickness of the arrows indicates the size of net value added formation due to foreign exports in the sourcing region (that is pointed at by the arrow), with a threshold of 38 billion RMB in absolute values. The two largest values for EC and SC in 2007 (see column two in Table 6) are own value added (directly and indirectly) generated by their own foreign exports. One relatively isolated foreign exporting region—namely, NM—experienced neither large *outflowing* interregional value added spillovers to the RoC nor significant *inflowing* ones from the RoC. This exception may be partly due to its unique characteristic of containing China's capital city.

It has been hypothesized that a country's position in global supply chains explains part of the disparities in GDP per capita disparities.¹⁵ The same may hold for regions. We find a positive relationship: the correlation coefficient between GRP *per capita* and net interregional value added spillovers *per capita* is 0.83 in 2007. This suggests that the position of regions in international supply chains is positively correlated with Chinese regional GRP per capita disparities, a finding that we expect to hold true for other economies too.

When inspecting the dynamics, it is evident that the two (i.e., EC and SC) dominant foreign exports centres, in terms of positive net interregional value added spillovers, strongly increased in importance. The net interregional value added spillovers were quite small for these two downstream regions in 2002, roughly 31 billion RMB in EC and 39 billion RMB in SC. These values increased to 368 billion RMB in EC and 238 billion RMB in SC in 2007, respectively.

This finding is comparable to the study of Bems et al. (2010), who report that 20 per cent–30 per cent of the decline of the United States' and European Union's final demand was borne by foreign countries through demand spillovers, with member countries of the North American Free Trade Agreement and emerging Europe hit the hardest. A similar reasoning can be applied to China. If the foreign exports from EC and SC contract, interior regions will be hit severely.

¹⁵ Antràs et al. (2012) examined the correlation between their measurement of upstreamness and country characteristics such as GDP *per capita*.

Fig. 1. Net interregional value added spillovers due to foreign exports 2007

Notes: *The arrows point to the origin of the net interregional value added spillovers; the thickness of the arrows indicates the size of each net interregional value added spillover (with a threshold of 38 billion RMB in absolute values). Please refer to Table 6 for more detailed figures. The two values, namely, 1,595 billion RMB for EC and 957 billion RMB for SC, are own (direct and indirect) value added generated by their own foreign exports.

5 Conclusion and discussion

Using China’s modified 2002 and 2007 interregional input–output tables, we explored two distinct but inherently related empirical questions. These were: (i) Given a stimulus in a specific industry in one province, how much of the indirect value added effects spills over to other regions and (ii) which regions and to what extent, benefit from China’s foreign exports? The novel dataset, which separates foreign-owned processing exports from other gross exports, enables us to evaluate a hypothetical stimulus (which is relevant for policy programmes) and to account for actual value added formation due to foreign exports with domestic ownership.

In terms of total national indirect value added effects, coastal regions have relatively larger effects than interior regions. This also holds true for interregional value added spillovers in 2007. Moreover, interregional value added spillovers account for one quarter (NE) to one-half (NM) of total national indirect value added effects in 2007, which is clearly not negligible when evaluating regional policy programmes.

Given the relatively larger value added effects in coastal regions, one policy implication is worth noting. All other things being constant, final use impulses in coastal regions would generate a larger total national value added. At the same time, we find that the intraregional indirect value added effects dominate the interregional spillover effects. In this regard, to achieve growth in interior regions, more investment in interior regions would be preferred (see also He and Duchin 2009; Kim and Kim 2003 for Korean case).

In addition, a new measure of net interregional value added spillovers is computed to position China's individual region (either upstream or downstream) in the production chain. China's regions show clear upstream and downstream features. In terms of interregional value added spillovers due to foreign exports, three interior regions (CR, NW and SW) occupy the upstream ends, providing natural resources and raw materials, which are relatively far from final users. In contrast, the East Coast and South Coast are downstream regions with net interregional value added spillovers to interior regions. Importantly, these positions in the production chain become more pronounced over time, which may have implications for the income per capita differences among regions.

It is also found that China is integrated firmly through foreign exports in coastal regions, which have absolutely strong interregional value added spillovers to interior regions. In this sense, despite the conventional interpretation of the importance of foreign exports, it has an additional role to play; that is, to link China's different regions together through interregional value added spillovers.

Appendix

Table A1. Classification of China's regions and sectors

Code	Region	Provinces / cities included
NW	Northwest	Inner Mongolia (5), Shaanxi (27), Gansu (28), Qinghai (29), Ningxia (30), Xinjiang (31)
CR	Central Regions	Shanxi (4), Henan (16), Hubei (17), Hunan (18), Anhui (12), Jiangxi (14)
NE	Northeast	Heilongjiang (8), Jilin (7), Liaoning (6)
NM	Northern Municipalities	Beijing (1) and Tianjin (2)
NC	North Coast	Hebei (3) and Shandong (15)
EC	East Coast	Shanghai (9), Jiangsu (10), Zhejiang (11)
SC	South Coast	Guangdong (13), Fujian (19), Hainan (21)
SW	Southwest	Sichuan (23), Chongqing (22), Yunnan (25), Guizhou (24), Guangxi (20), Tibet (26)
Sector	Description	
1	Agriculture	
2	Mining	
3	Food products	
4	Textile and wearing apparel	
5	Wooden products	
6	Paper and printing	
7	Chemical products	
8	Non-metallic mineral products	
9	Metal products	
10	Machinery	
11	Transport equipment	
12	Electronic products	
13	Other manufacturing products	
14	Electricity, gas and water supply	
15	Construction	
16	Trade and transport	
17	Services	

Notes: The numbering of provinces/cities (in parenthesis) is in accordance with its location in Figure 1.

Table A2. Interregional value added spillovers to each region due to foreign exports

	Foreign exports-led interregional value added spillovers (billion RMB)								Total
	EC	SC	NM	NC	NE	SW	NW	CR	
2007									
EC	–	65.4	24.5	63.0	54.3	39.6	79.1	173.4	499.2
SC	80.3	–	13.9	39.6	45.0	54.6	49.5	79.9	362.9
NM	11.3	14.0	–	50.7	20.1	4.7	13.6	15.5	129.8
NC	12.8	12.0	24.3	–	21.1	8.9	21.7	35.3	136.2
NE	3.8	6.6	5.0	10.4	–	3.0	7.3	5.8	42.0
SW	3.1	9.1	1.1	2.8	3.4	–	5.1	4.2	28.7
NW	6.5	9.0	4.2	12.7	6.5	6.6	–	10.8	56.3
CR	13.2	8.6	3.2	12.6	8.1	4.3	9.9	–	59.9
Total	131.0	124.8	76.1	191.7	158.5	121.8	186.3	324.8	
2002									
EC	–	15.8	1.6	7.7	3.8	6.0	6.4	28.8	70.1
SC	20.3	–	2.6	5.5	4.9	13.8	3.7	19.2	70.0
NM	4.8	3.9	–	13.3	6.3	2.0	2.0	6.6	38.8
NC	5.5	3.2	3.1	–	4.2	2.1	2.2	9.8	30.0
NE	1.3	1.7	0.8	1.6	–	1.2	1.3	2.0	9.8
SW	1.2	2.5	0.1	0.4	0.6	–	0.6	1.4	6.9
NW	1.3	1.4	0.2	1.1	0.9	1.6	–	2.0	8.6
CR	4.8	2.3	0.2	1.5	0.8	0.9	1.1	–	11.6
Total	39.2	30.9	8.6	31.1	21.5	27.5	17.3	69.7	

Notes: All figures in the Table are absolute values (billion RMB, current prices). The net value added spillovers in Table 6 can be obtained via calculating the spillovers from one region to another and the other way around.

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Resumen. Este estudio desarrolla un método para descomponer el total nacional de los efectos indirectos del valor añadido (inducidos por la demanda final) en efectos intrarregionales y efectos de *spillovers* interregionales. La descomposición se aplica a los cuadros interregionales de input-output de China de 2002 y 2007 y separa las exportaciones de procesamiento de propiedad extranjera de las exportaciones normales. En primer lugar, se observa que los *spillovers* interregionales representan de una a dos cuartas partes del total nacional de los multiplicadores indirectos del valor añadido nacional en 2007, con los mayores *spillovers* producidos en las regiones costeras. Este hallazgo es importante para explicar la generación de valor añadido regional, por lo que tiene implicaciones reales para los programas de políticas regionales. En segundo lugar, se desarrolla una nueva medida denominada '*spillovers* interregionales netos de valor añadido' para emplazar las regiones individuales de China en las cadenas de producción mundiales. Esta medida muestra que las regiones aguas arriba del Centro, el Noroeste y el Suroeste de China son beneficiarias netas de *spillovers* interregionales de valor añadido generados por las exportaciones al extranjero en las regiones costeras. Con el tiempo, esta observación se vuelve más pronunciada.

要約: 本稿では、(最終需要により引き起こされる)国内の間接的な付加価値効果額を地域内効果と地域間に及ぶスピルオーバーに分解する方法を提示する。結果を、中国の2002年および2007年の、外資系企業による輸出額を通常の輸出額から分別している地域間産業関連表に当てはめる。まずは、2007年の地域間スピルオーバーが、国内の間接的付加価値乗数の4分の1から2分の1を占めることと、最大のスピルオーバーは沿岸部の地域で発生していることがわかる。この知見は、地域における付加価値の発生を説明する上で重要であり、地域政策プログラムに大きな影響を与えるものである。次に、新しい測定項目、すなわち、中国の各地域をグローバル生産拠点チェーンとして位置づけるべくnet interregional value added spillovers(地域間付加価値スピルオーバー効果総額)を作成する。この項目により、中国の中央、西北部、南西部の内陸の地域が、沿岸地域の海外輸出により生み出される地域間付加価値スピルオーバー効果を楽しんでいることが示される。この観察調査結果は、経時的により明確になる。