China and the World Economy

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RESEARCH MEMORANDUM

China and the World Economy:
A Global Value Chain Perspective on Exports, Incomes and Jobs

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Abstract

Based on a new dataset of world input-output tables we analyze the impact of foreign demand on Chinese factor incomes and employment since 1995. We extend the global input-output methodology introduced by Johnson and Noguera (2012) and find that exports of value added rapidly increased after 2001, peaking at 28% of GDP in 2006. During this period the increase in foreign demand added about 70 million jobs, predominantly for unskilled workers. Due to strong domestic inter-industry linkages more than half of these jobs were created outside the manufacturing sector. Foreign demand generated income for domestic capital rather than for labor, as wages remained low. The current global economic crisis strengthens the process of reorientation of the Chinese economy, which appears to have started in 2006 already. Domestic final demand for non-tradables has become the main source of growth and the sources of export income steadily shifted away from mature markets to emerging markets.

Introduction

Exports have played an important role in the structural transformation of the Chinese economy in the past decades. Stimulated by supportive government policy, export activities quickly expanded, absorbing a large part of the abundant rural labor supply and making China the world's largest exporter since 2009. Facilitated by its accession to the World Trade Organization in 2001, China benefitted strongly from the rapid fragmentation of production and quickly took part in globally integrated production networks (Baldwin, 2006). The desirability of a heavy reliance on foreign demand has been questioned frequently, fuelled by the volatility and weakness of demand in world markets since the onset of the global crisis in 2008. This has led to repeated calls for stimulating domestic consumption and diverting away from foreign demand. At the same time though, it is argued that export-led growth will remain important for China for sustaining employment opportunities in the near future in the event of a global growth rebound. Yang Yao (2010) argues that the double transition of demography and rural migration has not been completed, necessitating abundant demand for labor also within the next 10 to 15 years. In addition, decent employment opportunities for the growing pool of college-educated workers are needed (see also World Bank 2012).

In order to assess the possible role of foreign demand in generating income and employment in the future, it is necessary to know how important exports have been in the past. This has been heavily debated and by now it is well recognized that China is less dependent on international trade than suggested by standard headline indicators such as the gross-export-to-GDP ratio. This ratio rapidly increased from 20% in 1995 to a peak of 39% in 2006 (OECD *National Accounts statistics*). China's exports contain a major share of imported intermediates, however. As a consequence, domestic value added in exports (which is part of GDP) is much lower than gross export revenues. Well-known case studies of electronic products such as the iPod and laptops that are produced and exported by China suggest that the domestic value added content is rather low. These products are assembled based on expensive imported components and the major share of the price of the final product is captured by multinational lead firms in the production networks. China is mainly involved in assembling, testing and packaging activities that are poorly compensated (Dedrick et al., 2010).

Based on industry-level statistics, seminal work by Chen et al. (2004) has pointed out that the domestic value added content of exports has been around 60% in the early 2000s, and even much lower for particular industries such as electronics manufacturing. This has been corroborated in later work by Koopman et al. (2012), Pei et al. (2012) and Chen et al. (2012) using comparable industry data and techniques, and by studies based on firm and transaction level trade data, such as Kee and Tang (2012). The latter study and Chen et al. (2012) also found that the domestic value added content increased somewhat between 2002 and 2007. The effects of foreign demand on employment and factor income distributions have been much less studied. If there is rapid labor productivity growth in export production, employment opportunities are growing less than domestic value added. Feenstra and Hong (2010) and Chen et al. (2012) have shown that this effect has sizable consequences indeed. In addition, it has often been suggested that with poor wages and the proliferation of foreign-controlled firms in the Chinese manufacturing sector, much of the income derived from exporting accrues as remuneration of foreign capital rather than domestic labor.

In this paper we revisit the debate on the importance of foreign demand for income and employment growth in China, providing for the first time a long time-series perspective covering the period from 1995 to 2011. The analyses are based on a new set of international input-output tables with a full-fledged model of bilateral trade flows. Previous studies on the importance of exports for Chinese growth such as Feenstra and Hong (2010) and Chen et al. (2012) relied on national input-output tables and assumed export demand as exogenously given. In the past, most of Chinese exports consisted of final products mainly assembled on the basis of imported intermediates, and hence could be modeled as exogenous to the Chinese economy. More recently, China moved up in production chains, starting to export intermediate products for assembly and further processing elsewhere. Examples of such products are cotton textiles and electronic components exported to other Asian countries and Africa. These exports partly return to the Chinese economy in embodied form, satisfying domestic final demand. This invalidates the assumed exogenous nature of export demand in analyses based on national input-output tables. Instead, we analyze the income effects of international trade using the so-called 'trade in value added' methodology, based on multi-regional input-output tables, as introduced by Johnson and Noguera (2012).[1] This methodology provides a consistent accounting framework of the direct and indirect effects of domestic and foreign demand growth on value added, based on the multiplier analysis first introduced by Leontief (1936, 1941). We extend the methodology and also analyze the impact of foreign demand on the remuneration of labor and capital. Furthermore, we focus explicitly on the creation of employment for various labor types characterized by levels of educational attainment. To this end we have collected a new dataset of wages and employment by level of educational attainment and capital incomes at a detailed industry-level. This allows us to investigate for the first time how foreign demand have driven Chinese incomes and employment in the long-run.

The remainder of the paper is organized as follows. The methodology for measuring exports of value added, capital income and employment is discussed in section 2. The proposed techniques put heavy requirements on the data for outputs, intermediate inputs and employment, which are particularly important for the case of China. We use a newly developed time-series of intercountry input-output tables based on 41 regions covering the world economy from 1995 onwards, called World Input-Output Tables (WIOTs) (Timmer et al., 2012). These WIOTs were constructed by linking national input-output tables through detailed bilateral trade statistics, distinguishing between imports for intermediate and final use. The tables are consistent with national accounts time series on outputs and inputs and are the first to allow for consistent

[1] See also Koopman et al. (2012) for discussion.

analyses over time. The WIOTs will be discussed in section 3, with special emphasis on the derivation of the time-series of input-output tables for China. We also discuss the new data set on employment by skill type and income in detailed Chinese industries in this section. In section 4, we present our main results. We find that China's income dependence on consumption abroad increased rapidly between 2001 and 2006. During this period the growth of foreign demand and changes in China's role in global value chains caused about 70 million additional jobs, predominantly for unskilled workers. Due to strong inter-industry linkages more than half of these jobs were created outside the manufacturing sector. Foreign demand generated income for domestic capital rather than for labor, as wages remained low. We also find that since 2006 a process of rebalancing has been underway in the Chinese economy. This process was further strengthened by onset of the global financial crisis. After 2006, domestic final demand for non-tradables became the main source of growth, rather than foreign demand. In addition, traditional export markets in mature economies such as Japan, the US and the European Union lost importance and Chinese exports of value added shifted towards emerging markets. Section 5 provides concluding remarks.

2. Methodology

In this section we outline our approach to measure the importance of exports for Chinese income and employment, based on a global input-output framework. We follow the approach adopted by Johnson and Noguera (2012), which is an extension of a standard input-output decomposition technique introduced by Leontief (1936, 1941) towards a multi-country setting. By tracing the value added at the various stages of production, it provides an ex-post accounting of the value of final demand. This allows one to measure the importance of foreign demand relative to domestic demand for home-country value added growth in a consistent framework.[2] We introduce our accounting framework drawing on the exposition in Johnson and Noguera (2012) and then generalize their approach by a further breakdown of value added by type of production factor, such as labor of various skill types and capital inputs.

We assume that there are S sectors, F production factors and N countries.[3] Output in each sector of each country is produced using domestic production factors (capital and labor) and intermediate inputs, which may be sourced domestically or from foreign suppliers. Output may be used to satisfy final demand or used as intermediate input in production at home or abroad.

[2] See Miller and Blair (2009) for an elementary introduction into input-output analysis. This approach is also followed by Bems et al. (2011) in a simulation exercise of the fall in global demand in 2008. An alternative approach is proposed by Koopman et al. (2011), which aims to decompose the value of exports, rather than an analysis of final demand as this paper does. Los et al. (2012) discuss the relationship between the two approaches.

[3] Although we will apply annual data in our empirical analysis, time subscripts are left out in the following discussion for ease of exposition.

Final demand consists of household and government consumption and investment.[4] To track the shipments of intermediate and final goods within and across countries it is necessary to define source and destination countries, as well as source and destination sectors. For a particular product, we define i as the source country, j as the destination country, s as the source sector and t as the destination sector. By definition, when markets clear, the quantity of a product produced in a particular country-sector[5] must equal the quantities of this product used domestically and abroad. Because we only observe the value of products traded, we further assume that each product has only one price, irrespective of its use, such that the revenue for the producer equals the value of use across destinations.[6] The product market clearing condition can now be written as

$$y_i(s) = \sum_j f_{ij}(s) + \sum_j \sum_t m_{ij}(s,t) \quad (1)$$

where $y_i(s)$ is the value of output in sector s of country i, $f_{ij}(s)$ the value of goods shipped from this sector for final use in any country j, and $m_{ij}(s,t)$ the value of goods shipped from this sector for intermediate use by sector t in country j. Note that the use of goods can be at home (in case $i = j$) or abroad ($i \neq j$).

Using matrix algebra, the market clearing conditions for each of the SxN goods can be combined to form a compact global input-output system. Let $\mathbf{y}$ be the vector of production of dimension (SNx1) stacking output in each country-sector, and $\boldsymbol{f}$ the vector with dimension (SNx1) stacking final demand in any country for output from each country-sector. We further define a global input-output matrix $\mathbf{A}$ of dimension (SNxSN) with elements $a_{ij}(s,t) = m_{ij}(s,t)/y_j(t)$, which are intermediate input coefficients describing the output from sector s in country i used as intermediate input by sector t in country j as a share of output in the latter sector. The matrix $\mathbf{A}$ describes how a given product in a country-sector is produced with different combinations of intermediate products and can be written as $\mathbf{A} \equiv \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} & \cdots & \mathbf{A}_{1N} \\ \mathbf{A}_{21} & \mathbf{A}_{22} & \cdots & \mathbf{A}_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{A}_{N1} & \mathbf{A}_{N2} & \cdots & \mathbf{A}_{NN} \end{bmatrix}$ where $\mathbf{A}ij$ is the SxS matrix with typical elements $a_{ij}(s,t)$. The diagonal sub-matrices track the requirements for domestic intermediate inputs, while the off-diagonal elements track the requirements for foreign intermediate inputs. The matrix $\mathbf{A}$ summarizes the flows of all intermediate goods across sectors and countries and using this we can rewrite the stacked SxN market clearing conditions from (1) as

[4] In the input-output table the final demand categories are separately modeled, but they are taken together for the empirical analysis.

[5] We use the term country-sector to denote a sector in a country, such as the Chinese chemicals sector and the German transport equipment sector.

[6] In the empirical analysis we will use input-output tables at basic prices, which exclude trade and transportation margins and net taxes. This price concept comes closest to the assumption made here.

$$\begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \vdots \\ \mathbf{y}_N \end{bmatrix} \equiv \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} & \cdots & \mathbf{A}_{1N} \\ \mathbf{A}_{21} & \mathbf{A}_{22} & \cdots & \mathbf{A}_{2N} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{A}_{N1} & \mathbf{A}_{N2} & \cdots & \mathbf{A}_{NN} \end{bmatrix} \begin{bmatrix} \mathbf{y}_1 \\ \mathbf{y}_2 \\ \vdots \\ \mathbf{y}_N \end{bmatrix} + \begin{bmatrix} \sum_j \mathbf{f}_{1j} \\ \sum_j \mathbf{f}_{2j} \\ \vdots \\ \sum_j \mathbf{f}_{Nj} \end{bmatrix}$$

In this expression, $\mathbf{y}_i$ represents the S-vector with production levels in country i, and $\mathbf{f}_{ij}$ indicates the S-vector of final demands in country j for the products of country i. In compact form, the system can be expressed as

$$\mathbf{y} = \mathbf{A}\mathbf{y} + \mathbf{f} \qquad (2)$$

Rearranging (2) we arrive at the fundamental input-output identity introduced by Leontief (1949)

$$\mathbf{y} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \qquad (3)$$

$\mathbf{I}$ is an (SNxSN) identity matrix with ones on the diagonal and zeros elsewhere. $(\mathbf{I} - \mathbf{A})^{-1}$ is famously known as the Leontief inverse. It represents the total production values in all stages of production that are generated in the production process of one unit of final output. To see this, let $\mathbf{z}$ be a column vector with the first element representing the global consumption of goods from a particular country-sector, while all the remaining elements are zero. The production of final output $\mathbf{z}$ requires intermediate inputs given by $\mathbf{Az}$. In turn, the production of these intermediates requires the use of other intermediates given by $\mathbf{A}^2\mathbf{z}$, and so on. As a result the increase in output in all sectors is given by the sum of all direct and indirect effects $\sum_{k=0}^{\infty} \mathbf{A}^k \mathbf{z}$. This geometric series can be rewritten as $(\mathbf{I} - \mathbf{A})^{-1}\mathbf{z}$.

Johnson and Noguera (2012) used this set-up to analyze exports of value added. Below we generalize their approach and further split value added into the contributions from production factors labor and capital. We define $p_i(s)$ as the direct factor input per unit of gross output produced in sector s in country i and create the stacked vector $\mathbf{p}$ with dimension SNx1 from these direct factor input coefficients. An element in this vector is country- and sector-specific, for example the hours of low-skilled labor used in the Chinese electronics industry to produce one dollar of output in that country-industry. The elements in $\mathbf{p}$ do not account for production factors embodied in intermediate inputs used. To take these into account, we need to use equation (3), and derive the factor requirements vector $\mathbf{k}$ (with SN elements) for any final demand vector $\mathbf{f}$ by pre-multiplying the gross outputs needed for production of this final demand by the requirement vector as follows

$$\mathbf{k} = \hat{\mathbf{p}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f} \qquad (4)$$

where a hat indicates a diagonal matrix with the elements of a vector (in this case $\mathbf{p}$) on the diagonal. If the final demand vector $\mathbf{f}$ is chosen specifically (like $\mathbf{z}$ above), the vector $\mathbf{k}$ as obtained in equation (4) gives all direct and indirect factor inputs needed for the production of the specific final demand vector that is analyzed.

Equation (4) can thus be used to investigate the relative importance of various sources of final demand for production factor usage. For the purpose of this paper we are particularly interested in the effects of foreign versus domestic consumption and investment demand. For a particular country i, we define foreign final demand ($\mathbf{f}_i^{\mathrm{FOR}}$) and domestic final demand ($\mathbf{f}_i^{\mathrm{DOM}}$) as the following SN vectors:

$$\begin{bmatrix} \sum_{j\neq i}\mathbf{f}_{1j} \\ \sum_{j\neq i}\mathbf{f}_{2j} \\ \vdots \\ \sum_{j\neq i}\mathbf{f}_{Nj} \end{bmatrix} = \mathbf{f}_i^{\mathrm{FOR}} \qquad \begin{bmatrix} \mathbf{f}_{1i} \\ \mathbf{f}_{2i} \\ \vdots \\ \mathbf{f}_{Ni} \end{bmatrix} = \mathbf{f}_i^{\mathrm{DOM}}$$

which implies that $\mathbf{f}_i^{\mathrm{FOR}} + \mathbf{f}_i^{\mathrm{DOM}} = \mathbf{f}$. Substituting this in the linear system given in equation (3) one can now derive the gross output generated due to final demand from home country i, and due to final demand from other countries

$$\mathbf{y} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}^{\mathrm{DOM}} + (\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}^{\mathrm{FOR}} \qquad (5)$$

Let $\mathbf{p}_i$ be an SN-elements vector with the S true direct factor input coefficients for country i as elements and zeros elsewhere. Using equation (4), we arrive now at

$$\mathbf{k}_i = (\hat{\mathbf{p}}_i)(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}^{\mathrm{DOM}} + (\hat{\mathbf{p}}_i)(\mathbf{I} - \mathbf{A})^{-1}\mathbf{f}^{\mathrm{FOR}}$$

$$= \boldsymbol{k}_i^{\mathrm{DOM}} + \boldsymbol{k}_i^{\mathrm{FOR}} \qquad (6)$$

In this equation, we have decomposed the amount of factors used in each sector of the home economy as given by $\mathbf{k}_i$ into the amount used to satisfy domestic final demand $\mathbf{k}_i^{\mathrm{DOM}}$ and used to satisfy foreign demand $\mathbf{k}_i^{\mathrm{FOR}}$. The latter measures *value added exports* defined by Johnson and Noguera (2012) as the amount of value added produced in a given source country that is ultimately embodied in final products absorbed abroad.

Below we will further decompose this into the value added by labor and capital using the definition of value added as the income for all factors of production. We refer to these as *factor services exports:* the amount of value added by a particular factor of production in a given source country that is ultimately embodied in final products absorbed abroad. Thus we provide a link between the generation of domestic income and foreign demand and use this as a measure of export dependence. By appropriately choosing **p**, we also analyze the income and number of jobs generated by domestic and foreign demand, cross-classified by skill-category.

3. Data sources and framework

To implement the accounting method outlined above, one needs a database with linked consumption, production and income flows both within and across countries. National input-output tables that provide a consistent framework of all transactions within an economy provide a useful starting point. However, these tables typically do not provide any information on the origin of the goods used beyond domestic or imported, and similarly they do not indicate the destination of their exports. This type of information is crucial for a thorough analysis of a country's position in the global economy. Therefore we use the newly constructed World Input-Output Database that provide time-series of national input-output tables linked through bilateral trade statistics, covering 41 regions in the world. This database provides also a breakdown of value added into income for capital and various labor types. The main characteristics of the World Input-Output Database are discussed in section 3.1.[7] All WIOTs and underlying data sources are publicly available for free at www.wiod.org. This contains data up to 2009. For the purpose of this paper we have extended the data to 2011 using similar methodologies.

Given the complex nature of the Chinese statistical system and idiosyncrasies in its reporting practices, particular attention is needed for the choice and treatment of Chinese statistics. In section 3.2 we discuss in more detail how Chinese input-output tables have been linked into the WIOTs. Section 3.3 describes the construction of data on Chinese factor income and employment at a detailed industry level.

3.1 World Input-Output Tables (WIOTs): concepts and construction

For this paper we use a new database that provides a time-series of world input-output tables (WIOTs) from 1995 onwards, distinguishing between 35 industries and 59 product groups. It is based on national input-output tables of forty major countries in the world, linked through international trade statistics, covering more than 85 per cent of world GDP, plus a model for the remaining non-covered part of the world. It has three distinguishing characteristics compared to

[7] Here we provide a brief discussion of the main characteristics of the WIOTs. For a more elaborate discussion of construction methods, practical implementation and detailed sources, see Timmer (ed.) (2012).

other existing multi-regional input-output tables, such as GTAP, the OECD Input-Output database, and the Asian International Input–Output Tables published by IDE-JETRO.[8] First, the latter provide only a limited number of benchmark year input-output tables whereas WIOD explicitly allows for intertemporal study through the provision of time-series of tables. Second, in contrast to the GTAP and OECD databases, the supply of products is broken down by country and industry of origin. Third, WIOD is the only database in which value added is decomposed into compensation for capital and labor inputs. This is discussed in more detail below. We first outline the basic concepts of the world input-output tables.

Basically, a world input-output table (WIOT) is a combination of national input-output tables in which the use of products is broken down according to origin. In contrast to national input-output tables, this information is made explicit in the WIOT. For each country, flows of products are split into domestically produced or imported. In addition, the WIOT shows for imports in which foreign *industry* the product was produced. This is illustrated by the schematic outline for a WIOT in Figure 1. It illustrates a simple WIOT in the case of three regions: countries A and B, and the rest of the world. The rows in the WIOT indicate the use of output from a particular industry in a country. This can be for intermediate use or final use, either domestically or foreign.[9] A fundamental accounting identity is that total use of output in a row ($\mathbf{y}$ as defined in equation (2)) equals total output of the same industry as indicated by the sum of inputs in the respective column in the left-hand part of the tables. The columns convey information on the technology of production as they indicate the amounts of factor and intermediate inputs needed for production. Intermediate inputs are either sourced from domestic industries or imported and make up the elements $m_{ij}(s,t)$ in equation (1). The residual between total output and total intermediate inputs is value added, which measures the direct contribution of domestic factors to output. Final use is indicated in the right part of the table, and this provides information on the $\mathbf{f}$ vector defined in equation (2).

[Figure 1 about here]

WIOTs have been specifically constructed to allow for both cross-country and intertemporal comparisons by benchmarking them to the concepts and statistics from the National Accounts, and a common industrial classification (International Standard Industrial Classification revision 3). All national tables are harmonized to conform to a common set of concepts removing idiosyncrasies regarding price concept, treatment of financial services, negatives in the intermediate blocks and ad-hoc columns and rows such as statistical discrepancies. Typically, input-output tables are only available for a limited set of years (e.g. every five year) and once

[8] The Asian international input–output table published by IDE-JETRO, has been used for example to study the effects of the US crisis on East Asian production (Kuroiwa and Kuwamori, 2011). GTAP has been used by Koopman et al. (2011) and Johnson and Noguera (2012) to study exports of value added.

[9] In a multi-regional input-output table, final use by a country includes consumption by households, government and non-profit organisations, and gross capital formation, but not exports.

released by the national statistical institute revisions are rare. This compromises the consistency and comparability of these tables over time as statistical systems develop, new methodologies and accounting rules are used, classification schemes change and new data becomes available. For example, Chinese GDP series have been heavily revised when the results of the Economic Census of 2004 became available in 2006, partly due to an underrepresentation of the services industries in previous series (Holz, 2008; Bosworth and Collins, 2008). The published input-output tables, however, have not been revised. This is discussed more in depth in the next section. To remedy this, WIOTs have been constructed on the basis of National Accounts time series and benchmark Input-Output tables.[10] Benchmark tables are linked over time through the use of the most recent National Accounts statistics on final expenditure categories, and gross output and value added by detailed industry. This is done by using a SUT updating method (the SUT-RAS method) as described in Temurshoev and Timmer (2011), which is akin to the well-known bi-proportional (RAS) updating method for input-output tables. This treatment ensures both intercountry and intertemporal consistency of the tables.

A second characteristic of the WIOTs is that the supply of products is broken down by country and industry of origin. This type of information is not available in any input-output table published by national statistical offices. At best, use of a product is split into domestic origin or imports, typically based on the so-called import proportionality assumption, applying a product's economy-wide import share for all use categories. Various studies have been found that this assumption can be rather misleading, in particular at the industry-level as import shares can vary significantly across use category (Feenstra and Jensen, 2012).[11] To allow for this effect, national SUTs in the WIOD were linked through a classification of bilateral import flows by three end-use categories using detailed international trade statistics. Bilateral import flows of all countries covered in WIOD from all partners in the world at the 6-digit product level of the Harmonized System (HS) were taken from the UN COMTRADE database. Based on the detailed product description, goods were allocated to intermediate use, final consumption use, or investment use. This procedure effectively extends the UN Broad Economic Categories (BEC) classification.[12] WIOTs also cover trade in services collected from various international data sources (including OECD, Eurostat, IMF and WTO), checked for consistency and integrated into a bilateral service trade database.

[10] In fact, Supply and Use tables are used if available, rather than input-output tables. Input-output tables are of the industry-by-industry or product-by-product type. Supply and use tables are of a product-by-industry nature and hence provide a better linking with trade data that is typically product-based and employment data that is typically industry-based.

[11] This depends critically on the level of product detail at which this assumption is applied. Empirical analysis shows that applying it at a lower level of aggregation improves the fit to data constructed on the basis of surveys.

[12] Some products, such as complete passenger vehicles, were allocated proportionally to two use categories, in this particular case consumption and investment use.

The WIOTs are expressed in current US$ using official exchange rates from the IMF to convert tables in national currencies. All tables are expressed in basic prices, which is a price concept that excludes net taxes and trade and transportation margins.[13]

3.2 Chinese input-output tables

To estimate the Chinese part of the WIOTs, use has been made of detailed national input-output tables for the benchmark years 1992, 1997, 2002 and 2007, combined with additional supply and use tables. The IO-tables are of the product-by-product type and at producer prices. Tables for 1992 and 1997 use the Chinese Standard Industrial Classification (CSIC) 1994 and tables for 2002 and 2007 use the CSIC 2002. Both classifications have been mapped into the ISIC revision 3 used in WIOD.[14] All tables are publicly available from the Chinese National Bureau of Statistics (NBS 1995, 1999, 2006, 2009). The input-output tables provide more industry detail (about 120 commodities) and are of higher quality than the published supply and use tables. To generate detailed supply tables, the main diagonal elements have been taken from the IO-tables combined with secondary production information from the supply table in estimating the non-diagonal elements (only available for mining, various manufacturing industries, and public utilities). The use table is derived from the IO-tables by mapping each product to the industry that is primary in its production. A standard RAS-procedure was used to obtain row and column consistency.

Two important idiosyncrasies of the Chinese tables had to be dealt with, namely the treatment of industrial processing services, and the recording of statistical discrepancies. First, the treatment of import and export data for export processing production changed between the construction of the 2002 and the 2007 input-output tables. In the latter table, the export and import data exclude those goods that are used in industrial processing services. Instead, only the value added generated in the processing by Chinese firms is recorded as exports. The excluded goods for processing are related only to those goods that are directly provided by foreign firms (e.g. an Italian textile firm provides all the inputs and asks a Chinese firm to return the finished textile good). In an appendix table of the official NBS input-output publication (NBS, 2009), additional information is given on the size of these flows. The share of the excluded goods for processing in total imports is about 9 per cent, with much higher shares at the product level (imports of textiles, for example, increase by 40 percent). To maintain consistency with earlier tables and international practice, we added the excluded goods for processing to exports and to the imported intermediate use block. Second, the published Chinese input-output tables have a column called "Errors" that reflect the statistical discrepancy between use (intermediate inputs + final demand)

[13] Trade and transport margins are allocated as output to the respective trade and transport industries.

[14] Industry concordances with the international industry classification system are available from the authors upon request. The main problems related to the distributive trade industry. Sales data from the China First Economic Census 2004 was used to split trade into wholesale and retail trade.

and supply (= gross output + import) which can be up to five percent of total supply.[15] We distributed the error in each product across final demand proportionally to the shares in final demand.

Final demand category totals as well as industry intermediate use and value added from the IOTs are benchmarked to those from the national accounts to allow for intertemporal consistency. For example, Chinese GDP series have been heavily revised in 2006 when the results of the Economic Census of 2004 became available, partly due to an underrepresentation of the services industries in previous series (Bosworth and Collins, 2008), but published input-output tables have not been revised. The value added series by main sector for China are from the *China Statistical Yearbook* (CSY) published by the NBS, of which the latest issue was 2011 with data up to 2010. The CSY provides longitudinal series for five broad sectors of the economy, namely agriculture, industry, construction, transportation and commerce, and other services. In additional tables, the CSY provides more detailed information for services industries, but the sum of these industries is not consistent with the sector totals. Shares, in combination with additional information, were adjusted such that the more detailed sectoral series are consistent with the totals for services. For detail in manufacturing industries, gross value added shares by industry were obtained from the industrial statistics published in the *China Industrial Economic Statistics Yearbook* by the NBS Department of Industrial and Transportation Statistics. The IO-tables are benchmarked on the constructed consistent time-series as described in section 3.1.[16] The data for 2011 are based on value added by broad sectors and final expenditure categories provided in the OECD national accounts. The value added series used for extrapolation do not provide the full 35 industry level breakdown and higher aggregates are used instead. Also, the 2011 numbers are preliminary estimates from the NBS, and new input-output data have not become available for years more recent than 2007. As a result, the data for 2010 and 2011 is of a somewhat lower quality, and are therefore not part of the official WIOD database.

3.3 Factor incomes and employment by educational attainment in China

The WIOD socio-economic accounts (SEA) for China contain annual data for 35 industries on capital stock and investment, as well as wages and employment by skill type (low-, medium-, and high-skilled). Employment is defined as 'all persons employed', including all paid employees, but also self-employed and informal workers. Employment series by three broad sectors for China are from various issues of the *China Statistical Yearbook* and match those used by Bosworth and Collins (2008). Detailed industrial employment series for 35 industries are based on various issues of the *China Industrial Economic Statistics Yearbook* (CIESY) and the

[15] Personal correspondence with the NBS indicated that if the error gets larger than five percent of total supply, the excess error is moved to changes in inventories and valuables.

[16] There are some conceptual discrepancies between the National accounts series thus derived and the IO-table for 2007 but they are relatively minor (amounting to 2 per cent or less depending on the final demand category considered) and relate to different treatment of import margins and financial intermediation services indirectly measured (see Zhao, 2010).

China Labor Statistical Yearbook (CLSY). The CIESY provides employment data at a detailed level for enterprises at or above the "designated size". In addition, the CLSY provides data for all enterprises including all below the "designated size", but at a lower level of detail. In principle, we follow the industry data construction as in Wu and Yue (2010).[17] Wu and Yue (2010) use all industry level census data (namely China's 1985 and 1995 Industrial Censuses and the 2004 and 2008 Economic Censuses) to estimate consistent employment data above and below "designated size", and those outside the "system", basically the self-employed and informal workers. The latter are allocated only to labor-intensive industries. The detailed industry level estimates are reconciled using the three broad-sector estimates in Wu (2011) and national totals as controls (see de Vries et al., 2012, for further discussion).

Labor income is defined as compensation for all workers engaged in production and should include an imputation for income of self-employed workers. Labor compensation of self-employed is typically not registered in the National Accounts, which as emphasized by Krueger (1999) leads to an understatement of labor's share. This is particularly important for less advanced economies that typically feature a large share of self-employed workers in industries like agriculture, trade, business and personal services. The estimates of labor income in the Chinese input-output tables seem to include an imputation for this and the labor income to value added ratios derived from the IO-tables are our starting point. Data for years in between benchmarks have been obtained by interpolation based on adjusted National Accounts series. National Accounts data published before 2006 follow the labor income definition above, more recent data do not. Two changes in the income GDP accounting method after the economic census of 2004 introduce a break in the labor share time series by industry, as pointed out by Bai and Qian (2010). First, profits of state-owned and collective-owned farms are included in labor compensation, introducing an artificial upward change in the agricultural labor shares. Second, income of self-employed owners is included in gross operating surplus and not anymore in labor income, following the conventions of the System of National Accounts. We use the adjustment factors for both changes at the sector level given in Bai and Qian (2010) to arrive at consistent time series following the definition of labor shares before the 2004 Economic Census which fits our purpose.[18] Capital income is defined as a residual measure by subtracting labor compensation from gross value added. It thus includes all income for the use of capital assets and pure profits.

Employment is split by educational attainment levels using the 2004 Economic Census, which distinguishes between: Junior school and below; High school; Vocational college; Undergraduates; and Graduates and above. Junior school and below is mapped into "low-skilled", High school and vocational college into "medium-skilled" and undergraduates and above into "high-skilled" following Wu and Yue (2010) and the definitions given in UNESCO

[17] See also Banister and Cook (2011) for an analysis of manufacturing employment statistics.
[18] Labor income is thus overestimated as it includes compensation for capital of self-employed outside agriculture, but this is considered to be minor.

(2007). For agriculture, the educational attainment is from the labor force survey as published in NBS (various issues), *China Labor Statistical Yearbook*. Educational attainment data by fifteen industries is extrapolated using trends from the same source for the period from 2002 to 2008. For years before 2002, economy-wide growth rates in primary (for low-skilled), secondary (for medium-skilled), and tertiary (for high-skilled) educational attainment are used from Barro and Lee (2010). Relative wages by educational attainment for 3 broad sectors of the economy are imputed using micro data from the *China Household Income Project* (CHIP) surveys for 1995, 2002, and 2007 and ratios in between are interpolated. Individuals observed in the CHIP surveys were drawn from larger samples of the NBS using a multistage stratified probability sampling method and the only available source for wage data by educational attainment. We used the urban surveys to impute relative wages across skill types for agriculture, industry and services separately, and assumed the corresponding ratios at lower levels of industry aggregation.[19] For the total economy, the wage ratio of high-skilled to low-skilled workers increased from 1.41 in 1995 to 1.71 in 2007.

4. The impact of foreign demand: empirical results

In this section we describe our findings on the importance of foreign demand for growth in the Chinese economy since 1995, using the accounting methodology outlined in the section 2. Depending on data availability we will study the period up to 2011 (for exports of value added) or 2009 (for employment). In section 4.1, we first examine the importance of foreign final demand for income growth in China, broken down by market (mature and emerging markets). We also focus more in-depth on exports of value added at detailed industry level. In section 4.2 we analyze the impact of foreign demand on the generation of employment opportunities, both across sectors and across different types of labor skills. In section 4.3 the link between exports and the factor income distribution is further studied, focusing on the division of value added between labor and capital, both foreign and domestically owned.

4.1 Exports of value added

Seminal work by Chen et al. (2004) has pointed out that the domestic value added content of Chinese exports has been around 60% in the early 2000, and even much lower for particular sub-industries such as electronics manufacturing. These industries were characterized by a strong focus on assembly activities based on imported intermediates with low added value. This has been corroborated in later work by Koopman et al. (2010) and Chen et al. (2012) using similar input-output methodologies, and in alternative studies based on detailed trade statistics measures

[19] The CHIP survey is split into an urban and a rural survey. The definition of wage income varies considerable between urban and rural questionnaires preventing the combination of both surveys. However, while absolute wage levels differ substantially between the urban and rural surveys, relative wages across skills are comparable and it is the latter we use.

such as by Zhang et al. (2012). The most elaborate analysis to date is by Chen et al. (2012), who were the first to analyze time-series developments. They found that the domestic value added content of exports rose quickly between 2002 and 2007. But as exports continued to grow much faster than GDP, it might still have been the case that China's income dependence on foreign demand rapidly increased in this period. We will test this hypothesis below.

Based on equation (6), we decompose the value added generated in China into the amount embodied in final goods absorbed abroad (exports of value added, abbreviated as VA-exports) and embodied in domestic final demand. To this end, we use value added to gross output ratios as production requirements in vector **p** used in equation (6). We have defined our accounting framework in section 2 such that the two value added parts sum up to GDP in China. One can interpret the share of VA-exports in GDP as the part of domestic income that is generated by, and hence dependent on, serving foreign final demand. In Table 1 we track the development of this indicator for China and a set of major emerging and mature countries for the period from 1995 to 2011. We find that the VA-export share in Chinese GDP was rather stable until the early 2000s but quickly rose after its accession to the WTO from 19% in 2001 to a peak of 28% in 2006. But since then it has been on a declining trend, which was clearly exacerbated by the global economic crisis. The share dropped strongly between 2008 and 2009 and did not recover in the two years after. But still, the Chinese level of dependence on foreign demand is much higher than for most other emerging or mature economies of its size.[20] In general, larger economies depend less on external trade than smaller economies, and therefore comparisons with China should be made with large economies only. We find that Brazil, India, Japan and the US have much lower levels of dependence on foreign demand. But the Chinese level is not exceptional. In 2011 its level came close to that of Mexico, which is closely connected with the US through the North-American Free Trade Arrangement. German levels of export dependence are even much higher and are already recovering from the drop in 2009. Its level in 2011 is almost 10 percentage points higher than the Chinese level.

Our estimates of the Chinese exports of value added compare well with previous findings for earlier years. In a cross-country study by Johnson and Noguera (2012) based on a multi-regional input-output table constructed out of GTAP data, comparable ratios for 2004 were found. Based on detailed Chinese IO-tables, Chen et al. (2012) find somewhat lower levels of VA-exports for 2002 and 2007 although they do not calculate these ratios directly. Combining Tables 1 and 2 from Chen et al. (2012) one can infer that the share of VA-exports in GDP increased from 13% in 2002 to 25% in 2007, which shows an even faster increase than our estimates. Although the basic input-output approach is similar to ours and both studies use the 2002 and 2007 national tables, there are various differences in the data used. They used sophisticated national input-

[20] One might hypothesize that the share in China is overestimated because GDP is underestimated due to poor coverage of domestic services activities in the National Accounts. While this was certainly true for the estimates of GDP before the results of the 2004 Economic Census were available, this is no longer obvious for more recent estimates in the National Accounts. As we benchmark our time-series on the latest national accounts series, this mis-measurement of GDP is less severe than before.

output tables with separate models of production for domestic use, processing exports and non-processing exports. Processing exports generally use more imported inputs and have less domestic linkages than domestic final demand. Chen et al. (2012) show that for China the domestic value added content of processing exports is much lower than for non-processing exports, which in turn is much lower than for domestic demand. They conclude that by using the average production structure, exports of value added will likely be overestimated.[21] Due to data constraints, we use a single table in which average production structures are used for both exports and domestic use. Given the lower domestic value added content of exports compared to domestic demand, our estimates can be considered as an upper bound. On the other hand, we embed the national Chinese tables into an international table and account for the domestic value added content of imports as well. By using only a national table, Chen et al. (2012) are forced to assume that the latter is zero and their estimates are downwardly biased for this reason. Nevertheless they find a similar rapid increase in the exports of value added for the period from 2002 to 2007 as in this study.

Based on the WIOT we can investigate the importance of various foreign markets for Chinese GDP through a further decomposition of the exports of value added by region of destination. To this end we split $\mathbf{f}^{FOR}$ in equation (5) into two sets of foreign markets: mature markets (Western Europe, US, Japan, Canada and Australia) and emerging markets (the rest of the world). The results in figure 2 show that the Chinese economy was already on its way to reorient itself away from mature OECD markets to emerging markets elsewhere. In 2001, final demand from emerging markets made up 4% of Chinese GDP, more than doubling to 9% in 2007. In contrast, the share related to final demand in mature markets increased only from 14% to 18% in the same period, and has been growing at a much slower rate. The share of VA-exports to mature markets in overall VA-exports was high and stable around 77% over the period from 1995 to 2001 but dropped quickly to 64% just before the onset of the global crisis and continued to decline afterwards to 61% in 2011. This reorientation of exports away from mature markets is a common trend in the world economy, but is particularly strong for China. Based on similar calculations for the other 39 countries in the WIOD database, we find a drop in the share of mature markets from 68% to 62% of VA-exports in 2007 (weighting by country's VA-exports and excluding VA-exports to China). Only 6 out of the 39 countries had experienced a faster drop in this share than China, including Turkey and Indonesia. While mature markets still account for almost two thirds of the exported value added in China, further reorientation towards growth in emerging markets will be needed in face of the expected prolonged depression in demand from mature markets.

[Table 1, Figure 2 about here]

[21] Koopman et al. (2012) have also indicated the importance of modeling export production separately for analyzing the value added content of exports in countries where production in processing zones is pervasive.

With the decline in the importance of foreign demand for inducing income in China, other demand sources must take up the slack. For quite some time there are calls for a shift in the country's economic model from export-led growth toward greater reliance on domestic demand, particularly household consumption (see e.g. China's 12th Five-Year Plan). An important role is foreseen for the services sectors as they are still underdeveloped, but hold a large potential for employment generation and improving the overall structure of the economy. To investigate the importance of services demand in the past we decompose GDP into three demand sources rather than two as done so far: foreign demand, domestic demand for tradable goods (agricultural and manufacturing products) and domestic demand for non-tradable goods and services (other products). This is done by splitting the domestic final demand vector **f** in equation (6) by product group, based on information in the WIOTs. Final demand includes both household and government consumption, and investment demand. We find that domestic demand for non-tradables has gradually become more important for Chinese GDP, accounting for 42% in 1995 to 55% in 2011. In the period of the export boom, this ratio has been constant, but the global economic crisis has naturally led to an upward tick, which was retained in the latest years. As average GDP per capita increases, it is expected that this ratio will increase as demand will continue to shift gradually towards non-tradables.

[Figure 3 about here]

Chinese VA-exports are not originating exclusively in the manufacturing sector, although the majority of the exports do. To this end we decompose exports of value added as calculated above by sector of origin by partitioning the vector of production requirements **p** by detailed industry. Given the preliminary nature of our data at a detailed industry level for the more recent period, we will discuss the results up to 2007, the year of the last input-output table. This also coincides with the peak in the export dependence of China. We first decompose by three broad sectors: agriculture, manufacturing and services (including here all sectors in the economy except agriculture and manufacturing). We find that only about 50% of the exported value added is earned in manufacturing and that this share has been roughly constant over the period from 1995 to 2007. Importantly, the share of services is rather high and increasing to over 40%. The share of agriculture declined to around 10% in 2007 (see Table 2). The sectoral shares in VA-exports contrast sharply with the shares in gross exports. Export of manufacturing goods made up 84% of gross exports, while services accounted only for 15% in 2007.[22] This difference between sectoral exports of value added and gross sectoral exports has also been found by Johnson and Noguera (2012). For a large set of countries, they found that in 2004 exports of value added

[22] These numbers are derived from the WIOTs, but not separately shown here.

originating in agriculture and services were occasionally much bigger than gross exports from the same sectors. This is a reflection of the growing network-like nature of most production processes in today's world, fragmenting not only across countries, but also across industries within and across regions. Domestic services and agricultural activities are important contributors to the production of manufacturing goods, providing intermediate inputs, such as business, transport and energy services, and raw materials such as cotton and food stuffs. The value added in services and agriculture ultimately ends up in the gross export value of the manufacturing good. Depending on the strength of the domestic inter-industry linkages these contributions can be significant. While they will be low for exports originating from processing zones, they can be high for exports produced outside these zones. Our analysis suggests that on average, domestic linkages in China are quite strong and consequently the services and agricultural industries contribute significantly to the exports of value added. This characteristic of the Chinese economy would be unobserved when only analyzing gross exports figures.

Using an even finer partition of the requirements vector by detailed industry we can calculate the share of value added in each industry that is induced by foreign final demand. In Table 2 we report exports of value added originating from an industry as a percentage of the total value added in that industry. By definition, this share is in between zero and one, being zero when all value added is ultimately absorbed by domestic final demand, and one when it is ultimately absorbed by foreign final demand. For example, an industry that produces final products exclusively for exports,[23] as in Export processing zones (EPZs), will have a value of 1. Industries such as electrical machinery in which EPZ production is predominant are expected to have a high ratio. As explained above, VA-exports can also be high when an industry delivers intermediate inputs that are used for production for foreign demand in later stages, either in the domestic economy or abroad. This is a prominent characteristic of upstream industries producing materials such as fuel, paper and wood.

The results in Table 2 show that the dependence on exports is increasing for all manufacturing industries. Although a closer look at the results for other years (not documented here) shows that there are some differences in the timing, VA export shares in most industries start to trend upwards after 2000. Industries that rely mostly on domestic demand depended for less than one-third of their value added on foreign demand in 2007. This includes food manufacturing that almost exclusively serves domestic household consumption, non-metallic minerals manufacturing that mainly serves intermediate demand by the booming construction sector, and transport equipment serving both consumption and investment demand. Also value added in

[23] Or intermediates that are not re-imported in embodied form.

machinery production is predominantly dependent on high domestic investment demand. On the other hand, textiles, electrical machinery and in particular miscellaneous manufacturing (including furniture, jewelry, musical instruments, sports goods and toy production) depend for two-thirds or more on foreign demand. These shares have been rising quickly since 1995 from levels of around 50%, but seem to have reached their maximum around 2005 and flattened since. Overall, 42% of manufacturing value added is directly or indirectly related to foreign demand. But also agriculture and services depend for almost one fifth of their value added on foreign demand, mainly by providing intermediates to domestic manufacturing plants producing for exports.

[Table 2 about here]

4.2 Jobs induced by foreign demand

One of the main reasons for stimulating exporting activities by Chinese policy makers was the promise of abundant job creation, providing a way to absorb the massive rural labor surplus. An early attempt by Feenstra and Hong (2010) to test the effectiveness of this policy suggested that export demand might be responsible for generating about 70 million jobs in 2000, and was indeed driving overall labor demand during 2000-2005. But their attempt to project export-induced employment for later years indicated the crucial importance of having access to hard employment data to account for the shifting industry structure of exports. In particular, diverging trends in productivity growth across and within industries appeared to be hard to predict and led to wildly different projections.[24] In this study we will use actual employment statistics rather than predictions that allows for much more precise estimates. We do so by using employment to gross output ratios in the production requirement vector **p** in equation (6). Employment is measured as the number of workers at a detailed industry level (for 34 sectors of the economy), including imputations for informal workers as discussed in section 3.

Concomitant with policy-makers' expectations, we find that production for exports has indeed been an important driver of job growth. The number of workers directly and indirectly related to serving foreign demand increased from 111 million in 1995 to almost 180 million in 2007, equivalent to a rise from 16% of the total labor force in 1995 to 23% in 2007. As a share of wage and salary earners, this number will be even higher as most export-related activity takes place in an employee-based factory system. As found for VA-exports, the increase in job-exports only

[24] In particular, Feenstra and Hong (2010) overestimated the increases in labor productivity, which they approximated implicitly on wage trends.

took off after 2001. Most of the jobs were generated in manufacturing, increasing employment by 31 million over this period, while 21 million in services and 16 million in agriculture (see Figure 4). Due to the low levels of labor productivity in agriculture and services relative to manufacturing, their shares in all jobs related to foreign demand (around one-third for both) is much higher than their shares in value added, in particular for agriculture. This can be seen by comparing Tables 2 and 3.

Within manufacturing the number of workers induced by foreign demand increased the most in electrical machinery, followed closely by the textile industry (see Table 3). This contrasts sharply with the shares of these industries in overall value added exports as given in Table 2. Due to its much lower labor intensity, the labor absorption capacity of electrical machinery manufacturing is much lower than for textiles. In addition, through strong backward linkages into domestic agriculture, textile exports have particularly high domestic value added content, while electronics have not, something also found by Chen et al. (2012).

[Figure 4 about here]

[Table 3 about here]

The technique introduced in this paper also allows one to address another rebalancing issue that is frequently being discussed, namely the shift of domestic demand away from goods towards services. While a natural development in economies as per capita incomes rise, this demand shift could be further stimulated by removing some of the numerous restrictions, such as for example bans and limitations on private and foreign investment, that currently limit competition in various services sectors. Due to the higher productivity growth in goods production than in services production, this shift in domestic demand is thought to generate additional jobs, see Feenstra and Hong (2010). To test this hypothesis we decompose changing demand for Chinese labor into three sources as before: foreign demand, domestic demand for tradables (agricultural and manufacturing products) and domestic demand for non-tradables (other products). This is done by splitting the final demand vector **f** in equation (6) by product group, based on information in the WIOTs.

In Table 4 we present the contribution of each demand source to the annual change in total number of jobs in the economy over the period 1995 to 2009. It is shown that in the period up to

2001, foreign demand did not generate many extra jobs and employment induced by domestic demand for tradables even dropped. In particular in industry, labor input is growing relatively slowly compared to other inputs, in particular capital. Employment is even decreasing in the late 1990s in some industries such as textiles, chemicals, metals and machinery as a strong process of restructuring took place in particular in the so-called state-owned enterprises, boosting labor productivity growth (Cao et al., 2009). After 2001, employment induced by foreign demand took off. Labor productivity still increased rapidly in the export sector, but booming foreign demand outpaced this by a large margin, adding about 12 million jobs annually over the period from 2001-2007. In contrast, employment generated by domestic demand fell on average by 6 million per year. This loss was exclusively concentrated in the demand for tradables as domestic demand grew only slowly, and productivity growth in domestic industry was high. In contrast, labor productivity growth in services industries was slow, as also found by Cao et al. (2009) and Collins and Bosworth (2009). Consequently, demand for non-tradables became the main driver of employment growth in China. Since 2006 employment induced by non-tradable demand has increased much faster, adding on average 16 million jobs per year during 2006-2009.

[Table 4 about here]

Another motive for stimulating export activity was the need for a rebalancing in the structure of labor demand for particular skills. In recent years, the placement of the growing supply of university students into good jobs has aroused much concern (World Bank, 2012). Partly to reduce unemployment after the 1997 Asian financial crisis, China hugely increased the number of students in higher education. However, we find that production for foreign demand did not play an important role in absorbing this increase. While abundant, jobs related to foreign demand are not particular demanding in terms of skills. We split the labor requirements into the demand for low-, medium- and high-skilled workers, subdividing workers needed per unit of gross output based on educational attainment levels of the labor force as described in section 3. These ratios are used as the production requirement vectors in our decomposition equation (6). We find that the skill content of exported jobs is not improving quickly. Actually, since 2001, the number of low-skilled workers involved in serving foreign demand increased more rapidly than medium- or high-skilled workers, even when we exclude workers in agriculture (see Figure 5). In 2007, out of the 117 million non-agricultural workers involved, 56 million were low-skilled, 53 million medium-skilled and only 9 million high-skilled. This finding is surprising and suggests that exporting was not a major force in providing more employment opportunities for the expanding skilled labor force in the Chinese economy.

[Figure 5 about here]

4.3 Capital income induced by foreign demand

While foreign demand has been important for job generation, it might have been even more beneficial for capital. As industrial wage increases were limited due to abundant labor supply, the major part of increased value added might have accrued as income for capital rather than labor. Moreover, given the abundant presence of foreign joint-ventures and affiliates, exporting activities from Chinese territory might generate mainly above normal returns for foreign-owned capital. To test these hypotheses we decompose value added into compensation for labor and capital by setting the vector p in equation (6) as the shares of labor and capital income in value added for each industry. As discussed in section 3, we measure labor income as the costs of labor for the employer, including wages and additional benefits for employees, plus the incomes of self-employed workers. Capital income was defined as the residual after subtracting labor income from value added and includes compensation for all capital assets including depreciation, asset revaluation and pure profits. By defining the income for capital as the residual, exports of labor and capital services will add up to VA-exports studied in section 4.1.

The decomposition of income into labor and capital is shown in Figure 6. We find that a major part of the increased income due to serving foreign demand is paid out as compensation for capital services, rather than for labor services. Exports of labor services made up about 9% of Chinese GDP in 1995 and this has barely increased in the period up to 2007. Capital services exports however shot up from 10% in 1995 to 17% of GDP in 2007.[25] As wages are held down by an abundant supply of labor, capital income benefitted most from serving foreign demand.

[Figure 6 about here]

[25] Note that this compensation of capital related to foreign demand is conceptually not related to financial transactions on the capital account. Only in the case capital is owned by foreigners and profits are repatriated, this might be the case, as discussed below.

So far, the analysis is based on the location of production factors as we decompose gross domestic product in China. In case of significant foreign ownership of firms, it is also interesting to decompose gross national product, which corrects for incomes generated on the domestic territory but by foreign-owned production factors.[26] Given the relative low level of cross-border labor migration, domestic wage income will be mainly national. But the wedge between domestic and national capital income will be higher due to significant presence of foreign-owned capital in China. A rough estimate of the size of this effect can be made using ownership data collected in the industrial firm-level survey from the China National Bureau of Statistics, see also Duan et al. (2012). This annual survey includes all industrial firms with sales above 5 million RMB to distinguish between domestic, foreign, and HMT (Hong Kong, Macau, Taiwan) ownership (Brandt et al., 2012). According to these survey results foreign firms made up 22% of manufacturing value added, HMT firms 11% and mainland Chinese firms the remaining 67%. Foreign shares vary from less than 20% in textiles, non-electrical machinery and metals to over 40% in electrical machinery and transport equipment.[27] We can make a rough estimate of the foreign share in capital income by assuming that the capital-value added ratio does not differ across ownership. To the extent that capital intensities are higher in foreign than in domestic firms, this assumption would lead to a downward bias in our foreign capital income share. Sheng and Yang (2011) find evidence of factor differences across ownership of export-processing firms in China related to skill use, but did not study capital use. Ma, Ta and Zhang (2011) find a decrease in capital-intensity of both domestic and foreign-owned firms after entering export activities. Weighting the exports of capital services by the foreign ownership shares at the industry level to take into account the industry composition of VA-exports, it is found that in 2007 22% of the capital income in manufacturing induced by foreign demand would accrue to foreign firms.[28] Further assuming that there is no foreign ownership in the rest of the economy, compensation for foreign-owned capital would make up 12% of capital-exports, and only 8% of total VA-exports. Although a conservative estimate, it clearly suggests that a major part of increasing income related to exports are captured by Chinese-owned production factors.

5. Concluding remarks

In this paper we analyzed the role of foreign demand in driving income and employment growth in China since 1995 based on an ex-post global input-output analysis. We extended the methodology introduced by Johnson and Noguera (2012) and applied this to a new dataset of world input-output tables combined with new industry-level data on factor incomes and employment by skill type for China. We corroborate findings of Chen et al. (2004, 2012),

[26] It also includes income generated abroad by Chinese owned production factors, but that is outside the scope of this paper.
[27] We thank Hong Ma for providing us with these shares.
[28] Foreign profits are not necessarily repatriated but might be re-invested on the Chinese domestic territory.

Johnson and Noguera (2012) and Koopman et al. (2012) that gross-exports to GDP ratios for China overestimate the impact of foreign trade at a given point in time, and value-added based measures should be used instead. Our time-series analysis of value-added exports indicates that China has become increasingly dependent on export for generating income and employment. It suggests that the period between the accession of China to the WTO in 2001 and the onset of the global economic crisis in 2008 is characterized by a particular dynamic process of outward orientation. Exports of value added increased from 18 % of GDP in 2001 to a peak of 28% in 2006, dropping to a low of 21% in 2009 and constant afterwards. It is easily concluded that onset of the 2008 financial crisis was a watershed in this development, forcing the transition from outward-oriented to domestic-demand-oriented growth. But in fact some signs of rebalancing in the Chinese economy were visible before 2009, and the crisis strongly reinforced these tendencies. Since 2001, almost all employment growth was due to increasing foreign demand and in contrast domestic demand has generated few additional jobs, due to a combination of sluggish demand and rapid labor productivity growth in the production sectors. But in 2006, employment growth induced by domestic demand was higher than that induced by foreign demand for the first time since 2001. In particular domestic demand for non-tradable goods increased, generating large employment opportunities. We also found that China already started to reorient its export demand before the onset of the crisis, increasingly serving emerging markets, rather than advanced markets. This trend will continue given expected sluggish demand in mature economies. We also found that foreign demand contributed to factor income inequality as it mainly accrued as income for capital rather than for labor. While labor income through serving foreign demand stagnated at 10% of GDP, capital income increased to 17% of GDP in 2007. Contrary to conventional wisdom, we found that most of this capital income accrued to Chinese and not foreign-owned firms.

More in detail we found that some industries depended much more heavily on foreign demand than others. Textiles, electrical machinery and miscellaneous manufacturing (including furniture, sports goods and toy production) depend for two-thirds or more of their income on foreign demand, but food, transport equipment and machinery manufacturing less than 40%. Growth in exports played an important role in absorbing the abundant rural labor supply adding almost 70 million jobs between 2001 and 2006. Due to strong inter-industry linkages more than halve of these jobs were created outside the manufacturing sector. This reinforces the importance of considering domestic linkages when analyzing the impact policies in the tradition of Hirschman (1958). Services and agriculture are important sources of intermediate deliveries and crucial in sustaining Chinese comparative advantages. For example, textiles manufacturing has strong backward linkages into cotton production while electrical machinery manufacturing has only few domestic linkages. Strong inter-industry linkages limit the room for targeted sector-specific policies and provide arguments for general support measures rather than an industry- or export-targeted approach. We also found that foreign demand induced mainly jobs for low- and medium-skilled workers, and did little to generate new employment opportunities for high-skilled workers. The current set of activities carried out in China in global value chains is still heavily dominated by routine activities that require little skills. Without upgrading to more skill-intensive activities it will be hard to find sufficient employment opportunities for the growing group of college-educated workers.

We would like to stress that our findings are mainly illustrative of the main trends due to the considerable uncertainty about the validity and consistency of the various statistical sources used and the assumptions underlying the demand-oriented input-output analysis. We mention two caveats in particular, one on the empirical data and one on the methodology used. Due to our focus on developments over time, we are not able to separately model the export processing sector in China. Chen et al. (2012) and Koopman et al. (2012) have shown that processing exports generally use more imported inputs and have less domestic linkages than domestic final demand. Our estimates of foreign demand induced value added should therefore be considered as upper limits, although it is not a priori clear how this would affect developments over time. This will depend not only on trends in the domestic value added content of exports, but also on the share of various types of exports in total production. The importance of processing exports seems to have declined in recent years. Also, consistent data on Chinese output, employment and wage incomes by industry are notoriously hard to construct. Although we have drawn on the most sophisticated estimates to date, there remains considerable doubt on the numbers as estimates from various sources are hard to reconcile. Recent work based on micro-databases should allow us to improve this situation. In particular it allows to get a better insight into the heterogeneity of firms in terms of value added and factor use, linked to their exporting status (see e.g. Sheng and Yang, 2011; Ma, Ta and Zhang, 2011; Kee and Tang, 2012). If for example exporting firms in the same industry have lower value-added to gross output ratios than non-exporters than our exports of value added are overestimated. Similarly, if exporters are more labor intensive (measured as the wage ratio in value added) than non-exporters our labor share is underestimated.

In interpreting the results the limitations of our approach should be considered as well. First, input-output analysis focuses on the average effects of increasing demand, rather than the marginal effects which are more relevant. Particularly in situations of underutilization of capital, marginal effects will be much lower than average effects. Future analyses that focus on similar questions for the recent crisis period should accommodate this. In addition, our analysis only considered linkages in a one-year period. We did not take into account that the domestic demand for investment is also partly induced by foreign demand as domestic capital capacity is built to serve foreign demand. From this perspective, we might underestimate the impact of foreign demand if capital-output ratios are increasing. Endogenizing investment demand can be done through dynamic input-output modeling, a topic left for future research. Finally, our demand–side analysis does not explicitly account for the technology and knowledge spillovers that might accompany when producing for export markets. While there is evidence that the most productive firms mainly self-select into exporting, learning externalities within global production networks can be extensive and might propel firms into higher value-added activities. Without these, opportunities for future growth in the Chinese economy will be limited.

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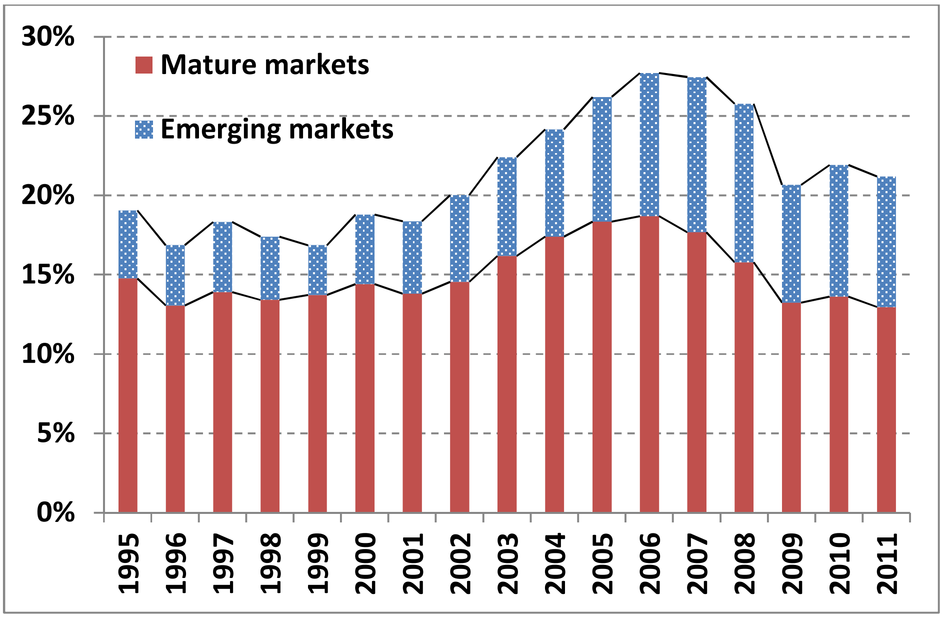
Figure 1 Schematic outline of World Input-Output Table (WIOT), three regions

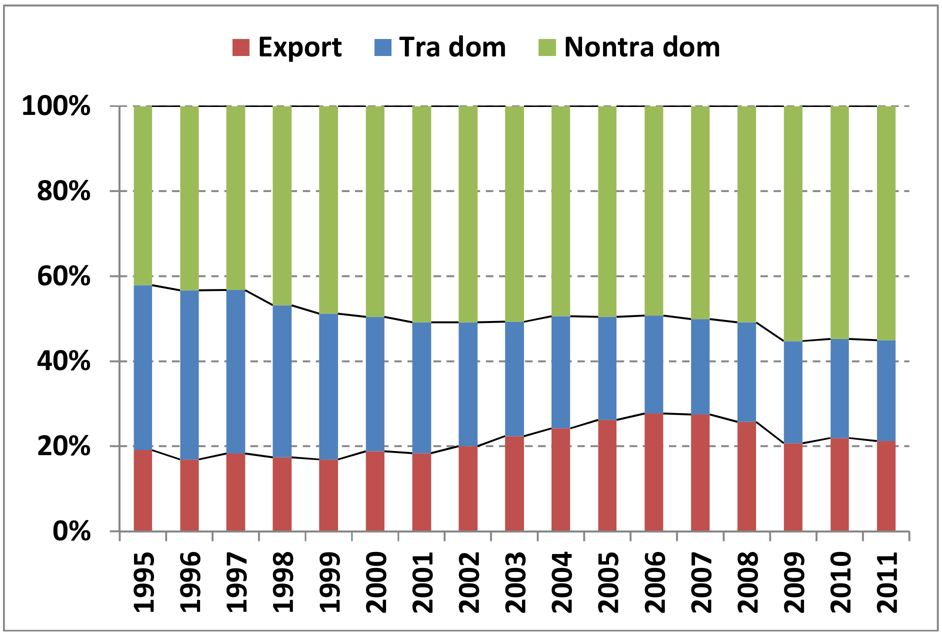
		Country A Intermediate *Industry*	Country B Intermediate *Industry*	Rest of World Intermediate *Industry*	Country A Final domestic	Country B Final domestic	Rest of Final domestic	Total
Country A	*Industry*	Intermediate use of domestic output	Intermediate use by B of exports from A	Intermediate use by RoW of exports from A	Final use of domestic output	Final use by B of exports from A	Final use by RoW of exports from A	Output in A
Country B	*Industry*	Intermediate use by A of exports from B	Intermediate use of domestic output	Intermediate use by RoW of exports from B	Final use by A of exports from B	Final use of domestic output	Final use by RoW of exports from B	Output in B
Rest of World (RoW)	*Industry*	Intermediate use by A of exports from RoW	Intermediate use by B of exports from RoW	Intermediate use of domestic output	Final use by A of exports from RoW	Final use by B of exports from RoW	Final use of domestic output	Output in RoW
		Value added	Value added	Value added				
		Output in A	Output in B	Output in RoW				

Figure 2 Exports of value added by market destination (as % of GDP)



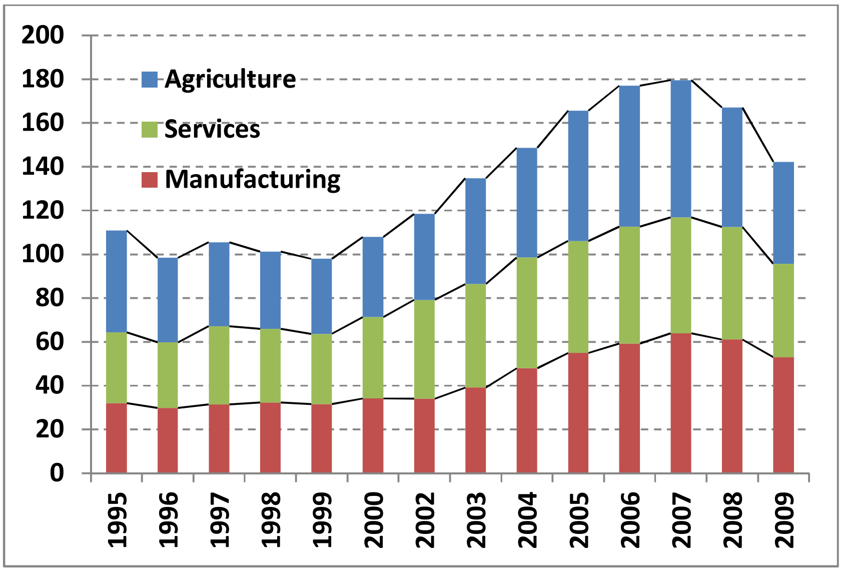
Note: decomposition of exports of value added from China based on equation (6), using value added to gross output ratios and splitting $\mathbf{f}^{FOR}$ into final demand from mature markets (Europe, US, Japan, Canada and Australia) and emerging markets (the rest of the world). Source: World Input-Output Database, April 2012 and authors' projections.

Figure 3 Final demand sources of Chinese GDP



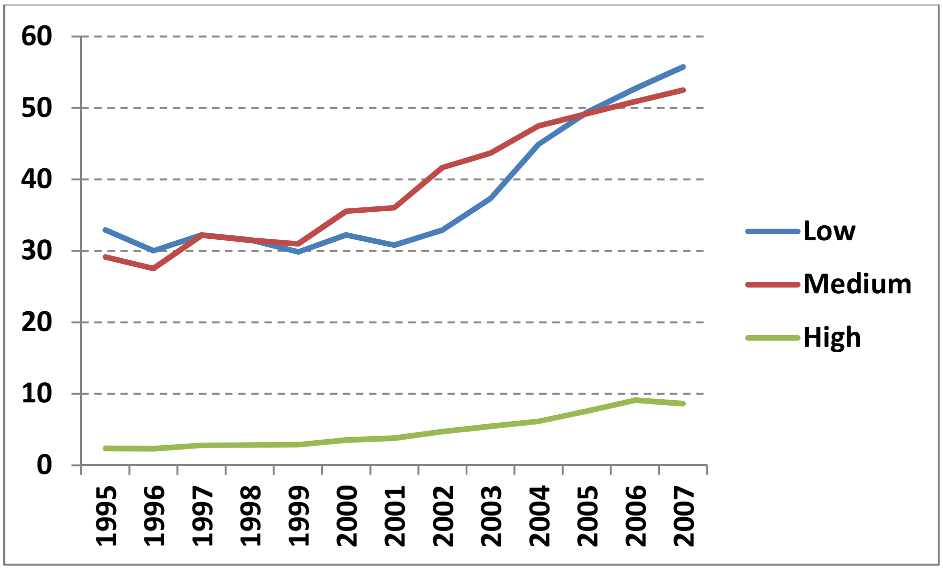
Note: Decomposition of GDP into value added induced by source of final demand in equation (6) using value added to gross output ratios and splitting $\mathbf{f}^{FOR}$ into foreign final demand (*Export)*, domestic final demand for tradables (agricultural and manufacturing products, *Tra dom*) and non-tradables (all other products, *Nontra dom*). Source: World Input-Output Database, April 2012 and authors' projections.

Figure 4 Number of workers induced by foreign final demand, by sector of employment (millions).



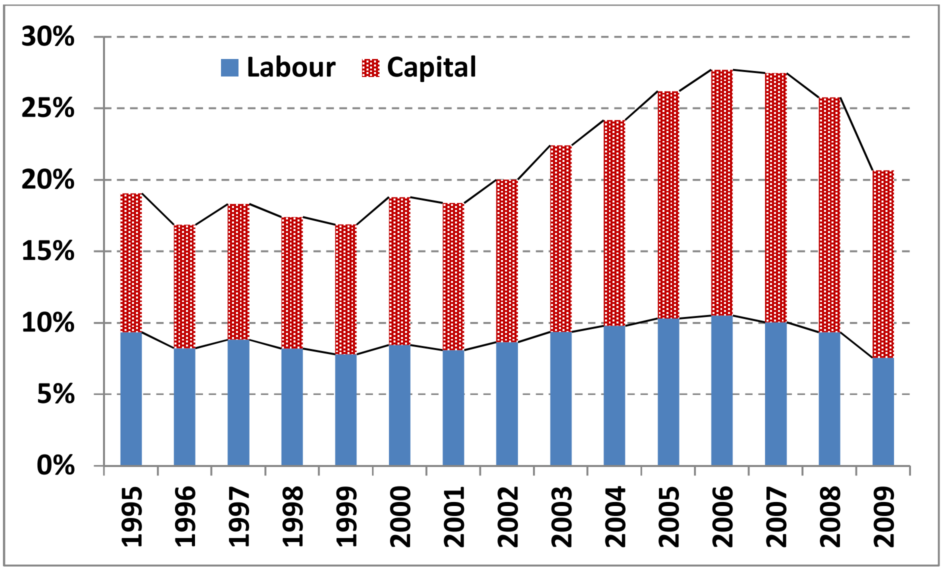
Note: decomposition of workers induced by foreign final demand by sector of employment based on equation (6), using employment to gross output ratios. Source: World Input-Output Database, April 2012.

Figure 5 Number of non-agricultural workers induced by foreign final demand, by level of educational attainment (millions)



Note: decomposition of non-agricultural workers induced by foreign final demand by level of educational attainment based on equation (6), using employment by skill-type to gross output ratios. Source: World Input-Output Database, April 2012.

Figure 6 Export of factor incomes as share of GDP (%)



Note: decomposition of exports of value added from China based on equation (6), into income for labour and capital using income by production factor to gross output ratios. Source: World Input-Output Database, April 2012.

Tab le 1 Exports of value added as percentage of Gross domestic product

	China	Brazil	India	Mexico	Japan	Germany	US
1995	19.1	6.8	10.0	18.1	8.4	18.8	8.5
1996	16.9	6.1	9.9	19.3	8.9	19.5	8.5
1997	18.3	6.3	9.8	17.9	9.9	21.2	8.8
1998	17.4	6.3	10.0	17.8	9.9	21.9	8.0
1999	16.9	8.4	10.2	17.9	9.3	22.1	7.6
2000	18.8	8.9	11.8	18.1	9.8	24.7	7.7
2001	18.4	10.7	11.4	16.2	9.5	25.8	7.1
2002	20.0	12.4	12.5	15.7	10.2	26.8	6.8
2003	22.4	13.3	12.2	16.3	10.7	26.5	6.8
2004	24.2	14.5	14.1	16.7	11.7	27.7	7.1
2005	26.2	13.5	14.8	17.6	12.4	29.1	7.3
2006	27.7	12.9	16.3	18.0	13.6	31.0	7.8
2007	27.5	12.0	15.8	18.3	14.7	32.3	8.5
2008	25.8	12.2	15.2	17.8	14.3	32.3	8.8
2009	20.7	10.1	12.6	17.2	11.0	28.4	8.1
2010	21.9	10.2	14.1	18.7	12.9	30.2	8.9
2011	21.2	11.0	13.5	20.1	12.3	31.0	9.5

Note: calculation of $\mathbf{f}^{FOR}$ based on equation (6). Source: World Input-Output Database, April 2012.

Table 2 Exports of value added by industry

ISIC rev. 3 code	*Industry name*	Exports of value added (mil US$) 1995	2007	Exports of value added as share of value added (%) 1995	2007
15t16	Food and Beverages	4,571	24,958	14.0	17.9
17t18	Textiles	15,377	64,123	54.8	65.3
19	Leather and Footwear	2,834	11,084	50.3	56.2
20	Wood Products	1,710	9,718	29.9	33.2
21t22	Paper and Printing	2,402	13,870	22.7	33.0
23	Fuel	1,750	12,331	22.6	36.7
24	Chemicals	6,134	51,710	25.6	42.4
25	Rubber and Plastics	3,891	24,545	36.9	51.2
26	Other Non-Metallic Mineral	3,706	14,108	13.5	17.4
27t28	Basic and Fabricated Metal	10,156	79,444	28.2	41.6
29	Machinery, Nec	4,366	41,099	18.0	35.7
30t33	Electrical Equipment	11,233	113,249	47.7	66.1
34t35	Transport Equipment	1,909	22,790	14.5	28.3
36t37	Manufacturing, Nec	1,849	18,280	46.3	78.1
D	All manufacturing	71,888	501,309	28.4	42.0
AtB	Agriculture	19,065	75,082	13.1	19.9
C, EtQ	Other sectors	47,737	383,346	14.5	19.9
	Total economy	138,690	959,737	19.1	27.5

Note: Nec = not elsewhere classified. In million current US$, using exchange rates for currency conversion. Exports of value added are calculated from $\mathbf{f}^{FOR}$ based on equation (6) using value added to gross output ratios at the industry level.
Source: Calculations based on World Input-Output Database, April 2012.

Table 3 Number of workers induced foreign final demand (thousands)

ISIC rev. 3 code	*Industry name*	1995	2007	change 1995-2007
15t16	Food and Beverages	1,485	2,628	1,143
17t18	Textiles	8,579	14,290	5,711
19	Leather and Footwear	1,274	3,675	2,401
20	Wood Products	1,001	3,217	2,216
21t22	Paper and Printing	1,025	3,659	2,634
23	Fuel	211	342	131
24	Chemicals	1,919	3,300	1,381
25	Rubber and Plastics	1,769	6,003	4,235
26	Other Non-Metallic Mineral	1,811	1,565	-246
27t28	Basic and Fabricated Metal	2,910	3,933	1,023
29	Machinery, Nec	1,806	3,964	2,158
30t33	Electrical Equipment	3,328	9,445	6,117
34t35	Transport Equipment	662	1,616	954
36t37	Manufacturing, Nec	4,294	6,230	1,937
D	All manufacturing	32,073	63,867	31,794
AtB	Agriculture	46,611	62,720	16,109
C, EtQ	Other sectors	32,312	53,014	20,702
	Total economy	110,996	179,600	68,604

Source: Calculation of $\mathbf{f}^{FOR}$ for China based on equation (6) and using employment to gross output ratios at the industry level. Based on World Input-Output Database, April 2012.

Table 4 Annual change in number of workers induced by changes in final demand (millions)

	Domestic final demand for		Foreign final demand	All demand
	tradables	non-tradables		
1995-96	5.7	15.8	-12.7	8.9
1996-97	0.9	0.6	7.2	8.7
1997-98	-8.1	20.6	-4.3	8.2
1998-99	-1.3	12.2	-3.3	7.6
1999-00	-9.4	6.4	10.0	6.9
2000-01	-2.3	13.2	-1.5	9.4
2001-02	-12.2	7.3	12.1	7.2
2002-03	-12.3	2.9	16.3	6.9
2003-04	-6.3	0.1	13.9	7.7
2004-05	-20.0	9.3	16.9	6.2
2005-06	-14.8	9.1	11.4	5.8
2006-07	-3.7	7.1	2.6	5.9
2007-08	5.5	12.0	-12.6	4.9
2008-09	1.8	28.1	-24.8	5.2

Note: Annual change in number of workers induced by changes in foreign final demand, and in domestic final demand for tradables (agricultural and manufacturing products) and non-tradables (all other products). Calculation based on decomposition by source of final demand in equation (6) using employment to gross output ratios. Source: World Input-Output Database, April 2012.