Interregional Trade, Supply Chains and Regional Income Disparity

JIANSUO PEI*, JAN OOSTERHAVEN† and ERIK DIETZENBACHER†

** School of International Trade and Economics, University of International Business and Economics, 10 Huixin Dongjie, Beijing 100029, China. Email: jiansuo.pei@gmail.com*

† Faculty of Economics and Business, University of Groningen, PO Box 800, NL-9700 AV, the Netherlands. Emails: j.oosterhaven@rug.nl and h.w.a.dietzenbacher@rug.nl

Abstract: To explain China's regional income disparity, heterogeneous production functions for different regions is added recently. This study extends this contribution by developing a multi-regional model, based on China's 2002 updated interregional input-output table. It is found that interregional trade and regional income disparities are partly explained by a region's position in the global supply chain. Typically, South Coast and East Coast locate in the top tier of the hierarchy while conversely for Central Regions, Northwest, and Southwest. Moreover, it is shown by a scenario analysis that regional disparity will persist, but to a lesser extent due to *Regional Development Programs*.

Keywords: Income disparity; multi-regional model; trade; supply chain; hierarchy; China

JEL classifications: R15; C67; F14; O18

INTRODUCTION

China's mercurial economic growth has been extraordinary in the world economy, with a record of roughly 10% *real* average annual growth rate in terms of gross domestic product (GDP) for over three decades. In 2010, China surpassed Japan and became the second largest economy. On the other hand, growth has been unequal among regions in China, for instance, in 2009 the regional GDP ranges from 4.4 billion Renminbi (RMB for short) in Tibet to 3.9 trillion RMB in Guangdong Province (over 89 times as much as Tibet's GDP). Measured by GDP per capita, the differences are also huge; in 2009 it was roughly 10.3 thousand RMB in Guizhou Province and 78.3 thousand RMB in Shanghai (7.6 times as much as Guizhou's GDP per capita). Given its vast area and huge population, the interregional equity issue has been a big concern to China's central government. In fact, to tackle the potential consequences of regional disparity, China started the "*Western Development Program*" in 1999 and has launched several regional development programs thereafter, the "*Rise of Central China Program*" in 2009 for instance.

Not only important politically, regional disparity problem has also received much attention in the theoretical literature. In particular, studies investigating whether or not the convergence happens among regions, which are closely related to research on economic growth (see recent overviews by MAGRINI, 2004; ISLAM, 2003). This line of research is rooted in neoclassical growth theory (SOLOW, 1956; SWAN, 1956). There are mainly two types of methodologies are adopted: namely the "regression technique" which employs cross-sectional growth regressions to see whether regional disparity is narrowing, i.e. converging, or the opposite holds true (see BARRO and SALA-I-MARTIN, 1991, 1992, 2004; MANKIW *et al.*, 1992, for early contributions); and the "distributional approach" that uses the so-called *Markov transition matrix* to "capture the dynamics and to reveal the changes in the shape of the distribution" (for instance, QUAH 1996a, 1996b; SAKAMOTO and ISLAM, 2008). But as indicated in MAGRINI (2004), the underlying assumptions of the theory are confined to a closed economy, which is clearly not appropriate for interdependent economies, in particular for regions within one country, say China. Previous research, however, seems to address the question whether or not convergence was and/or is expected among China's distinct regions/provinces, applying techniques discussed above (see also, JIAN *et al.*, 1996; RAISER, 1996; ZHANG, 2001, among others).

Obviously, the studies of convergence and of disparity represent two sides of the same coin. In this sense, the investigation of disparity problem can equally answer the question if and how convergence or divergence could be continued. Specifically, the convergence would naturally follow if the underlying determinants for disparity diminished; and *vice versa*. It seems relatively straightforward to address the disparity problem: what are the causes for the disparity? Will they persist or change? By answering these questions, the convergence or divergence issue will be tackled. It is argued that the causes for the disparity are comparative advantages that determine regional economic structures, thus also interregional interdependency. This viewpoint is supported by a recent study by JIA and GAN (2010), where they argue that disparity can be caused by heterogeneous production functions present in different regions. Further, they state that region-specific industry compositions are likely to be the determinants of disparity, *i.e.* region-specific economic structure is decisive. Thus the investigation of regional economic structures is of particular importance.

In theory, exports play important role for economic growth and aggregate industry productivity (FEDER, 1982; MELITZ, 2003), and likely to contribute to the regional disparity (SUN and PARIKH, 2001; ZHANG, 2001; MAGRINI, 2004; SAKAMOTO and ISLAM, 2008). Intuitively, one may expect that the inland regions will serve the coastal regions with natural resource and raw materials, while the coastal regions serve the foreign consumers with final products by exports. Therefore, the interregional interdependency that forms regional trade hierarchy in the global supply chain may result in regional disparity. And those regions that locate in higher hierarchy shall be found higher per capita incomes. Building on previous studies, the regional disparity problem is investigated from the perspective of comparative advantage and thus regional trade hierarchy in the global supply chain.

To verify this hypothesis, the interregional IO (IRIO) model is utilized, which was developed and proposed by ISARD (1951) (see also, OOSTERHAVEN, 1981; MILLER and BLAIR, 2009) with application to China's interregional IO data.[1] Because the so-called intra-regional effects, interregional spillover effects, and interregional feedback effects can be fully accounted for (see ZHANG and ZHAO, 2005 for a Chinese study). Firstly, the complex total of intra-regional effects and interregional spillovers is disentangled by adopting an additive decomposition methodology (OOSTERHAVEN, 1981; MILLER and BLAIR, 2009). Then, scenario analysis is performed in the light of China's regional development programs. In reality, the hypothesis that the regional location in global supply chain can partly explain the interregional trade, and in turn explains the regional disparity is confirmed by our empirical findings.

The most related studies adopting similar methodology to investigate China's regional disparity are HE and DUCHIN (2009) and YANG and LAHR (2008). In HE and DUCHIN (2009), the focus is on infrastructure differences and also on regional comparative advantages. What's more, they project scenarios for 2010 and 2020 to provide an indication of the benefits that would be generated by means of facilitating infrastructure. But their dataset is for three mega-regions of China, which, as noticed in many previous studies (see SAKAMOTO and ISLAM, 2008; MAGRINI, 2004 for example) exhibits the study to inability of revealing economic structures (to relatively larger extent). Hence, more disaggregated data are called for.

YANG and LAHR (2008), on the other hand, view the problem from the perspective of productivity. Labor productivity, defined as value added per worker, is decomposed to five partial effects. In this way, they answer the interregional disparity in GDP per capita from the perspective of different interregional labor productivity growth pattern. But due to data constraints they are forced to use a ten-industry framework in the study which is relatively aggregate. Therefore, in terms of comprehensiveness, more disaggregated industry classification serves as better starting point to the understanding of region-specific economic structures, which is crucial for the inspection of causes for disparity.

In addition to a more comprehensive dataset, last but not least, the data are updated to the most recent year available. Our approach is stronger in three aspects: firstly, the region-specific industry compositions (economic structures) are paid special attention, extends the argument made in JIA and GAN (2010); more importantly, spatial interactions (i.e. interregional interdependencies) are taken into full account; thirdly, the inspection of regional trade hierarchy in the global supply chain is among the first attempts empirically.

The remaining of this paper is structured as follows. In section 2, traditional convergence analysis and analysis of the industrial structure of regions viewed in isolation are present. In section 3, data issue and methodology of analyzing interregional interdependency are given. Then, additional insights compared to section 2 are provided in section 4. The last section concludes by illustrating further insights that an interregional approach add for policy purposes and discusses.

DESCRIPTIVE ANALYSIS

First the analysis based on traditional convergence literature will be presented, and then the industrial structure of regions viewed in isolation.

Convergence or divergence?

To set the stage, the conventional method of convergence estimation will be the starting point. Table 1 summarizes stylized facts about the regional disparity problem.[2] From 1995 to 2008, a hump-shaped distribution is found for thirty-one provinces. Peak found in 2004-2006, as measured by *mean/median* (column three in Table 1), which shows the skewness of distribution. And other indices (i. e., *s.d./mean*, *max./min.*, and σ index, respectively of columns four through six in Table 1) are all indicating the spread around the mean and have maximum for 2002-2004. The regional development policies may have impact on the disparity changing, for instance, the *Western Development Program* launched in 1999, the *Northeast Revitalization Program* started in 2003, and the *Bohai-Rim-Region Program* initiated in 2004. But it takes time before a policy takes effect, thus, the disparity is expected to decline some time later (both the index σ and σ* were indeed lessening after 2006).

Table 1 about here

Industrial structure of regions: viewed in isolation

However, since Table 1 is aggregate estimates, economic structures which determine the regional comparative advantage cannot be captured. To study different economic structure among regions, the location quotient measure is utilized (MILLER and BLAIR, 2009). Besides, Table 2 is also expanded to incorporate industry compositions information and national productivity levels along the regions; disparity measures such as GDP per capita along the industries. It is worth noting that, however, different from conventional way of estimating the location quotient, the estimation was conducted for value added which is more policy relevant. All numbers are calculated based on China's 2002 updated IRIO table and *2002 Statistics Yearbook*.

Table 2 about here

Per row in Table 2 the regional industrial structure is presented. To give an idea about the meaning of the numbers, take agriculture (industry 1) for example. There are four regions have values more than one, namely Southwest with 1.56, Central Regions with 1.37, Northwest with 1.32, and North Coast with 1.10. Recall the way to compute: the share of a typical industry *i*'s value added in a typical region *r* in national industry *i*'s value added over that region's total value added share in total national income (or in formula, $(v_i^r / v_i^\bullet)/(v_\bullet^r / v_\bullet^\bullet)$). In other words, it gives information about the regional comparative advantage in certain industries; the bigger the number is the stronger comparative advantage it has. Along this line, Northwest found comparative advantage in *mining* (industry 2), while Northern Municipalities found comparative advantage in *service* (industry 17), and so forth. But what it all means?

In fact, there are three major industries contribute to earn economy-wide income (see column last but one), which are *services* (27.9%), *agriculture* (13.7%) and *trade and transport* (13.2%). But these three have among the least productivity (the last column), in particular the agriculture industry with about 4.5 thousand RMB per employment*year (about a quarter of the national average productivity). In consequence, given its giant share, the regions have comparative advantage in agriculture product will end up with low income. This assertion is verified in the row that records regional GDP per capita (the last row in Table 2). Three out of the four regions specializing in agriculture production have lower GDP per capita than the national average. In contrast, the EC has comparative advantage on *textile and wearing apparel* (industry 4, 112% higher than the national average) and *electronic product* (industry 12, 62% higher than the average), while the SC has overwhelming comparative advantage on *electronic product* (125% higher than the average). They found relatively high per capita incomes (188% and 162% of national average, respectively for the EC and the SC).

Importantly, measured by the so-called *regional specialization coefficient* (HOEN and OOSTERHAVEN, 2006), which indicates the uniqueness of a specific region, ranges from 0 to 100%: the higher the ratio is the more unique it shows relative to the national economic structure. The NM is found to be the most peculiar region (24.9%), in that it has comparative advantage in *services* (79% higher than the national average) and *electronic product* (74% higher than the average). And these two industries have relatively high productivities and big shares in national economy (27.9% and 3.6% of the entire GDP, respectively) that contributes positively to the GDP per capita level. On the other hand, the NM has the lowest location quotient in agriculture, only one-fifth of the average level. As mentioned previously, the agriculture has the lowest productivity, so taking together these two negative effects will give positive impact on income per capita level in the NM.

Besides, it is found that the economic structure is persistent or even strengthened along time (for example their comparative advantage for agriculture industry in regions NC, CR, NW, and SW has become even more pronounced).[3] The productivity progress also varies much, from 23% increase (for *agriculture* industry that has the lowest productivity) to 346% increase (for *metal* products industry) from 1997 to 2002. Then, the regional shares of national area are provided reflecting own feature while the related population density (persons per square kilometers) reveals the regional demographic status (which may also play a role for regional comparative advantage which in turn affects the disparity, given urbanization ratio increased from 30% in 1997 to no roughly 39% in 2002). GDP per capita (thousand RMB per head) shows explicitly the magnitude of regional disparity.

Preliminary conclusion: add interregional interdependencies

Up till now, closed economies and comparative advantage as indicated by industrial structure has been illustrated. The different regional industry compositions, among other factors, are likely to be the causes of disparity (this point is also made in JIA and GAN, 2010). However, comparative advantage leads to trade and regions have specific locations. Interregional input-output analysis is needed to analyze whether regions have different positions in worldwide supply chains. Our hypothesis is: yes and this partly explains GDP differences. So the next section will account for the interregional interdependencies.

METHODOLOGY DEVELOPMENT

Construction and updating of China's interregional input-output table

Before the development of methodology, the data need to be prepared. The primary source data are China's interregional input-output (IRIO) tables constructed by State Information Center of China in collaboration with IDE in Japan.[4] The resulting IRIO Table includes 17 sectors covering

8 regions in year 1997 (in Appendix, Table A1 and Table A2 summarize the coverages of regions and sectors).

Figure 1 about here

$\mathbf{x}$ is defined as the 17*1 vector of total output/input; $\mathbf{v}$ gives the 17*1 vector of total value added. Denote $\mathbf{m}$ and $\mathbf{e}$, the 17*1 vector of imports from *rest of the world* (ROW) and 17*1 vector of exports to ROW, respectively. Superscript *r* and *s* indicates region-specific values; so *rs* means products used by region *s* originated from region *r*. Then, matrix $\tilde{\mathbf{Z}}^{rr}$, which is a 17*17 local intermediate deliveries matrix (including imported goods), and matrix $\mathbf{Z}^{rs}$ is a 17*17 intermediate deliveries matrix delivered from region *r* to region *s*. Matrix $\tilde{\mathbf{F}}^{rr}$ gives 17*5 matrix of regional final demand (including rural household consumption, urban household consumption, government consumption, gross fixed capital formation and changes in inventories) consumed of locally produced and imported products; and $\mathbf{F}^{rs}$ is a 17*5 matrix of region *s*'s final demand supplied by region *r*. The region-specific total final uses are given by $\mathbf{f}^{r}$; and total export (scalar) and total import (vector) are denoted as *e* and $\mathbf{m}^{\bullet}$, respectively.

For this study, the first step is to split-up the foreign imports from local deliveries (both for intermediate demands and final uses). As customary, given the limited information availability, the so-called proportional method is used for this purpose (see LAHR, 2001 for an evaluation of such method). Explicitly, intermediate uses or final uses are assumed to use the imported products in a same proportion per industry. Denote $\mathbf{t}^{r}$, whose element is given by $t_i^r = m_i^r / (\tilde{z}_{i\bullet}^{rr} + \tilde{f}_{i\bullet}^{rr})$, where $\bullet$ indicates over which a sub- or super-script is summed. Thus, the self-sufficiency ratio equals to one minus import ratio ($\mathbf{i} - \mathbf{t}^{r}$), and the resulting net local deliveries would be the values in Figure 1 multiplied by domestically provided ratios.[5] In formulas: $\mathbf{Z}^{rr} = (\mathbf{I} - \hat{\mathbf{t}}^{r})\tilde{\mathbf{Z}}^{rr}$ and $\mathbf{F}^{rr} = (\mathbf{I} - \hat{\mathbf{t}}^{r})\tilde{\mathbf{F}}^{rr}$. Finally, the resulting framework is shown as Figure 2.

Figure 2 about here

Further, the dataset is updated to year 2002 which is the most recent year available, by using 1997 IRIO as initial values, combining the provincial IO data released by National Bureau of Statistics of China for 2002. Figure 2 with 1997 IRIO initial values serve as the starting point for updating.[6] Taking from JUNIUS and OOSTERHAVEN (2003), the generalised RAS (GRAS) method (also known as "*sign-preservation RAS*", where both negative and positive values are allowed) is used, and relevant data are prepared and then the updating program is run.[7] It is worth noting that, the GRAS is further combined with national cells constraints in the updating, where three dimensions (*i.e.* row sums, column sums, and the national cell constraints) were taken into account altogether simultaneously (OOSTERHAVEN *et al.*, 1985). Finally, the 2002 updated IRIO table is ready for subsequent analysis.

Methodology: interregional spillovers and value added generation

The IRIO model is preferred, because i) it preserves as much as possible of the information about region-specific comparative advantage, which determines its own economic structures or the industry compositions, as discussed in last section; ii) it adds information about interregional transactions; iii) it serves as a tool to investigate the spillovers among regions, which is beyond the ability of other competing methods;[8] Moreover, industry level scenario analysis is perfectly possible in an IRIO framework.

Under the framework of Figure 2, $\mathbf{A}^{rr}$ is defined as 17*17 pure intra-regional input coefficient matrix, with its typical element computed as $a_{ij}^{rr} = z_{ij}^{rr} / x_{j}^{r}$; $\mathbf{A}^{rs}$ is a 17*17 interregional import coefficients matrix, from region r to s ($r \neq s$), its elements are similarly calculated by using $a_{ij}^{rs} = z_{ij}^{rs} / x_j^s$. Further, denote $\mathbf{F}^{rC} = \sum_{s(s\neq r)} \mathbf{F}^{rs}$ a 17*5 matrix of final demand of *rest of China* served by region *r*. Note also that $\mathbf{y}^r = \mathbf{F}^{rr}\mathbf{i} + \mathbf{F}^{rC}\mathbf{i} + \mathbf{e}^r$. In compact form,

$$\underset{(nr\times nr)}{\mathbf{A}} = \begin{pmatrix} \mathbf{A}^{rr} & \mathbf{A}^{rs} \\ \mathbf{A}^{sr} & \mathbf{A}^{ss} \end{pmatrix}, \quad \underset{(nr\times 1)}{\mathbf{x}} = \begin{pmatrix} \mathbf{x}^{r} \\ \mathbf{x}^{s} \end{pmatrix}, \quad \underset{(nr\times 1)}{\mathbf{y}} = \begin{pmatrix} \mathbf{F}^{rr} + \mathbf{F}^{rs} \\ \mathbf{F}^{sr} + \mathbf{F}^{ss} \end{pmatrix}\mathbf{i} + \begin{pmatrix} \mathbf{e}^{r} \\ \mathbf{e}^{s} \end{pmatrix}$$

The dimensions of each matrix are given in parenthesis by lower-case letters. The *n* refers to the number of industries; *r* gives how many regions are studied. **i** is a vector with *one*s of appropriate length. Moreover, **c** is introduced as the value added coefficient, with its typical element $c_j = v_j / x_j$. Hence, the value added accounting equation can be derived from the fundamental input-output formula,

$$\mathbf{v} = \hat{\mathbf{c}}\mathbf{x} = \hat{\mathbf{c}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{y} \tag{1}$$

Where $\mathbf{L} = (\mathbf{I} - \mathbf{A})^{-1}$ is the Leontief inverse, and a hat indicates the diagonalization. Then, denote $\mathbf{v}_e^r$ the value added that is generated by export for a given region *r*. By formula,

$$\mathbf{v}_e^r = \hat{\mathbf{c}}^r \mathbf{L}^{rr}\mathbf{e}^r + \hat{\mathbf{c}}^r \sum_{s(s\neq r)} \mathbf{L}^{rs}\mathbf{e}^s \tag{2}$$

Formula (2) can be decomposed into the following effects (see OOSTERHAVEN, 1981; MILLER and BLAIR, 2009 for early contributions):

$$\mathbf{v}_e^r = \hat{\mathbf{c}}^r\mathbf{e}^r \text{ (within region direct effects)} \quad (3.1)$$

$$+ \hat{\mathbf{c}}^r(\mathbf{L}^{rr} - \mathbf{I})\mathbf{e}^r \text{ (within region indirect effects)}^9 \quad (3.2)$$

$$+ \hat{\mathbf{c}}^r\sum_{s(s\neq r)}\mathbf{L}^{rs}\mathbf{e}^s \text{ (interregional spillover effects)} \quad (3.3)$$

In the same fashion, the decompositions of value added for both within-regional trade ($\mathbf{V}_{\mathbf{F}r}^r$) by category and interregional trade ($\mathbf{V}_{\mathbf{F}C}^r$) by category can be derived. In formulas,

$$\mathbf{V}_{\mathbf{F}r}^r = \hat{\mathbf{c}}^r\mathbf{F}^{rr} \text{ (within region direct effects)} \quad (4.1)$$

$$+ \hat{\mathbf{c}}^r(\mathbf{L}^{rr} - \mathbf{I})\mathbf{F}^{rr} \text{ (within region indirect effects)} \quad (4.2)$$

$$+ \hat{\mathbf{c}}^r\sum_{s(s\neq r)}\mathbf{L}^{rs}\mathbf{F}^{ss} \text{ (interregional spillover effects)} \quad (4.3)$$

and,

$$\mathbf{V}_{\mathbf{F}C}^r = \hat{\mathbf{c}}^r\mathbf{F}^{rC} \text{ (within region direct effects)} \quad (5.1)$$

$$+ \hat{\mathbf{c}}^r(\mathbf{L}^{rr} - \mathbf{I})\mathbf{F}^{rC} \text{ (within region indirect effects)} \quad (5.2)$$

$$+ \hat{\mathbf{c}}^r\sum_{s(s\neq r)}\mathbf{L}^{rs}\mathbf{F}^{sC} \text{ (interregional spillover effects)} \quad (5.3)$$

Apparently, the equation $\mathbf{v}^r = \mathbf{V}_{\mathbf{F}r}^r\mathbf{i} + \mathbf{V}_{\mathbf{F}C}^r\mathbf{i} + \mathbf{v}_e^r$ holds, and this is done for each of the eight regions. To summarize, in a very straightforward way, the value added that is generated by the production of trade, either domestic sales or foreign trade, has been decomposed into three classes of effects. This enables us to account for interregional spillover effects.

Moreover, from global supply chains point of view, if one region is more close to the final consumers, then this very region's position in the global supply chain will be higher thus locate high in the hierarchy. In contrast, those regions that are more close to the natural resource and raw materials will locate in lower hierarchy in the global supply chain. By so doing, implications on regional disparity issue can be inferred. What's more, the results can also be used to check the impact of regional development programs by an additional exercise of scenario analysis.

EMPIRICAL RESULTS WHEN INTERREGIONAL INTERDEPENDENCIES ARE CONSIDERED

Compared with Section 2 (regions are viewed in isolation), additional insights are provided in this section. In this regard, four types of empirical results will be presented for illustration. First, as an economy with more than 1.3 billion people, production for domestic consumers serves as the dominant part of the whole production, which is discussed next. Several observations stimulate us to have a closer look at the production for foreign export, both in aggregate and at industry level, which are discussed in subsequent sections. Scenario analysis is given in the last sub-section.

Accounting for interregional interdependencies: estimating value added generation by domestic final uses production at aggregate level

Table 3 gives the most aggregated results by using 2002 IRIO, where row two and row three show the value added that is generated by production of domestic final use, both absolute and as a percentage of total value added. At first sight, roughly four groups of regions may be distinguished: South Coast, with three-fifth value added generated by production of domestic final use; East Coast and Northern Municipalities with about 70%; followed by Northeast and North Coast with roughly 87%; and finally the rest with more than 91% (see Table A1 in Appendix for the definition of regions, and Figure 3 below for their location).[10]

Table 3 about here

For each region as a whole, the within-region sales including direct injections and roundabouts (indirect effects) plays dominant role (see the subtotal rows in Table 3). By category, the urban household consumption (UHC) production accounts for the most, ranging from 12.8% (for NC) to 21.1% (for SC) in the value added generation that is realised by direct final use production. While for indirect effects, the gross fixed capital formation (GFK) leads the list, contributing about 15.8% (for NW) to 22.3% (for SW).[11] Obviously, GFK requires more specialized products than UHC, which therefore tend to be imported from the *rest of China* more frequently. In contrast, the spillovers are relatively small in magnitude, (see *subtotal* in bottom panel in Table 3, which ranges from 8.1% to 19.2%). The implication is clear: the stimulation by means of direct investment in certain region, that very region would be the one benefit the most.

Related to Table 2 of regional disparity, the three least developed regions share a value added generation pattern that is quite similar, *i.e.* more than 91% of total value added can be attributed to production for domestic final use. However, when we take a closer inspection, the investment accounts for roughly one-third of value added generation in Southwest region. Observing further that the spillover effects play quite limited role, as 94% of total value added is realised by producing domestic final use, it is safe to argue that the promotion of investment in such area may be effective (as confirmed by HE and DUCHIN, 2009), which corresponds with the *Western Development Program*.

As far as interregional spillover effects are concerned in Table 3, the NC region receives no less than 19% of its value added from domestic final demand from spillovers. Within the 19% spillovers from other regions, over 5% is generated by final use in CR and another 5% originates from the EC. These results give clear picture about the interregional interdependences and interactions. The NC region is different from the SW region, which only receives 8% of its value added due to final domestic final demand from the other regions. To summarize, to raise income it might be effective to promote investment in the three least developed regions (CR, NW, and SW), particularly for the SW region that is relatively close.

Generally speaking, the ability to export abroad indicates relatively high productivity and thus high per capita income (see MELITZ, 2003), due to competitive foreign markets, technologically advanced products, foreign investments with transferred technology and so forth; and conversely. Hence, it is needed to carefully inspect the regional value added generation by production of foreign export and its implication for disparity.

Interregional interdependencies again: what does the foreign export-generated value added tell?
Table 4 presents the most aggregated estimates of export-led value added generation: column two and three give the total value added generated by production for exports, both in absolute and in percentage terms. Columns four and five respectively illustrate the direct effect and indirect effect, and followed by spillover effects. Looking at the spillovers, the foreign exports originated from EC and SC virtually benefit regions NC, CR, NW and SW considerably. In percentages, the exports of EC and SC contribute to over one quarter (for region NC) to roughly half (for region CR) of the total value added generated by exports production.

Table 4 about here

Regarding supply chains in the global economy, EC and SC are mainly coastal provinces that have natural locational advantages, as argued in ZHANG (2001) the reason why the disparity did not show in pre-reform period was mainly due to the fact that the comparative advantage in those regions were largely suppressed, when the Chinese economy opened up the comparative advantage started to take effect. Moreover, preferential policies for the coastal zones reinforced that advantage and even stimulated it.[12]

Imagine in the global supply chain, the closer a region is to the consumers in the ROW the higher tier of the hierarchy it locates; while those regions that provide raw material or natural resources, since they are far from the end users in the ROW, take lower position in the global supply chain. Thus, the regional trade hierarchy can be traced by using the absolute spillovers values, since they indicate the actual direct and indirect strengths of the supply chain. It is found that SC and EC are top the global supply chains in absolute terms, *i.e.* the overall performance of China's export is solely depending on the export performance of SC and EC (see Figure 3). As stated previously, the ability to export to the foreign market representing high productivity, and in turn may result in high income.

Figure 3 about here

In addition, there are four relatively independent exporting regions which, according to the definition, locate relatively high in the hierarchy. For SC, about 95% of value added stemmed from export production is locally attributable; the percentage for EC is 89%, NM is 88% and NE 80%. Further, it is observed the correlation between absolute value of value added generated by local foreign export and that of the share to total value added by all foreign export is 0.85; while the correlation for summation of net spillovers (in absolute values) and that of in percentages is as high as 0.92. This phenomenon, namely specialization or agglomeration, is well documented and discussed in new economic geography literature (see FUJITA *et al.*, 1999).

Spatial industrial structure when interregional interdependencies are considered: industry level investigation

In order to detect the spatial industrial links among regions via foreign export, the five most important industries (on the basis of relative importance in value added generation by foreign export production) in each of the eight regions are further investigated.[13] Table 5 is organized in the same fashion as Table 4.

Table 5 about here

Regional trade hierarchies are even more pronounced at industry level than at the aggregate level in Table 4. In particular, SC and EC are engines for exports in all regions. Notably, all regions are sensitive to spillovers from *mining* products (industry 2) and *chemical* products (industry 7) exports in SC and EC. Take industry 2 (*mining* products) export for example, because of their location in the global supply chain, the exports of SC and EC contribute to 32.7% of all export-led value added generation in NE, 47.7% in NC, and even two-thirds in CR, NW and SW in industry 2. In reality, inland regions (since they mainly provide raw material or natural resources) earn small portion by serving EC and SC; while EC and SC (relatively near to the final consumers) earn relatively larger portion by exporting to ROW. Eventually, a series of regional trade hierarchies at the product level is formed. In consequence, the regional disparity is a natural result that follows such mechanism, which further confirm the hypothesis

It is worth noting that, at the industry level region NM shows somewhat different nature than this general observation. It depends not much upon EC and SC, especially for its dominant exporting industries (*service* (industry 17), *trade and transport* (industry 16), and *electronic product* (industry 12)). This result fits well with what is concluded from Table 2 in case of the location quotients for value added. Region NM is outstanding also because of its special location (and possibly political status being the Capital and the Municipality). Yet, it is found to be benefited relatively the most from regions EC and SC.

To summarize, for export, all regions in most industries depend heavily on the performance of EC and SC. In other words, the exports from regions EC and SC may also be viewed as the indirect exports of other regions, and thus to some extent they are also the result of interregional trade. Naturally, one may ask what would happen if the exports from region SC or EC decreased for, say one trillion RMB due to whatever reasons, for instance the global financial crisis? Would this change widen or narrow the regional disparity?

Investment and export scenario analysis

Concerning the global financial crisis and the regional development programs launched in recent years, two types of scenarios are simulated. First, it is assumed that exports decrease with one trillion RMB (maintaining the 2002 export structure) in alternatively EC and SC due to the lack of external demand from ROW. The consequences are quantified, both at aggregate level and industry level. Second, considering the *Rise of Central China Program* and the *Western Development Program* initiated in respectively 2009 and 1999, it is assumed one trillion RMB investment were invested in either CR, NW or SW, with the 2002 *gross fixed capital formation* composition, and then make the estimation under this scenario. Main results are given in Table 6.

Table 6 about here

Table 6 is organized differently from Table 3 through Table 5. The total value added changes due to a shock in a region in question have been decomposed into within-region changes (direct effect and indirect effect), and interregional effects that occur in other regions due to the shock in the region at hand. Both aggregate estimation and five major industries (on the basis of relative importance) are presented. One common feature is that the changes are mainly confined within regions, which amount to roughly four-fifths (see Table 6 upper panel, column three plus column four over column two, except for NW that has 73%).

For the aggregate estimation, one may infer that the investment in NW would generate most value added (*i.e.* 1208 billion RMB); however, the 883 billion within-region benefit of NW is the smallest in percentage (since CR, NC, and EC also benefit (with 88 billion, 59 billion, and 35 billion, respectively) from a one-trillion-investment in NW). The CR is similar to the NW case, in that an investment in CR would also benefit EC and NC. In contrast, the investment made to SW would generate 856 billion within benefit (84% of the total), while in that case only CR would benefit 45 billion. In similar vein, the decrease of exports in EC and SC would hit CR sharply, with value added decrease 67 billion and 62 billion respectively, which reveals the relatively heavy dependence of CR to exports of EC and SC regions, echoing preceding arguments about the regional trade hierarchy.

To summarize the aggregate results, despite the dominant within-region effect, about one-fifth of total income change due to export contracting would impact other regions, in particular CR and NC. Second, for investment region NW is outstanding in that 27% of the benefit would spillover to other regions, where CR would benefit among the most. These findings urge us to detect the issue at industry level.

In the lower panel of Table 6, five industries are selected (according to relative importance) for each scenario. For the export shock, the five industries (*trade and transport* (industry 16), *service* (industry 17), *electronic product* (industry 12), *chemical products* (industry 7), and *textile and wearing apparel* (industry 4)) that would be impacted most, contribute two-thirds of the total change. For EC, the contraction would mainly hit CR, NC and SC. However, for the shock to SC, EC would incur relatively heavy losses, in particular for SC´s *chemical products* (industry 7). This reveals the relatively complex nature of regional interdependencies.

Concerning the investment shocks, three industries are most important in all three regions, namely *construction* (industry 15), *trade and transport* (industry 16), and *service* (industry 17). One major finding here is that for *construction*, the value added by definition can solely be realized within the region. For CR, EC and NC would be benefit relatively more due to the investment, in particular for sector 16 and sector 9 (*Metal products*). Importantly, the investments made in NW would contribute substantially to the income growth in *trade and transport* (industry 16) in CR, NC and EC; while that of SW would only contribute to the income growth in *agriculture* (industry 1) in CR. These findings may serve as another example of complementarity. It can be concluded that the investments to those least developed regions can contribute to narrow the regional disparity (similar findings are reported in HE and DUCHIN, 2009).

CONCLUSION AND DISCUSSION

Regarding regional disparity problem, it is important to study it in an interregional context. To set-up the data, the GRAS method is combined with national cell constraints to update China's 1997 interregional input-output table to 2002, which is among the first attempts empirically. Addition to the conventional convergence approach, comparative advantage and thus also interregional interdependency is added to address this issue. Further, it is shown that the regional trade, and therefore the hierarchy in the global supply chain serve an alternative explanation for regional per capita differences.

In fact, China's regions show a clear hierarchy, for instance, the three least developed regions (CR, NW, and SW) are among the lowest tier providing natural resource and raw materials to regions higher in the global supply chain (say, EC and SC), which partly explains their relative low per capita income. In contrast, the industrial compositions structures, and the access to direct foreign export, have implication on why EC and SC locate in the top tier of the hierarchy (end up with relatively high GDP per capita).

Furthermore, in order to quantify the impacts of two specific external shocks on regional disparity, scenario analysis is conducted. Despite the common feature that impacts are mainly confined within the region, investment seems to be an effective tool for income generation (similar argument is made in HE and DUCHIN, 2009). Hence, the regional development program is effective and beneficial and can be a feasible way to narrow regional disparity in the short run. For long-run consideration, since economic structure is crucial for household income level, upgrading of production structures (to gain the ability to participate in foreign export) may be an alternative to narrow regional income disparities.

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NOTES

1. It serves to complement the gap discussed in SAKAMOTO and ISLAM (2008), *i.e.* neither the "regression method" nor the "distribution technique" is able to explicitly capture the interregional spillover effects, which apparently is non-trivial in the interregional study context.
2. The so-called σ-convergence is used to demonstrate the dispersion of the GDP per capita among China's thirty-one provinces (see ZHANG, 2001). To this end, the estimation of the standard deviation of the logarithm of GDP per capita among the provinces in given years can be derived by $\sigma_t = \sqrt{\sum_{i=1}^{r} (\log(gpc_{it}) - \rho_t)^2 / r}$. Here, gpc_{it} gives GDP per capita level of province *i* for year *t* and ρ_t represents national average of the logarithm of GDP per capita (of all provinces) for year *t*. In the same fashion, the σ* is defined for the eight-region setting.
3. The comparison figures are obtained by [(2002 value - 1997 value)/(1997 value)]*100, with prices being converted to 2002 constant prices based on the primary data (*i.e.* 1997 IRIO Table), calculated using *China Statistics Yearbook*. Detail results are not shown, but available upon request.
4. The multi-regional IO (MRIO) table is used in their terminology. In fact, the interregional matrices are full matrices, in which sense the term interregional IO table (IRIO) is more appropriate by definition thus used in this study.
5. To be precise, the so-called *processing with customer's materials* (PCM) should be deducted both from export and import a priori, because the interdependence or roundabout effects do not hold for PCM production. In consequence, the import ratio would be adjusted downward accordingly. However, such detailed data are not available; in particular at regional level by industry, still one needs to interpret the result with caution. See PEI *et al*. (2011) for a detailed discussion on treatment of PCM in a national setting.
6. Obviously, Figure 2 has several advantages over Figure 1. For instance, it rules out the interference of import to "domestic" input structure which is relevant to our study and should be maintained. Hence, Figure 2 has been chosen as the starting point.

7. Detailed discussion of the updating procedure and formulas is omitted from the main text but available from the authors.

8. For instance, as discussed in SAKAMOTO and ISLAM (2008), neither "regression method" nor "distribution technique" is able to explicitly capture the interregional spillover effects.

9. In fact, the within region indirect effects can be further decomposed into two effects, namely *intra-regional effect without feedbacks* and *interregional feedbacks* (see MILLER and BLAIR, 2009; OOSTERHAVEN, 1981; and ZHANG and ZHAO, 2005; among others for detailed discussion). Meanwhile, the feedback effects are demonstrated to have relatively small magnitudes (though relevant theoretically); nonetheless, it is not the main focus of this study.

10. In Table 3, equations (4.1) and (5.1), (4.2) and (5.2), and (4.3) and (5.3) are combined for brevity sake. Obviously, they can be split-up without much difficulty but would increase the complexity substantially. In fact, it is observed that over 90% of VA generation by production for domestic final use is realized within region, *i.e.* production to meet local demand. For interested readers, they are available upon request.

11. One exception is for region SC, where the indirect effect of GFK only contributes 10.6% (less than of UHC with 11.3%) of total value added generation by production for domestic final use. This region stands out of its peers in the way that investment contributes the least share to value added generation among all the concerned regions. It could be an indicator for the development level, which means SC relies more on consumption rather than investment (like most of the developed economies).

12. This phenomenon is well documented in new economic geography literature; see FUJITA *et al.* (1999).

13. The regional trade hierarchy details are included at industry level due to space constraints. In fact, they are very much like Figure 3.

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APPENDIX: THE COVERAGES OF CHINA'S EIGHT REGIONS AND INPUT-OUTPUT SECTOR CLASSIFICATIONS

Table A1. China's eight economically defined regions

Code	Region	Provinces included
NE	Northeast	Heilongjiang, Jilin, Liaoning
NM	Northern Municipalities	Beijing and Tianjin
NC	North Coast	Hebei and Shandong
EC	East Coast	Shanghai, Jiangsu, Zhejiang
SC	South Coast	Guangdong, Fujian, Hainan
CR	Central Regions	Shanxi, Henan, Hubei, Hunan, Anhui, Jiangxi
NW	Northwest	Inner Mongolia, Shannxi, Ningxia, Gansu, Xinjiang
SW	Southwest	Sichuan, Chongqing, Yunnan, Guizhou, Guangxi, Qinghai, Tibet

Table A2. Industries in China's IRIO Table (Concordance Table)

17-industry classification		42-industry classification	
01	Agriculture	01	Agriculture
02	Mining	02	Coal mining, washing and processing
		03	Crude petroleum and natural gas products
		04	Metal ore mining
		05	Non-ferrous mineral mining
03	Food products	06	Manufacture of food products and tobacco processing
04	Textile and wearing apparel	07	Textile goods
		08	Wearing apparel, leather, furs, down and related products
05	Wooden products	09	Sawmills and furniture
06	Paper and printing	10	Paper and products, printing and record medium reproduction
07	Chemical products	11	Petroleum processing, coking and nuclear fuel processing
		12	Chemicals
08	Non-metallic mineral products	13	Nonmetal mineral products
09	Metal products	14	Metals smelting and pressing
		15	Metal products
10	Machinery	16	Common and special equipment
11	Transport equipment	17	Transport equipment
12	Electronic product	18	Electric equipment and machinery
		19	Telecommunication equipment, computer and other electronic equipment
13	Other manufacturing products	20	Instruments, meters, cultural and office machinery
		21	Other manufacturing products
		22	Scrap and waste
14	Electricity, gas and water supply	23	Electricity and heating power production and supply
		24	Gas production and supply
		25	Water production and supply
15	Construction	26	Construction
16	Trade and transport	27	Transport and warehousing
		30	Wholesale and retail trade
17	Service	28	Post
		29	Information communication, computer service and software
		31	Accommodation, eating and drinking places
		32	Finance and insurance
		33	Real estate
		34	Renting and commercial service
		35	Tourism
		36	Scientific research
		37	General technical services
		38	Other social services

		39	Education
		40	Health service, social guarantee and social welfare
		41	Culture, sports and amusements
		42	Public management and social administration

Fig. 1. *Layout of China's interregional input-output table*

	Intermediate deliveries		Domestic final use		Export	Import	TO
	in region *r*	in region *s*	in *r*	in *s*			
r	$\tilde{\mathbf{Z}}^{rr}$	$\mathbf{Z}^{rs}$	$\tilde{\mathbf{F}}^{rr}$	$\mathbf{F}^{rs}$	$\mathbf{e}^{r}$	$-\mathbf{m}^{r}$	$\mathbf{x}^{r}$
s	$\mathbf{Z}^{sr}$	$\tilde{\mathbf{Z}}^{ss}$	$\mathbf{F}^{sr}$	$\tilde{\mathbf{F}}^{ss}$	$\mathbf{e}^{s}$	$-\mathbf{m}^{s}$	$\mathbf{x}^{s}$
VA	$(\mathbf{v}^{r})'$	$(\mathbf{v}^{s})'$	$\mathbf{0}$	$\mathbf{0}$	$\mathbf{0}$	$\mathbf{0}$	
TI	$(\mathbf{x}^{r})'$	$(\mathbf{x}^{s})'$	$(\mathbf{f}^{r})'$	$(\mathbf{f}^{s})'$	e	$-\mathbf{m}^{\bullet}$	

Note: TO = total output; VA = value added; TI = total input.

Fig. 2. *Layout of China's IRIO table with import being split-up*

	Intermediate deliveries		Domestic final use		Export	TO
	in region *r*	in region *s*	in *r*	in *s*		
r	$\mathbf{Z}^{rr}$	$\mathbf{Z}^{rs}$	$\mathbf{F}^{rr}$	$\mathbf{F}^{rs}$	$\mathbf{e}^{r}$	$\mathbf{x}^{r}$
s	$\mathbf{Z}^{sr}$	$\mathbf{Z}^{ss}$	$\mathbf{F}^{sr}$	$\mathbf{F}^{ss}$	$\mathbf{e}^{s}$	$\mathbf{x}^{s}$
IM	$\mathbf{M}^{Zr}(=\hat{\mathbf{t}}^{r}\tilde{\mathbf{Z}}^{rr})$	$\mathbf{M}^{Zs}(=\hat{\mathbf{t}}^{s}\tilde{\mathbf{Z}}^{ss})$	$\mathbf{M}^{Fr}(=\hat{\mathbf{t}}^{r}\tilde{\mathbf{F}}^{rr})$	$\mathbf{M}^{Fs}(=\hat{\mathbf{t}}^{s}\tilde{\mathbf{F}}^{ss})$	$\mathbf{0}$	$\mathbf{m}^{\bullet}$
VA	$(\mathbf{v}^{r})'$	$(\mathbf{v}^{s})'$	$\mathbf{0}$	$\mathbf{0}$	$\mathbf{0}$	
TI	$(\mathbf{x}^{r})'$	$(\mathbf{x}^{s})'$	$(\mathbf{f}^{r})'$	$(\mathbf{f}^{s})'$	e	

Note: TO = total output; IM = import; VA = value added; TI = total input. A hat indicates diagonalization.

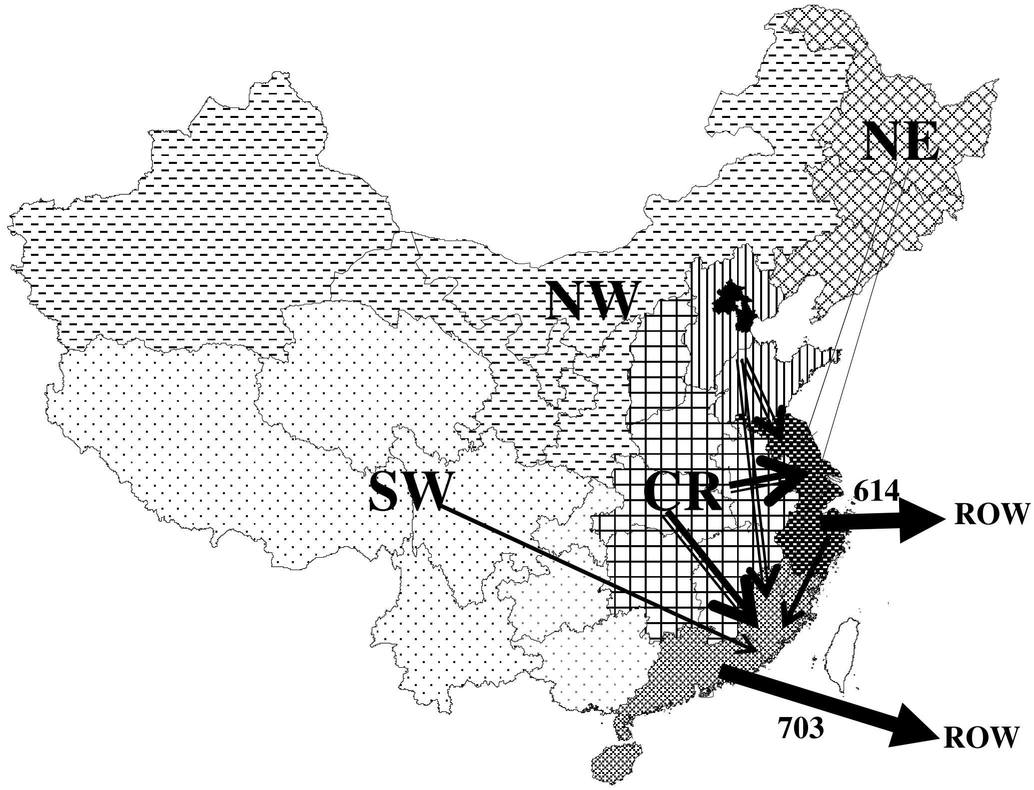

Fig. 3. *2002 China's regional hierarchies in the global supply chain and interregional interdependencies, absolute values (billion RMB)*

	Value added generation by local foreign export (billion RMB)	Net spillover *from* (billion RMB) NE	NM	NC	EC	SC	CR	NW	SW
NE	140	-	0.1	1.3	***9.6***	***8.3***	-2.5	-0.6	-0.4
NM	183	-0.1	-	-3.4	5.3	7.9	-3.3	-0.9	-0.3
NC	144	-1.3	3.4	-	***28.2***	***23.8***	-2.6	-1.0	0.1
EC	614	-9.6	-5.3	-28.2	-	***24.7***	-41.3	-7.1	-7.5
SC	703	-8.3	-7.9	-23.8	-24.7	-	-45.1	-7.6	-21.9
CR	86	2.5	3.3	2.6	***41.3***	***45.1***	-	0.1	0.9
NW	33	0.6	0.9	1.0	7.1	7.6	-0.1	-	0.1
SW	41	0.4	0.3	-0.1	7.5	***21.9***	-0.9	-0.1	-
	Total	**-15.9**	**-5.3**	**-50.5**	**74.3**	**139.3**	**-95.7**	**-17.2**	**-29.0**

Notes: 1. All figures in the table are absolute values (in 2002 billion RMB).

2. A positive entry indicates a net spillover from the region in a row to the region in a column; while negative entries indicate the opposite.

3. The thickness of the lines represents the strength of net spillovers (only those with absolute values more than 8.3 billion RMB are shown in the Figure).

Table 1. 31 Provincial GDP per capita, series disparities, and trends for 1995-2008

Year	Mean	Mean/Median	S.d./Mean	Max/Min	σ	σ*
1995	1.88	1.22	0.55	7.95	0.202	0.171
1996	2.41	1.13	0.56	8.65	0.200	0.170
1997	2.96	1.11	0.58	9.24	0.205	0.173
1998	3.46	1.13	0.60	9.81	0.209	0.181
1999	3.99	1.13	0.63	10.14	0.215	0.190
2000	4.66	1.14	0.61	8.91	0.210	0.186
2001	5.66	1.22	0.64	10.13	0.220	0.200
2002	7.24	1.26	0.70	10.46	0.230	0.225
2003	9.27	1.32	0.70	10.42	0.234	0.231
2004	12.43	1.40	0.70	10.83	0.235	0.230
2005	16.13	1.41	0.67	9.71	0.229	0.218
2006	21.05	1.40	0.65	9.44	0.229	0.214
2007	28.28	1.35	0.63	9.08	0.226	0.207
2008	37.08	1.36	0.59	8.29	0.220	0.194

Note: GDP per capita (thousand RMB per head, in 2005 constant prices); s.d. stands for standard deviation, and columns three (Mean/Median) through five (Max/Min) are descriptive measurements of provincial GDP per capita dispersion. Despite the σ, a similarly defined σ* is given as a disparity indicator for eight regions each year: the decline of σ (so the σ*) indicates converging of cross- province/-region dispersion of per capita incomes.

Source: Authors' calculation based on various years of *China Statistics Yearbook* and the formula given in *NOTE* 2.

*Table 2. 2002 Location quotients for value added * 100% and disparity measures*

Industry	NE	NM	NC	EC	SC	CR	NW	SW	Nat. Sh.%	Nat. Prod.
1	0.94	0.22	1.10	0.61	0.75	1.37	1.32	1.56	13.65	4.51
2	2.60	0.66	1.38	0.15	0.51	1.16	1.94	0.68	4.90	38.30
3	0.85	0.48	1.86	0.66	0.66	1.07	0.52	1.56	3.69	41.06
4	0.40	0.42	1.07	2.12	1.26	0.70	0.30	0.21	3.17	24.57
5	1.19	0.27	0.55	0.73	2.09	1.27	0.27	0.60	0.88	32.53
6	0.52	0.70	1.25	1.10	1.65	0.83	0.50	0.74	1.95	32.86
7	1.16	0.92	1.21	1.34	0.94	0.80	0.67	0.63	5.63	40.41
8	0.14	0.39	1.42	0.77	0.76	1.69	0.89	1.13	1.57	22.03
9	1.15	0.64	1.09	1.08	0.77	1.11	0.92	0.96	4.24	44.33
10	1.08	0.66	1.44	1.43	0.68	0.96	0.50	0.56	2.99	36.74
11	1.53	0.68	0.66	1.34	0.65	0.99	0.63	1.25	2.08	41.60
12	0.49	1.74	0.44	1.62	2.25	0.39	0.30	0.37	3.65	47.90
13	0.67	0.84	0.82	1.40	1.45	0.98	0.48	0.55	1.52	47.86
14	1.14	0.54	0.80	0.97	0.99	1.07	1.33	1.13	3.55	76.93
15	0.94	1.02	0.89	0.89	0.74	1.09	1.59	1.27	5.41	20.01
16	1.08	0.92	0.88	1.03	1.18	0.95	0.92	0.95	13.22	18.43
17	0.85	1.79	0.85	1.03	1.05	0.89	1.05	0.99	27.92	27.54
RSC%	12.47	24.91	10.66	12.08	11.97	8.53	14.64	12.38		***16.5***[a]
Area%	8.37	0.29	3.59	2.18	3.48	10.64	37.03	34.41		
Pop. den.	133	864	456	648	361	351	31	77	***133***[a]	
GDP/cap.	10.68	26.67	10.30	17.84	15.33	6.29	6.67	5.20	***9.46***[a]	

Notes: 1. "Nat. Sh.%" gives percentage contribution of value added per industry to national value added; "Nat. Prod." refers to nation-wide industry productivity, measured by thousand RMB per employment*year.

2. In row-wise, RSC stands for the *regional specialization coefficient* (ranges from 0 to 100%): the higher the ratio is the more unique it shows relative to the national economic structure. Area provides information on regional feature while the related population density (Pop. den., in persons per square kilometers) reveals the regional demographic status. GDP per capita (GDP/cap.) is given by thousand RMB per head.

3. The three figures with ***a*** give the national averages of productivity (16.53 thousand RMB per employment*year), the average population density in 2002 (133 people per square kilometer), and the national GDP per capita (9.46 thousand RMB in 2002).

Table 3. 2002 Regional value added generation patterns by domestic final demand: aggregate

		NE	NM	NC	EC	SC	CR	NW	SW
Value Added		994	427	1449	1724	1150	2144	709	1213
% of total VA		85	67	87	71	61	92	92	94
Direct (% VA)	RHC	5.93	2.08	7.74	6.50	7.08	9.80	6.25	10.80
	UHC	18.18	18.03	12.77	16.55	21.12	15.33	17.55	13.54
	GC	10.09	10.08	9.47	9.72	12.27	9.67	11.69	11.01
	GFK	9.74	9.95	10.92	11.41	9.86	10.01	13.09	10.05
	CI	-0.11	1.13	0.43	0.92	1.82	0.21	0.09	0.47
subtotal		**43.84**	**41.28**	**41.34**	**45.12**	**52.15**	**45.01**	**48.66**	**45.88**
Indirect (% VA)	RHC	4.75	1.93	6.15	4.41	3.62	6.70	3.85	6.69
	UHC	15.14	15.86	11.06	11.89	11.33	12.15	11.01	9.76
	GC	6.96	8.13	4.91	5.00	5.50	5.18	5.10	6.79
	GFK	16.55	16.56	17.22	16.84	10.57	16.27	15.79	22.27
	CI	0.09	1.75	0.16	1.17	1.27	-0.30	0.33	0.51
subtotal		**43.49**	**44.23**	**39.50**	**39.32**	**32.29**	**39.99**	**36.08**	**46.01**
Spillovers *from domestic final use in* (% VA):	NE	-	1.57	2.07	1.41	1.06	1.07	1.15	0.39
	NM	0.39	-	0.90	0.26	0.20	0.40	0.47	0.09
	NC	4.04	3.39	-	3.11	1.49	2.28	2.41	0.62
	EC	2.62	2.60	5.13	-	4.68	4.59	2.55	1.65
	SC	1.03	1.44	2.01	2.78	-	2.67	1.28	2.27
	CR	2.26	2.63	5.32	4.81	3.83	-	4.80	1.91
	NW	1.39	1.84	1.92	1.39	1.25	1.75	-	1.18
	SW	0.95	1.03	1.80	1.81	3.04	2.22	2.61	-
subtotal		**12.68**	**14.49**	**19.16**	**15.57**	**15.56**	**14.99**	**15.26**	**8.11**

Note: Value added is in billion RMB, which is generated by production for domestic final use for each region. The effects, including direct effect (equations (4.1)+(5.1)), indirect effect ((4.2)+(5.2)), and seven spillovers from domestic final use in other regions ((4.3)+(5.3)), are percentage contributions which sum up to 100%. RHC, UHC, GC, GFK, and CI stand for, respectively, rural household consumption, urban household consumption, government consumption, gross fixed capital formation, and changes in inventories.

Table 4. 2002 Regional value added generated by foreign exports: aggregate

	Value Added	% of total VA	Direct (% VA)	Indirect (% VA)	Spillovers *from exports of* (% VA): NE	NM	NC	EC	SC	CR	NW	SW
NE	176	15	39	41	-	1.10	3.56	8.02	6.04	0.74	0.46	0.26
NM	207	33	41	47	0.89	-	1.47	3.80	4.46	0.44	0.31	0.14
NC	225	13	30	34	2.19	2.86	-	16.17	11.70	1.95	0.72	0.54
EC	690	29	41	48	0.66	0.37	1.18	-	7.64	0.73	0.22	0.23
SC	743	39	57	38	0.32	0.18	0.34	3.77	-	0.35	0.11	0.23
CR	199	8	20	23	1.90	2.11	3.54	23.28	23.98	-	1.08	1.10
NW	58	8	29	28	2.44	2.70	4.43	14.85	14.51	3.52	-	1.46
SW	79	6	25	27	1.04	0.70	1.45	11.52	30.02	1.68	0.98	-

Note: Value added is in billion RMB, which is generated by production for foreign export. The effects, including direct effect (formula 3.1), indirect effect (formula 3.2), and seven spillovers from foreign exports in other regions (formula 3.3), are percentage contributions which sum up to 100%.

Table 5. 2002 Regional value added generation by foreign export: by industry

Industry	Value Added	Direct (% VA)	Indirect (% VA)	Spillovers *from exports of* (% VA): NE	NM	NC	EC	SC	CR	NW	SW
NE (includes 68.5% of total VA generated by foreign exports)											
2	39	21	34	-	1.51	8.40	18.82	13.87	1.40	0.65	0.45
16	31	49	40	-	0.92	1.69	4.24	3.03	0.46	0.37	0.18
17	19	50	43	-	0.48	1.19	2.76	2.09	0.28	0.20	0.10
7	18	39	38	-	1.13	4.74	7.79	7.70	1.06	0.57	0.42
1	14	40	51	-	0.79	1.65	2.82	2.22	0.34	0.24	0.14
NM (includes 80.3% of total VA generated by foreign exports)											
17	95	27	65	0.59	-	0.97	2.56	2.98	0.29	0.21	0.10
16	30	52	38	0.86	-	1.46	3.49	3.56	0.39	0.30	0.13
12	23	70	21	0.98	-	0.82	2.15	5.15	0.34	0.13	0.09
7	11	17	47	1.99	-	3.49	11.67	16.17	1.32	1.28	0.51
2	8	37	28	2.78	-	4.05	12.63	12.43	1.55	0.67	0.39
NC (includes 60.1% of total VA generated by foreign exports)											
16	35	37	31	2.14	2.56	-	14.02	9.40	1.77	0.76	0.51
1	29	25	50	1.73	1.91	-	10.95	7.92	1.45	0.63	0.41
2	25	15	25	3.42	4.27	-	27.84	19.85	2.95	0.72	0.77
17	24	32	44	1.48	1.86	-	10.74	7.95	1.32	0.49	0.37
7	23	14	33	2.91	2.98	-	22.15	20.72	3.17	1.08	0.91

Table 5. 2002 Regional value added generation by foreign export: by industry (*cont.*)

	Value Added	Direct (% VA)	Indirect (% VA)	Spillovers *from exports of* (% VA): NE	NM	NC	EC	SC	CR	NW	SW
EC (includes 67.6% of total VA generated by foreign exports)											
16	126	46	45	0.63	0.36	1.24	-	5.82	0.66	0.22	0.21
17	109	34	59	0.43	0.24	0.76	-	4.84	0.47	0.14	0.15
4	102	57	39	0.20	0.11	0.31	-	3.13	0.33	0.14	0.10
7	68	21	53	1.13	0.62	1.75	-	20.12	1.46	0.37	0.53
12	61	53	34	0.80	0.59	0.92	-	10.24	0.74	0.17	0.18
SC (includes 68.5% of total VA generated by foreign exports)											
16	157	58	38	0.28	0.15	0.31	3.06	-	0.27	0.11	0.19
17	135	36	61	0.19	0.11	0.19	2.20	-	0.21	0.07	0.14
12	106	82	14	0.42	0.29	0.23	2.50	-	0.34	0.09	0.18
4	63	82	16	0.08	0.05	0.10	2.11	-	0.13	0.06	0.11
7	47	50	36	0.54	0.35	0.80	9.90	-	0.92	0.23	0.80
CR (includes 58.5% of total VA generated by foreign exports)											
16	34	27	22	2.04	1.89	3.75	21.43	20.12	-	1.23	1.13
1	22	10	42	1.55	1.36	3.51	16.39	22.50	-	1.04	1.00
2	22	7	14	3.08	2.47	4.10	36.27	30.38	-	1.15	1.25
17	21	25	33	1.45	1.48	2.58	17.31	17.40	-	0.82	0.81
7	17	10	17	1.84	1.65	4.13	26.39	36.61	-	1.08	1.63
NW (includes 68.6% of total VA generated by foreign exports)											
2	11	9	19	4.57	4.03	4.36	24.79	25.36	5.88	-	2.16
16	8	35	25	2.06	2.65	9.47	12.11	10.28	2.52	-	1.13
1	8	12	63	1.56	2.22	2.83	6.91	9.05	1.51	-	1.13
17	7	33	38	1.59	1.78	3.12	9.79	9.60	2.32	-	0.97
9	5	26	8	2.49	4.05	5.06	27.11	19.26	6.73	-	1.20
SW (includes 64.1% of total VA generated by foreign exports)											
16	19	29	21	0.90	0.60	1.19	9.16	35.96	1.39	0.88	-
17	11	23	41	0.77	0.52	1.06	8.58	23.42	1.25	0.74	-
9	9	20	16	1.46	0.92	2.00	21.31	35.98	1.91	0.86	-
7	6	18	23	0.97	0.74	1.65	12.66	39.84	1.85	1.15	-
2	6	8	24	1.79	1.00	2.21	21.04	38.14	2.78	1.16	-

Note: The shares in parenthesis are contributions of industry group (detailed in column one, clustered based on relative importance) to total value added that are generated by production for foreign exports. Value added in column two is in billion RMB (2002 price). The effects are decomposed to direct effect (formula 3.1), indirect effect (formula 3.2), and seven spillovers from foreign exports in other regions (formula 3.3), which add up to 100%.

Table 6. Scenarios analysis: exports and investments changes of one trillion RMB

	Total VA Change	Within-region Direct	Indirect	Interregional spillover effects *on*: NE	NM	NC	EC	SC	CR	NW	SW
Aggregate impact per scenario											
EC	-1103	-412	-474	-20	-11	-52	-	-40	-67	-12	-13
SC	-1156	-552	-371	-14	-12	-34	-69	-	-62	-11	-31
CR	1027	313	503	16	11	51	58	30	-	28	18
NW	1208	405	478	32	23	59	55	32	88	-	36
SW	1014	269	587	9	5	23	28	29	45	19	-
EC exports by industry (includes 63.2% of the total VA change due to this scenario)											
16	-197	-84	-81	-1.9	-1.5	-7.1	-	-6.9	-10.4	-1.5	-2.5
17	-167	-54	-93	-0.8	-3.5	-3.7	-	-4.3	-5.3	-1.0	-1.3
4	-150	-83	-57	-0.2	-0.2	-3.6	-	-1.9	-3.2	-0.1	-0.1
7	-99	-21	-52	-2.0	-1.8	-7.3	-	-6.8	-6.6	-1.0	-1.1
12	-84	-46	-30	-0.3	-0.7	-0.8	-	-3.8	-1.9	-0.2	-0.2
SC exports (includes 65.7% of the total VA change due to this scenario)											
16	-233	-119	-78	-1.2	-1.4	-4.3	-9.6	-	-8.9	-1.1	-8.9
17	-194	-64	-107	-0.5	-3.7	-2.5	-6.9	-	-4.9	-0.9	-3.2
12	-150	-114	-19	-0.4	-1.5	-1.0	-8.2	-	-4.1	-0.3	-0.8
7	-95	-31	-22	-1.8	-2.3	-6.2	-17.9	-	-8.4	-1.2	-3.2
4	-89	-67	-13	-0.1	-0.1	-1.6	-4.2	-	-1.9	-0.1	-0.2
CR investments (includes 57.7% of the total VA change due to this scenario)											
15	190	188	1	0.0	0.0	0.1	0.1	0.1	-	0.0	0.1
16	133	18	84	1.8	1.5	7.3	9.6	5.0	-	2.9	3.4
17	102	3	78	0.7	3.4	3.8	6.0	3.2	-	2.3	1.8
9	86	3	53	1.8	1.0	6.3	7.7	2.6	-	6.8	3.1
10	81	44	23	0.6	0.4	3.8	6.1	1.2	-	0.7	0.7
NW investments (includes 65.1% of the total VA change due to this scenario)											
15	257	254	3	0.0	0.0	0.1	0.1	0.1	0.2	-	0.2
16	201	35	101	5.1	3.8	11.5	11.2	7.4	18.7	-	7.9
17	149	19	96	1.6	7.3	4.7	5.8	3.5	7.5	-	3.6
2	97	0	60	9.1	1.5	7.5	0.8	2.7	11.2	-	4.9
1	81	31	38	0.7	0.1	3.2	1.3	1.1	4.0	-	1.1
SW investments (includes 72.1% of the total VA change due to this scenario)											
1	316	9	282	0.9	0.3	3.8	2.1	3.2	10.0	4.8	-
15	182	180	2	0.0	0.0	0.0	0.1	0.1	0.1	0.0	-
16	104	20	61	1.0	0.7	3.1	4.4	4.8	6.6	1.7	-
17	74	3	57	0.4	1.6	1.5	2.8	3.0	3.2	1.4	-
9	54	3	38	0.8	0.3	2.2	3.1	1.6	3.9	1.5	-

Note: All are hypothetical values in billion RMB, respectively generated by exports (1 trillion RMB decrease in EC and SC) and investments (1 trillion RMB directs to either CR, or NW, or SW). The effects are defined and computed based on equations (3.1)-(3.3) through (5.1)-(5.3). The lower panel gives industry details.