International Review of Applied Economics

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/cira20

Structural change and industrial linkages: a perspective on China's growth pattern, 1995-2009

Roberto Alexandre Zanchetta Borghi

To cite this article: Roberto Alexandre Zanchetta Borghi (2023) Structural change and industrial linkages: a perspective on China's growth pattern, 1995-2009, International Review of Applied Economics, 37:2, 253-274, DOI: 10.1080/02692171.2023.2184464

To link to this article: https://doi.org/10.1080/02692171.2023.2184464

Published online: 04 May 2023.

INTERNATIONAL REVIEW OF APPLIED ECONOMICS
2023, VOL. 37, NO. 2, 253–274
https://doi.org/10.1080/02692171.2023.2184464

Routledge
Taylor & Francis Group

Structural change and industrial linkages: a perspective on China's growth pattern, 1995-2009

Roberto Alexandre Zanchetta Borghi

Institute of Economics, University of Campinas (UNICAMP), Campinas, Brazil

ABSTRACT

China has presented one of the most noticeable growth experiences in economic history. High growth rates in the post-1978 reform period have been marked by deep structural changes in the Chinese economy. This paper aims to discuss China's long-term economic growth from a Kaldorian-Structuralist framework that emphasises the importance of a large, diversified and integrated industrial base as a central engine of economic growth that may prevent balance-of-payments constraints. This study applies input-output indicators to reveal key sectoral transformations of the Chinese productive structure and changes in interindustry linkages during the 1990s and 2000s. Results provide evidence that: (i) the Chinese sustained growth pattern has relied on a diversified and increasingly integrated domestic industrial production; and (ii) most sectors have been able to generate through exports enough foreign exchange to pay for import needs.

ARTICLE HISTORY
Received 2 February 2022
Accepted 4 February 2023

KEYWORDS
China; economic growth; industrial sectors; interindustry linkages; input-output analysis

JEL CLASSIFICATION
F43; O14; O53

1. Introduction

The fact that economic growth in China was around 10% a year from the 1980s to the early 2010s – with major implications for the world economic order – represents an exceptional experience of sustained economic growth. Many questions regarding the continuity of this high growth trajectory have been raised, especially since the new policy directives in China. It is therefore important and timely to examine some of the achievements and transformations underlying the Chinese success story thus far.

China's growth miracle has been subject to several different analyses and controversies. On the one hand, the conventional view tends to attach China's growth to an export-led orientation after economic openness in the late 1970s. Opening up reforms are considered as a leading factor in China's sustained growth pattern, and great importance is attached to foreign trade and foreign capital as determinants of growth (World Bank 1996; Lardy 2002; Branstetter and Lardy 2008; Brandt and Rawski 2008; Yunling 2010).

On the other hand, there is also considerable evidence showing that the Chinese sustained growth pattern could be understood as a much more complex case of mixed domestic and foreign efforts. Large-scale investments, industrial development, state intervention and gradual economic reforms figure among the key issues to understand China's rapid growth

CONTACT Roberto Alexandre Zanchetta Borghi razb@unicamp.br

in a context of globalisation and rising mobility of capital and trade flows (Flassbeck 2005; Lo and Zhang 2011; Fang, Yang, and Meiyan 2009; Bibow 2010; Lin 2012; Felipe et al. 2013).

Lo and Zhang (2011) argue that China's sustained economic growth has been based mainly on China's internal dynamics, either improving allocative and productive efficiency or engaging into dynamic increasing returns associated with capital deepening. Authors use a broad theoretical perspective relying on Marxian theory of capital accumulation, post-Keynesian theory of demand determination, and Schumpeterian theory of innovation to address the overall process of China's economic transformation, although little empirical evidence is provided. Flassbeck (2005) and Bibow (2010), in turn, focus their analysis on the management of macroeconomic policies. In this regard, public banks to finance capital expansion, monetary and fiscal policies to sustain growth, and management of exchange rate policy, have been central to an economic transformation prioritising the role of manufacturing industries for development.

Felipe et al. (2013) point that China's economic success relies on its ability to master and accumulate more complex capabilities over time, which is reflected in the increasing diversification and sophistication of its export basket. Authors emphasise three stylised facts underlying the Chinese growth rates, namely, high investment rates, outward orientation through export-led growth policies, and the pursuit of industrialisation, in particular the production and export of manufactures. In this regard, Kaldor's law of manufacturing as engine of growth is reinforced, in addition to a long and difficult, but policy-induced, cumulative process of technological learning by Chinese firms. Zhu and Kotz (2011) discuss the Chinese growth pattern from a combination of investment and exports over time, while Jeon (2009) shows the validity of Thirlwall's law in China during the period between 1979 and 2002.

The paper aims to contribute to this debate in the development economics literature by combining a theoretical perspective based on Kaldorian and Structuralist contributions to understand China's long-term growth with robust empirical evidence of input-output analysis. Cross-fertilisation of ideas, as proposed by Lo and Zhang (2011), is important to shed light on a complex historical case as the Chinese one. At the same time, empirical evidence from input-output matrices are an adequate tool to show China's structural changes. Instead of adopting product-level data as by Felipe et al. (2013), this paper applies sectoral input-output indicators, in order to capture features highlighted by the theoretical perspective here adopted. In addition, the paper brings evidence that, apart from some sectors, structural change towards industrial diversification and integration does not follow necessarily an export-led strategy. Liu, Polenske, and Guilhoto (2010) also calculate some indicators, such as output multipliers and backward and forward linkages, when comparing China's and Brazil's productive structures, but do not link sectoral data analysis to a theoretical background.

Following a Kaldorian-Structuralist framework, the consolidation of a large, diversified and integrated industrial base is central to a process of dynamic economic growth without facing balance-of-payments constraints. The strengthening of industrial linkages contributes to productivity gains and demand spillovers across the productive structure, thus sustaining a high growth trajectory.

Input-output analysis is applied in this paper in order to provide a detailed examination of changes in China's productive structure over the 1990s and 2000s. The calculation of the following indicators allows depicting key sectoral changes: output multipliers,

backward and forward linkages, fields of influence, as well as export-import coefficients. Data availability from the World Input-Output Database (WIOD) used in this paper covers the whole period between 1995 and 2009.

Results point that there has been diversification and deeper integration of domestic industrial production during the Chinese high growth period, thus combining different features highlighted by Kaldorian-Structuralist contributions to sustained growth patterns. China's growth has intensely relied on high investment levels, where foreign demand has played an important part as a key source of foreign exchange for imports necessary for industrial upgrading, thus assuring the continuous development of domestic productive forces without facing balance-of-payment growth constraints. Large industrial sectors were the key economic sectors of the Chinese productive structure, as they generally presented the highest output multipliers and the strongest interindustry linkages. In addition, the Chinese economy became more diversified and industrial production, more integrated, over the years, given the strengthening of interindustry linkages, particularly between industrial sectors. Furthermore, the analysis of China's trade pattern reveals that, despite the increasing need of imports, the economy as a whole and most sectors were able to raise exports, thus assuring the necessary foreign exchange.

The paper is divided into three sections. The first section presents the main arguments related to the Kaldorian-Structuralist theoretical framework in the literature. The second section details the methodological approach based on input-output analysis. The third section discusses the main results of the paper concerning the sectoral transformations of the Chinese economy. Concluding remarks follow.

2. Productive structure and economic growth: Kaldorian-Structuralist contributions

The dichotomy between inward- and outward-oriented growth strategies misrepresents the complex dynamics of Chinese economic success. Whether, on the one hand, China has benefited from its integration in international trade and capital flows, on the other, the implementation of Chinese open-door policies has been aimed at capitalising on foreign resources, such as technology and foreign exchange, especially for continuous industrial development.

Additionally, as reforms have been gradual and limited, a dual planned and market economy has coexisted for a long time after initial implementation of economic reforms in 1978 (Naughton 2007; Wu 2005). Even after the second round of reforms towards the consolidation of a 'socialist market economy' in the 1990s, the Chinese state has remained very active and powerful in orientating the economy. Structural changes have occurred through clear state orientation, macroeconomic policies and particular conditions to foreign capital to operate domestically (Flassbeck 2005; Aglietta and Bai 2013).

Therefore, the combination of both external and domestic forces is important to account for the Chinese growth experience. In this regard, contributions from Kaldorian and Structuralist traditions can shed light on China's successful story, once highlighting the interaction between domestic and international dynamics, with particular emphasis on decisive structural changes towards industry for economic growth.

According to the Structuralist tradition, based on either the Latin American or the Anglo-Saxon approaches[1], the process of industrialisation is widely recognised as

essential to facing the bottlenecks and rigidities that may prevent low- and middle-income countries from achieving higher income levels. Patterns of sustained economic growth are generally associated with the promotion of industrialisation and the diversification of domestic manufacturing industries. Great emphasis is also placed on external constraints to industrialisation.

> sustained economic growth requires a transformation of the structure of production that is compatible with both the evolution of domestic demand and the opportunities for international trade. This transformation normally involves a substantial rise in the share of industry and [. . .] a shift away from dependence on primary exports towards manufactured goods as a source of foreign exchange *(Chenery 1980, 281).*

The Structuralist view differs from the Ricardian comparative advantages argument, according to which countries should specialise in the production of goods in which they have greater resource endowments and trade them in the international market so that a more efficient allocation of resources would be achieved. The conventional view has largely recalled this idea of development based on comparative advantages to defend deep and rapid liberalization reforms in the 1980s and 1990s through the Washington Consensus agenda for developing economies (Williamson 1990; Kuczynski and Williamson 2003). This pattern, however, China has clearly not followed.

According to the Structuralist tradition, the consolidation of a diversified and integrated industrial productive structure with strong interindustry linkages is a necessary condition for furthering long-term economic growth. The establishment of a domestic productive system could increase income levels through the demand that one sector would generate to another. Complementarity of demand between sectors could break the 'vicious circle of underdevelopment' but would require for some authors, such as Rosenstein-Rodan (1943) and Nurkse (1953), large-scale planned investments led by the State to be implemented at once, i.e. a 'Big Push', to assure inter-sectoral balance.

For other authors, such as Hirschman (1958, 1987), in support of an unbalanced growth strategy, efforts should focus on key sectors, i.e. those sectors with strong interdependence and linkages with other sectors in the economy. Two types of linkages between sectors are identified: backward and forward linkages. Backward linkage refers to the ability of a sector to stimulate production and investment of sectors that provide its inputs, whilst forward linkage relates to the ability of a sector to induce productive activities of sectors that demand its output. That 'Big Push' to promote a balanced process of growth would require precisely what underdeveloped economies lack, such as the amount of financial resources, managerial capabilities and planning efforts to carry out large-scale investments and industrialisation across all sectors at once.

Another key structural feature of developing economies is that they tend to produce and export goods with low-income elasticity of demand, such as primary commodities, while importing high-tech industrialised goods, which are provided with a higher income elasticity of demand. The opposite relationship holds true for central economies. That means a world system where cheap unprocessed commodities flow from the periphery to the centre and more sophisticated industrialised goods flow from the centre to the periphery, reinforcing productivity and technological differentials between these groups of economies (Prebisch 1950).

In response to this dichotomy regarding the productive specialisation and export-import dynamics between central and peripheral economies that is advocated in the Structuralist tradition the continuous industrialisation of developing economies, in order to progressively internalise the production of manufacturing goods previously imported, including consumer durables, intermediate inputs and capital goods. The ongoing industrialisation would result in a diversified and interdependent domestic productive structure that could spread demand effects as well as technological and productivity gains over the economy, i.e. a supply composition able to respond with national production to final and intermediate demand. These are key transformations to support a trajectory of high economic growth.

The Kaldorian economic tradition also discusses the importance of demand-supply composition for growth. On the one hand, it points out the sectoral supply composition, arguing that some sectors, namely manufacturing industries, are more capable of promoting dynamic growth. That implies sectors have different growth-enhancing properties. Manufacturing industries would be responsible for more technological progress and productivity increases in the economy, thus being able to promote more growth than any other sector when stimulated by demand. On the other hand, it addresses the supply composition in terms of domestic and foreign supply, given export-import demand differentials, concluding that the specialisation of trade and production structures in lower value-added sectors may lead to balance-of-payment growth constraints.

The defence of manufacturing as the engine of economic growth is clear, as highlighted by what is referred in the literature as Kaldor's laws. Kaldor's original work on the causes of the slow growth of the United Kingdom presented three laws (Kaldor 1966), later explored and expanded by Kaldor himself and other authors (Kaldor 1968, 1977, 1981; Thirlwall 1979, 1983, 2002; King 2009, 2010). The first law states that the faster the rate of growth of output in manufacturing is, the faster the rate of growth of total output in the economy will be. In other words, growth in manufacturing is positively associated with economic growth.

Connected with it, the second law, also known as Verdoorn's law, stresses the existence of a positive relationship between the rate of growth of output in manufacturing and the rate of growth of labour productivity in manufacturing. This law accounts for the special properties of manufacturing industries, since they intrinsically embrace static and dynamic economies of scale or increasing returns to scale that generate more output and productivity growth than other sectors.

The third law states that the faster the growth of manufacturing output is, the faster the rate of labour transference from non-manufacturing to manufacturing activities is, so that total productivity growth is positively associated with the growth of output and employment in manufacturing and negatively associated with the growth of output and employment outside manufacturing. Therefore, high growth of manufacturing output is important to the overall productivity growth. In other words, the faster the growth of output, the greater the rate of labour transference from other sectors in the economy where productivity is lower to manufacturing industries where productivity is higher, thus resulting in an increasing overall rate of productivity growth.

In addition to the aforementioned three laws, a fourth law can be included in Kaldor's framework, as discussed by Thirlwall (1983), despite controversies involving it. Originally, discussion made by Kaldor on international trade was mostly related to the

export-led perspective, in line with Kaldor-Dixon-Thirlwall (KDT) model (Kaldor 1970; Dixon and Thirlwall 1975), rather than with Thirlwall's law. Later, Kaldor recognised balance-of-payment growth constraints in an open economy, emphasis which is placed on by Thirlwall's law, according to which the long-term growth rate of a country is regarded as given by the ratio between the rate of growth of exports and the income elasticity of demand for imports (Thirlwall 1983). During the process of economic development, there is a need for generating foreign exchange to import necessary inputs for promoting changes in the domestic productive structure and internalising higher value-added activities. Consequently, the lack of foreign exchange would impose constraints on further economic growth, once trade deficits cannot grow indefinitely. Since Thirlwall's law is dynamic, it states that imports cannot grow faster than exports in the long run, meaning that trade deficits need to be stable, at least as percentage of GDP (McCombie and Roberts 2002).

Kaldorian contributions, therefore, have not only focused on the importance of the manufacturing sector per se as a dynamic source of growth, but also on its importance from an open economy perspective. Manufacturing industries embody increasing returns to scale and higher levels of labour productivity in the economy, from which results that manufacturing growth is the engine of GDP growth and that the higher the rate of growth of manufacturing output, the faster the overall rate of productivity growth. Additionally, due to different income elasticities of demand for exports and imports, exports of low value-added goods, mainly primary commodities, and imports of high value-added goods (especially manufacturing goods) would create a structural disequilibrium for economic development, thus requiring a migration to higher value-added manufacturing production in order to overcome balance-of-payments constraints on long-term economic growth.

It is important to highlight that more recent Kaldorian literature stresses that a country's growth rate of per capita income is directly proportional to the growth rate of its exports, with such a proportionality being inversely (directly) related to sectoral income elasticities of demand for imports (exports), which has been called as the Multi-Sectoral Thirlwall's Law by Araujo and Lima (2007). The income elasticities are weighted by coefficients measuring the share of each sector in total imports and exports, respectively. Empirical evidence is presented by Gouvea and Lima (2010) for a sample of Latin American and Asian countries, showing the evolution of each country's weighted trade income elasticities as the sectoral composition of exports and imports matters for growth, and also by Romero and McCombie (2016) for a sample of 14 European developed countries, indicating that the income elasticities of imports and exports are higher for medium- and high-tech manufactures.

It is also emphasised in the literature the effects of Kaldor-Verdoorn's law in an open economy. Pacheco-López and Thirlwall (2014) estimate a close association between manufacturing output growth and export growth for 89 developing countries over the period 1990–2011, thus affecting GDP growth by providing foreign exchange for imports and, therefore, relaxing a balance-of-payments constraint on demand. Additionally, Romero and Britto (2017) bring evidence of the importance of both demand growth and research intensity for productivity growth, including a relevant impact of higher research intensity on the magnitude of returns to scale in manufacturing. By considering both Kaldorian and Schumpeterian contributions to growth theory, Romero (2019)

proposes a model discussing the importance of high-tech sectors for increasing productivity and releasing balance-of-payments constraints on growth. It is argued that higher research intensity can generate higher growth, an increase in the growth rate of foreign output can exert a negative impact on the domestic economy and, in a multi-sectoral setting, changes in the performance of a given sector can affect the performance of others through inter-sector demand externalities, especially because an increase in productivity growth in a given sector, by increasing its non-price competitiveness and its export growth, eases balance-of-payment constraints and allows higher growth in other sectors of the economy.

In conclusion, from a Kaldorian-Structuralist perspective, it is clear the importance of consolidating a large, diversified and integrated industrial base to long-term economic growth without facing balance-of-payments constraints. Demand multiplier effects over the productive structure would be higher depending on: (i) the complementarity of demand between sectors and, consequently, the strength of domestic interindustry linkages; (ii) the sectoral supply composition, particularly the prevalence of industrial sectors, especially high-tech ones; and (iii) the dynamics between domestic and foreign supply, in order to avoid demand leakage to foreign markets.

3. Methodological notes on input-output analysis

This section details the input-output methodology applied in this paper to depict the productive structure of the Chinese economy. Chinese input-output tables were released by the World Input-Output Database (WIOD) covering the 1995–2009 period[2]. WIOD input-output tables were disposed at basic prices and industry-by-industry format. In order to make them comparable over the years, tables at current prices and previous year's prices were used to transform current prices into constant prices of the last available year (2009). All input-output indicators to be presented are therefore based on data expressed in 2009 constant prices.

Additionally, original 35-sectors tables were reduced to 17-sectors tables considering similarities of sectors' productive structures and preserving a large number of industrial sectors. Appendix 1 of this paper presents the map of sectoral aggregation used for China, showing the correspondence between the original WIOD 35-sectors matrix and the calculated 17-sectors matrix.

According to the input-output framework, total output in the economy (X) is given by the sum of output for intermediate consumption (Z) of different sectors and output for final demand (Y), as in (1). The matrix of interindustry flows (Z) and the total output allow the calculation of the matrix of technical coefficients (A), expressed by (2)[3].

$$X = Z + Y \tag{1}$$

$$a_{ij} = \frac{Z_{ij}}{X_j} \tag{2}$$

It follows that:

$$X = A \cdot X + Y \tag{3}$$

The solution to this equation gives the total output necessary to meet the final demand:

$$X = (I - A)^{-1} \cdot Y \tag{4}$$

where $(I - A)^{-1} = L$ is known as the Leontief inverse or the total requirements matrix.

The basic Leontief model allows several analyses of the productive structure, such as output multipliers, which indicate, for each sector, the amount of production directly and indirectly generated in the economy for each unit of final demand. The bigger the multiplier of one sector in comparison to the multipliers of other sectors, the greater its impacts on the rest of the economy, thus pointing to its importance to stimulate total output.

Additionally, input-output models allow calculations of indicators highlighting the linkages between sectors, such as Hirschman-Rasmussen backward and forward linkages. This approach of identifying key sectors in the economy and calculating sectoral linkages dates back to the works of Hirschman (1958) and Rasmussen (1956). The term 'forward linkage' is used to indicate the interconnection of a particular sector with sectors to which it sells its output, i.e. it measures how much of its output is demanded by other sectors. In turn, the term 'backward linkage' refers to the interconnection of a particular sector with those sectors from which it purchases inputs, i.e. it measures how much a sector demands from other sectors in the economy[4].

According to Miller and Blair (2009), sectors can be distributed over a four-way classification depending on the results of their backward and forward linkages. Sectors can be classified as: (a) generally independent of (or not strongly connected to) other sectors, when both linkages measure less than 1; (b) generally dependent on (or connected to) other sectors, when both linkages measure greater than 1; (c) dependent on interindustry supply, when only the backward linkage is greater than 1; and (d) dependent on interindustry demand, when only the forward linkage is greater than 1.

Previous indicators contribute to assessing the importance of each sector in terms of their impacts on the economic system as a whole but do not offer a clear picture of how interconnected the sectors are. The analysis of fields of influence shows the main linkages between sectors, describing how changes in direct coefficients are distributed within the economic structure. It allows the identification of the most important linkages between sectors in the productive process and how they have changed over time (Sonis and Hewings 1989, 1991; Guilhoto 2009).

Considering the matrix of technical coefficients A and defining a matrix of marginal changes in input direct coefficients as $E = [\varepsilon_{ij}]$, it follows that corresponding Leontief inverses would be given by $L = (I - A)^{-1} = [l_{ij}]$ and $L(\varepsilon) = (I - A - \varepsilon)^{-1} = [l_{ij}(\varepsilon)]$. Then, considering a small change in only one direct coefficient, i.e.:

$$\varepsilon_{ij} = \begin{cases} \varepsilon & \text{if } i = i_1, j = j_1 \\ \\ 0 & \text{if } i \neq i_1 \text{ or } j \neq j_1 \end{cases} \tag{5}$$

the field of influence of this change can be approximately expressed as:

$$F(\varepsilon_{ij}) = \frac{[L(\varepsilon_{ij}) - L]}{\varepsilon_{ij}} \tag{6}$$

where $F(\varepsilon_{ij})$ is the matrix of field of influence for coefficients a_{ij}.

In order to identify those coefficients with the greatest fields of influence, a value given by S_{ij} in Equation (7) is associated with each matrix $F(\varepsilon_{ij})$.

$$S_{ij} = \sum_{k=1}^{n} \sum_{l=1}^{n} [f_{kl}(\varepsilon_{ij})]^2 \tag{7}$$

In this approach, direct coefficients presenting the greatest values of S_{ij} are those with the largest fields of influence in the economy. The way chosen to illustrate results in this paper is to calculate both the average and standard deviation of S_{ij} values and classify each linkage as below the average, between the average and one standard deviation, between one and two standard deviations, between two and three standard deviations, or above three standard deviations. As the analysis is made in comparison with the average of all linkages, linkages that weakened in relative terms do not necessarily mean they reduced in absolute numbers. A colour-scale figure is used to represent the fields of influence between sectors throughout the economy according to this classification in different years, showing the relative transformations of the productive structure over time.

The analysis of China's productive structure is complemented by export-import coefficients that indicate the evolution of its trade pattern. That includes the composition of exports and imports, and both total and sectoral export and import penetration coefficients.

Sectoral export coefficients can be calculated as any direct coefficient, i.e. by the ratio between the value of exports of each sector and the total output of the corresponding sector. In other words, they represent the share of total output of each sector that is exported. Similarly, the total export coefficient is given by the share of the economy's total output that is exported. The bigger the export coefficient, the greater the orientation of domestic production to exports. It also provides a proxy to the ability of the economy or each sector to obtain foreign exchange from exports.

Analogous to Equation (1), there is a matrix of imports by sector (M) that shows how imports are distributed across the economy. Total imports are directed either to intermediate consumption of different sectors (Z_m) or final demand (Y_m), as in (8).

$$M = Z_m + Y_m \tag{8}$$

Import penetration coefficients account for the share of imports in non-exported total (both domestic and imported) production. That means, imports are added and exports subtracted from the denominator of total output for import penetration coefficients by sector and for the whole economy. The bigger the import coefficient, the higher the share of imports to meet domestic demand. This analysis shows the degree of output dependence on imports and, combined with the analysis of export coefficients, offers a perspective on eventual foreign exchange constraints.

4. Sectoral transformations of the Chinese economy

Investments have been key to the Chinese sustained growth trajectory. Investment rates have accounted for more than 40% and, in several years, nearly 50% of total GDP after the gradual opening up reforms. The importance of investment for economic growth is related not only to its spillovers and significant multiplier effects within the economic system as a source of demand, but also to its unique capacity to transform the productive structure. Investments have been important to industrial transformations take place as fast as they have occurred in China.

The contribution share by demand component to the GDP growth shows that the Chinese GDP growth rate since 1978 has been mostly attached to the dynamics of domestic demand, either final consumption or investment. Figure 1 indicates that in the beginning of economic reforms, final consumption was largely the main source of growth. During the first half of the 1980s, both investment and consumption contribution increased but investment increased at a faster pace. Afterwards, following the gradual trade openness over the Chinese coast, net exports began to contribute more significantly to economic growth. Indeed, they were important to avoid a lower growth rate during the economic turmoil that marked the Chinese economy in the late 1980s. The economy only recovered, however, after a new consumption and investment boom, so that the early 1990s experienced high growth rates. According to Molero-Simarro (2015), this period was marked by a profit-led growth.

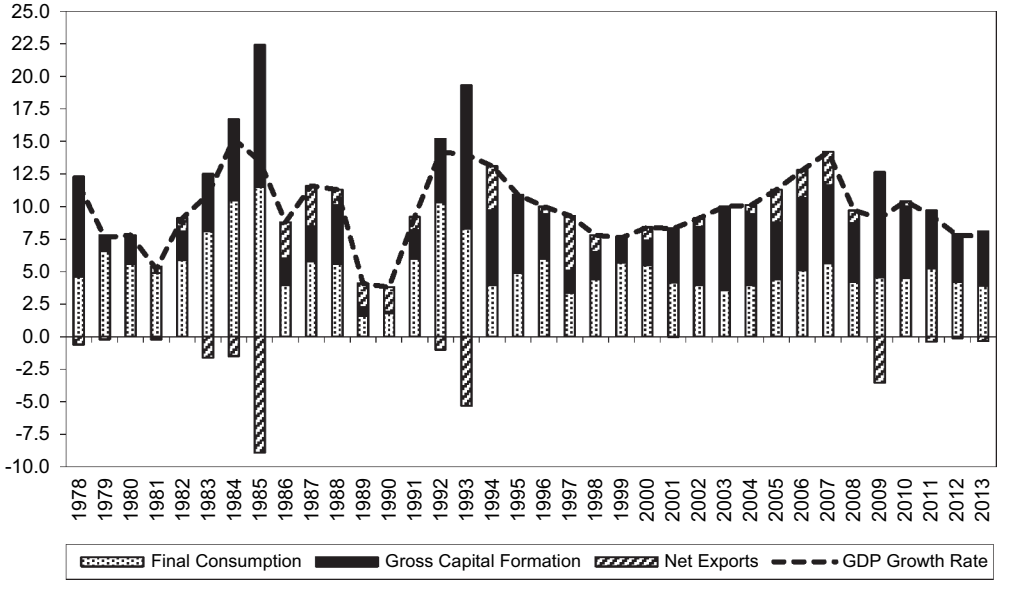

Figure 1. China – contribution share by expenditure component to the GDP growth, 1978–2013 (p.p.). Source: Author's elaboration based on data from the Chinese Statistical Yearbook, various years. Notes: (1) Final consumption includes household and government final consumption; (2) The sum of all three demand components in each column equals the GDP annual growth rate.

From the establishment of the institutional basis for a 'socialist market economy' in the 1990s onwards, China experienced a high, despite declining, growth rate in the second half of that decade followed by a sharp rise in the 2000s. Real GDP growth rate accelerated from 8.4% in 2000 to more than 14% before the 2008 international crisis. This period of intense economic growth relied on investment contribution as the leading factor in economic activity, clearly and consistently accounting for most of the high dynamism since 2001 and even after the economic crisis downturn (Figure 1). During that period, there was also a growing reliance of domestic value-added upon foreign markets, to the detriment of domestic household consumption.

Input-output indicators allow the identification of key economic sectors in the economy to verify how far structural changes provoked by a large amount of investments occurred. Output multipliers indicate, by sector, the amount of production generated in the economy for each unit of final demand, i.e. allow highlighting those sectors whose production has a stronger response to demand stimuli given their direct and indirect effects over the economic system.

For the 1995–2009 period, most sectors presented an average multiplier above 2, and all sectors, above 1.5. The main sectors able to stimulate total production from a given change in final demand were industrial sectors, in particular 'transport equipment', 'electrical equipment', 'textiles and footwear' and 'machinery' (Figure 2). In other words, these sectors presented deeper productive linkages in the economy as a whole, a sign of the large and diversified industrial base China developed. Apart from 'textiles and footwear', the other three sectors usually present higher technological intensity, being classified as medium-high or high-technology industries, according to OECD (2011) definition, which considers R&D intensities by

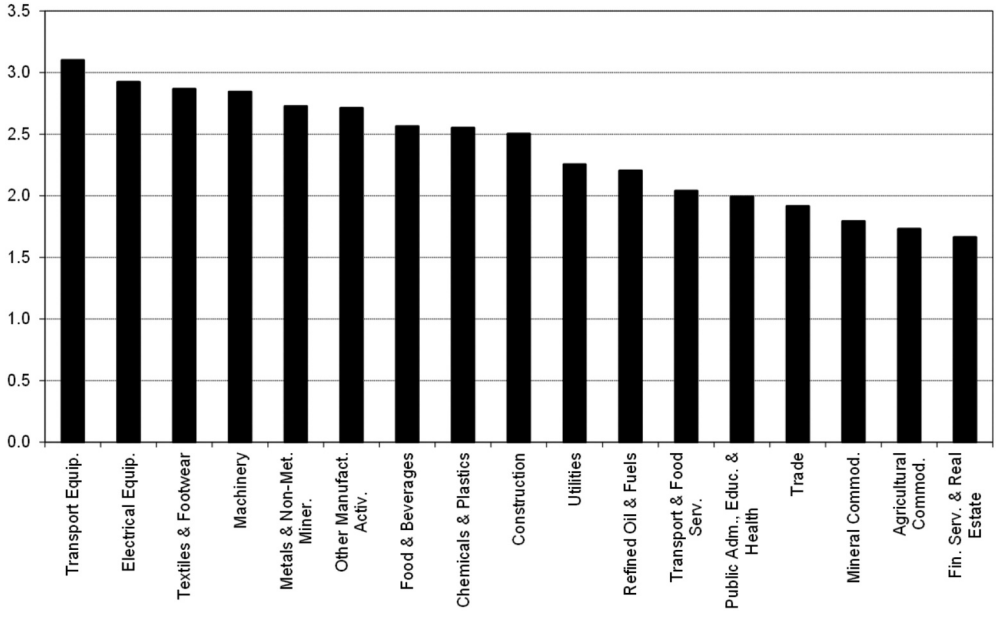

Figure 2. China – output multipliers, average 1995–2009. Source: Author's elaboration based on WIOD Chinese tables.

each sector. As discussed in the Kaldorian literature before, high-tech manufacturing industries may enhance growth spillovers to other sectors of the economy. In turn, several services and primary sectors ranked among the lowest output multipliers in the Chinese economy during this period. Evidence brought by Magacho and McCombie (2017, 2018) for a large pool of countries highlights the dynamic increasing returns to scale presented by manufacturing, especially for high-tech industries, showing that Verdoorn estimates depend upon the level of economic development of each country.

This analysis of output multipliers is complemented by the degree of dependence between sectors provided by Hirschman-Rasmussen forward and backward linkages. In accordance with these results, sectors could be classified as generally dependent on other sectors, dependent on interindustry supply, dependent on interindustry demand or relatively independent of other sectors. Sectors with the highest output multipliers in the Chinese productive structure also presented the highest backward linkages, therefore classified as dependent on interindustry supply. They usually required supply of intermediate inputs from other sectors whilst their production was generally directed to meet final demand (Figure 3).

Some other sectors with high output multipliers were 'chemicals and plastics', and 'metals and non-metallic minerals', which presented both forward and backward linkages above 1, thus considered as sectors generally dependent on other sectors, once important to the productive structure both as demanding and supplying inputs for other sectors in the economy. 'Mineral commodities', 'utilities' and 'refined oil and fuels' were dependent on interindustry demand, as they showed high forward linkages only. Some relatively independent sectors were some services and 'agricultural commodities', although they

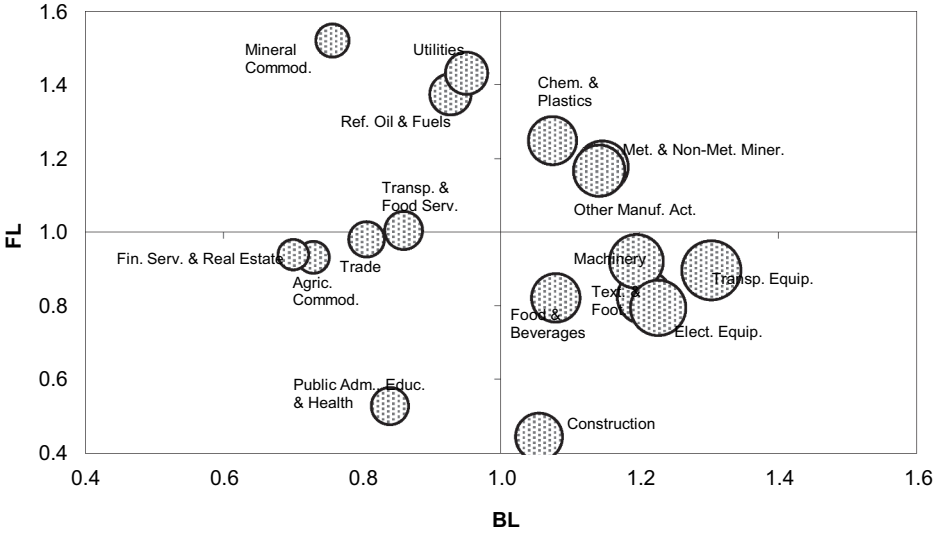

Figure 3. China – Hirschman-Rasmussen backward and forward linkages, average 1995–2009. Source: Author's elaboration based on WIOD Chinese tables. Note: The circle size represents the output multiplier of a sector proportional to other sectors' multipliers in the economy, so that the bigger the circle, the higher the multiplier in relation to other multipliers.

registered on average a considerable forward linkage. In this regard, 'public administration, education and health' figured as the most independent sector in the economy (Figure 3).

In order to depict how interconnected sectors are, the notion of fields of influence is applied, so that most important linkages between sectors become evident. Three major facts regarding relative transformations of the Chinese productive structure arise from the analysis of fields of influence over time in Figure 4.

Firstly, linkages between traditional primary sectors, namely agriculture and mineral commodities, and other sectors in the economy weakened, although they remained

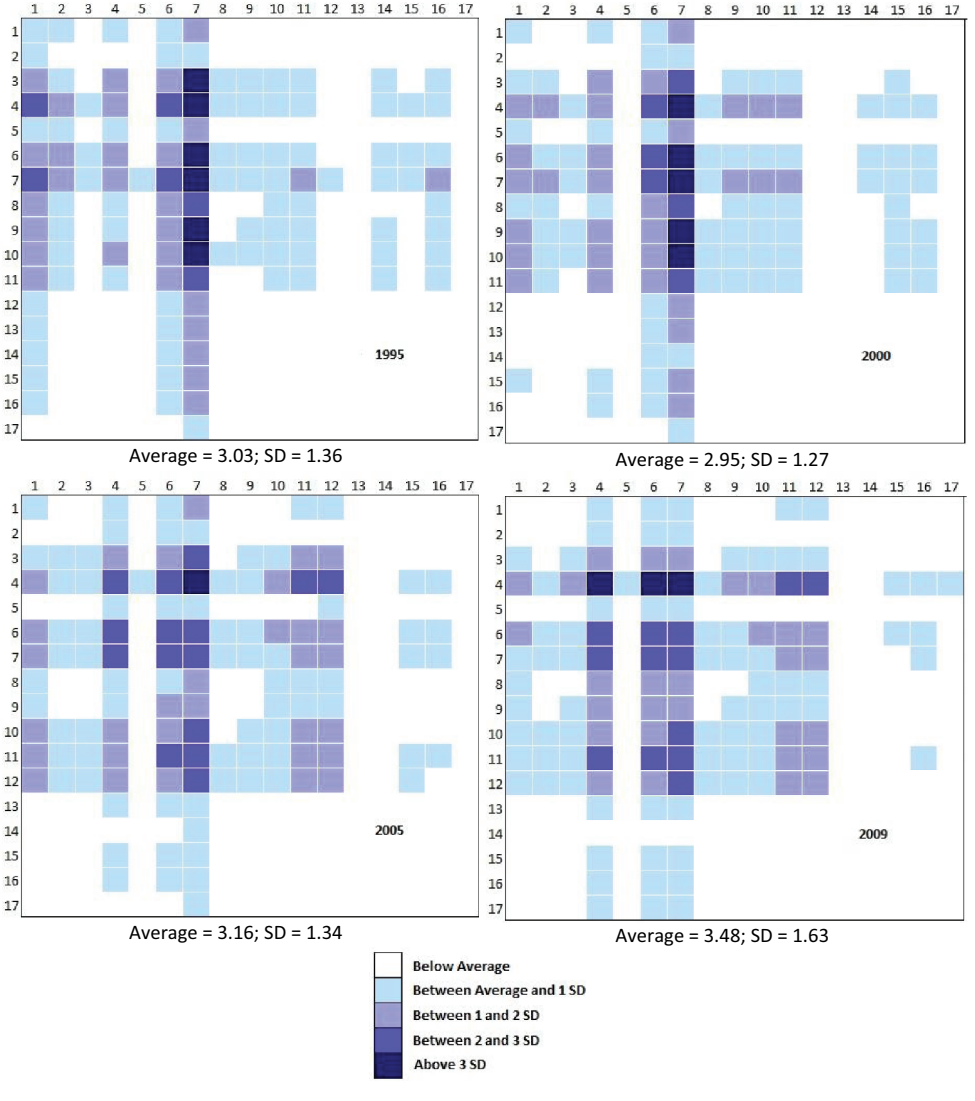

Figure 4. China – fields of influence, selected years. Source: Author's elaboration based on WIOD Chinese tables. Note: 1-2 as primary sectors; 3-13 as industrial sectors; 14-17 as services sectors. See Appendix 1 for sectors correspondence to numbers in detail.

important. Linkages between them as well as linkages between them and industrial sectors clearly attenuated in relation to linkages in the overall economy (see linkages between sectors 1 and 2 and the rest of the economy).

Secondly, linkages between services sectors and other sectors in the economy changed their configuration and, in general, weakened as well. Linkages only between services sectors were not highly significant, as they were below the average every year, whilst linkages between services and industrial sectors relatively reduced (see linkages between sectors 14 to 17 and the rest of the economy).

Thirdly, the Chinese economy became more diversified and industrial production became more integrated. Industrial linkages were mostly above the average of the economy every year and consistently presented the highest linkages.

There were also fewer outlier points of very intense interconnection, such as between 'metals and non-metallic minerals' and other industrial sectors, in favour of a relative strengthening of linkages between other industrial sectors. The relative intensity of linkages between key industrial sectors changed in the productive structure so that 'metals and non-metallic minerals' (sector 7), 'chemicals and plastics' (sector 6) and 'textiles and footwear' (sector 4) experienced, for instance, relative weakness, maintenance and strengthening of their linkages with other sectors in the economy, respectively (Figure 4). Additionally, it can be stressed the importance of medium-high and high-technology industries, namely 'chemicals and plastics' (sector 6), 'machinery' (sector 8), 'electrical equipment' (sector 9) and 'transport equipment' (sector 10), whose linkages in the matrix mostly showed above average results and, therefore, a relatively higher integration, especially with other industrial sectors. As documented in the Kaldorian literature, spillovers of manufacturing industries are important to a process of sustained economic growth.

The huge process of structural change that China promoted in its productive structure is reflected in its trade pattern. The share of manufactures exports in total merchandise exports continuously increased, passing from less than 60% in 1987 to more than 90% already in 2003. The share of manufactures imports in total merchandise imports followed an opposite trend, reducing from more than 80% in 1987 to approximately 55% in 2012 (Figure 5). These movements clearly show how sectoral composition changed in favour of industrial goods to the detriment of primary goods in the economy over the years. After 1994, the share of manufactures exports surpassed the share of manufactures imports. Not by coincidence, China began registering systematic trade surpluses and, consequently, alleviating foreign exchange constraints on growth. As pointed out by Jeon (2009, 143), 'a prosperous position in balance-of-payments allows fast economic growth'.

Exports of tradable sectors – mostly manufacturing industries – generated the necessary foreign exchange to assure imports to carry on with the process of economic development. Total import penetration coefficient also rose, meaning that a higher share of imports was used to meet domestic demand (Figure 6). Nonetheless, it

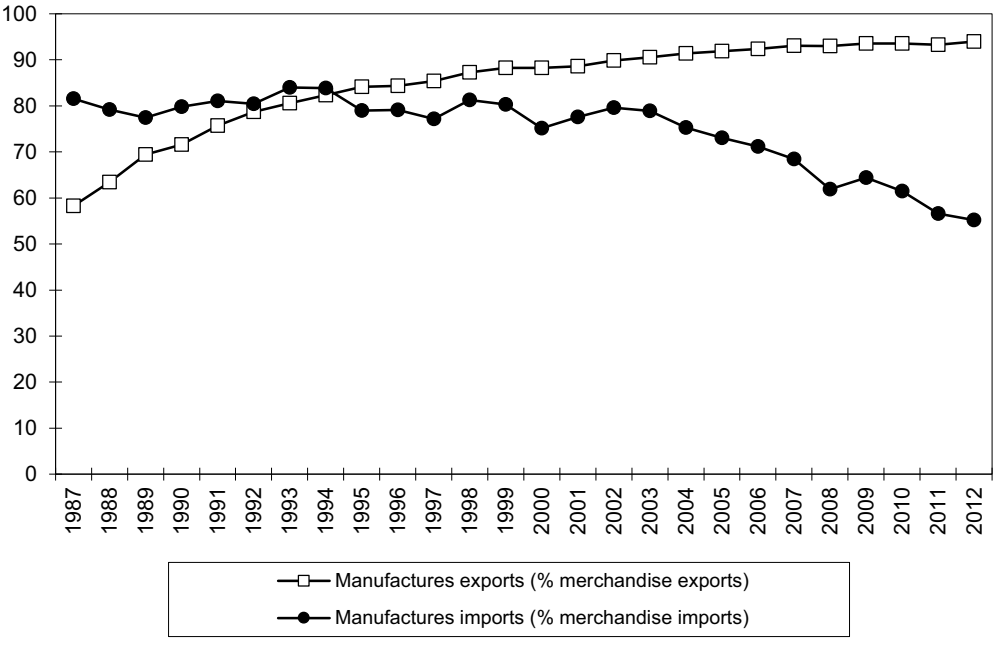

Figure 5. China – manufactures exports and imports, 1987–2012 (% merchandise exports and imports). Source: Author's elaboration based on data from the World Bank – World Development Indicators. Note: Manufactures comprise commodities in the Standard International Trade Classification (SITC) sections 5 (chemicals), 6 (basic manufactures), 7 (machinery and transport equipment), and 8 (miscellaneous manufactured goods), excluding division 68 (non-ferrous metals). Non-manufactures refer to primary goods, which, by exclusion, correspond to commodities in the SITC sections 0 (food and live animals), 1 (beverages and tobacco), 2 (crude materials, except fuels), 3 (mineral fuels and related materials), 4 (animal and vegetable oils), and 9 (commodities and transactions not classified elsewhere in the SITC), including division 68 (non-ferrous metals).

accounted for less than 10% of domestic demand and was consistently lower than the export coefficient.

Most sectoral export and import penetration coefficients followed the pattern observed for the overall economy that the import penetration coefficient increased but to a lesser extent than the export coefficient, therefore preventing the economy from foreign exchange constraints in the short-term. This was the pattern for most industrial sectors. Sectoral analysis shows, however, some important differences among them.

The trend of imports to meet domestic demand significantly increased for sectors such as 'mineral commodities', 'refined oil and fuels', 'metals and non-metallic minerals', 'electrical equipment', 'utilities', and 'construction'. Most of them are sectors that supply inputs for other sectors and infrastructure-related sectors. Given the massive infrastructure expansion and investments in general in China over the period, it was expected that the proportion of imports to meet domestic demand for these sectors would increase. However, the level of the import penetration coefficient was considerably high only for a highly export-oriented sector ('electrical equipment') and a less integrated sector in the

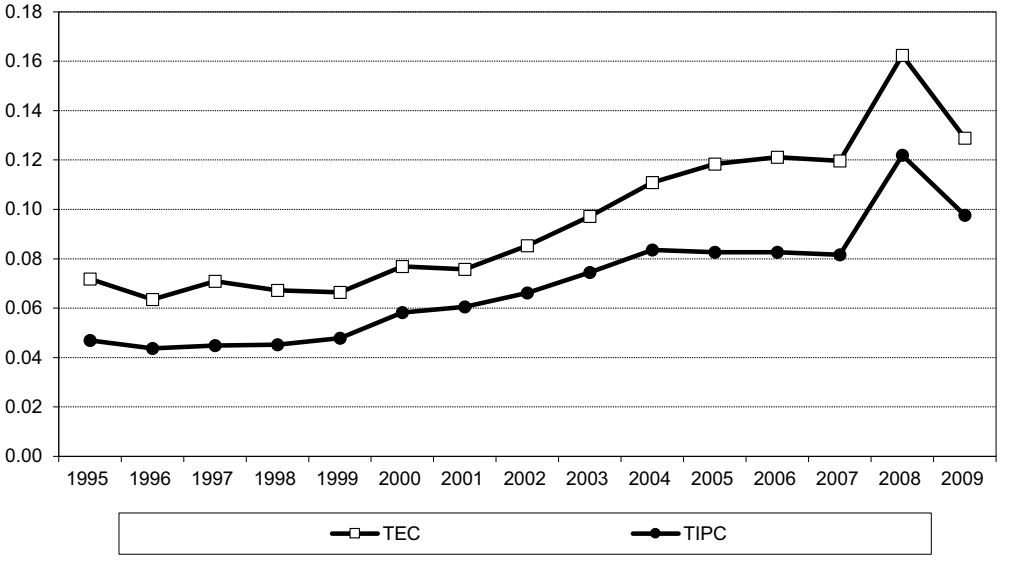

Figure 6. China – trade coefficients, 1995–2009. Source: Author's elaboration based on WIOD Chinese tables. Note: TEC = Total Export Coefficient; TIPC = Total Import Penetration Coefficient.

domestic productive structure ('refined oil and fuels'), as for the great majority of sectors the coefficient was lower than 10% (Figure 7).

Apart from 'refined oil and fuels', 'utilities', and 'construction', export coefficients were in general higher than import penetration coefficients. Among these sectors, two of them, which were more integrated into the domestic productive structure, namely 'construction' and 'utilities', presented a low level of import penetration, as they were relatively small sectors in the Chinese import structure. Sectors whose import penetration coefficients surpassed their export coefficients were 'mineral commodities', 'agricultural commodities', and 'public administration, education and health'. However, their level were not very high (Figure 7). Among them, one should remark that 'mineral commodities' became an increasingly large import sector in the mid-2000s.

Export coefficients were higher than import penetration coefficients for most of other large import sectors, such as 'machinery', 'chemicals and plastics', 'metals and non-metallic minerals', 'textiles and footwear', and 'electrical equipment' (Figure 7). They were, indeed, also large export sectors in the trade structure, although their production was not necessarily directed mostly to foreign markets, which was only the case of 'electrical equipment' and 'textiles and footwear'.

The Chinese trade pattern, therefore, reflected the structural composition in favour of industrial sectors, given the large industrial base built up over the years, as well as the fact that, despite the increasing need of imports, the economy and most of its sectors were able to meet this need by raising exports. In this regard, the Chinese economy was able to promote sustained growth without facing balance-of-payments constraints[5], as highlighted by Kaldorian and Structuralist theories regarding sustained trajectories of economic growth.

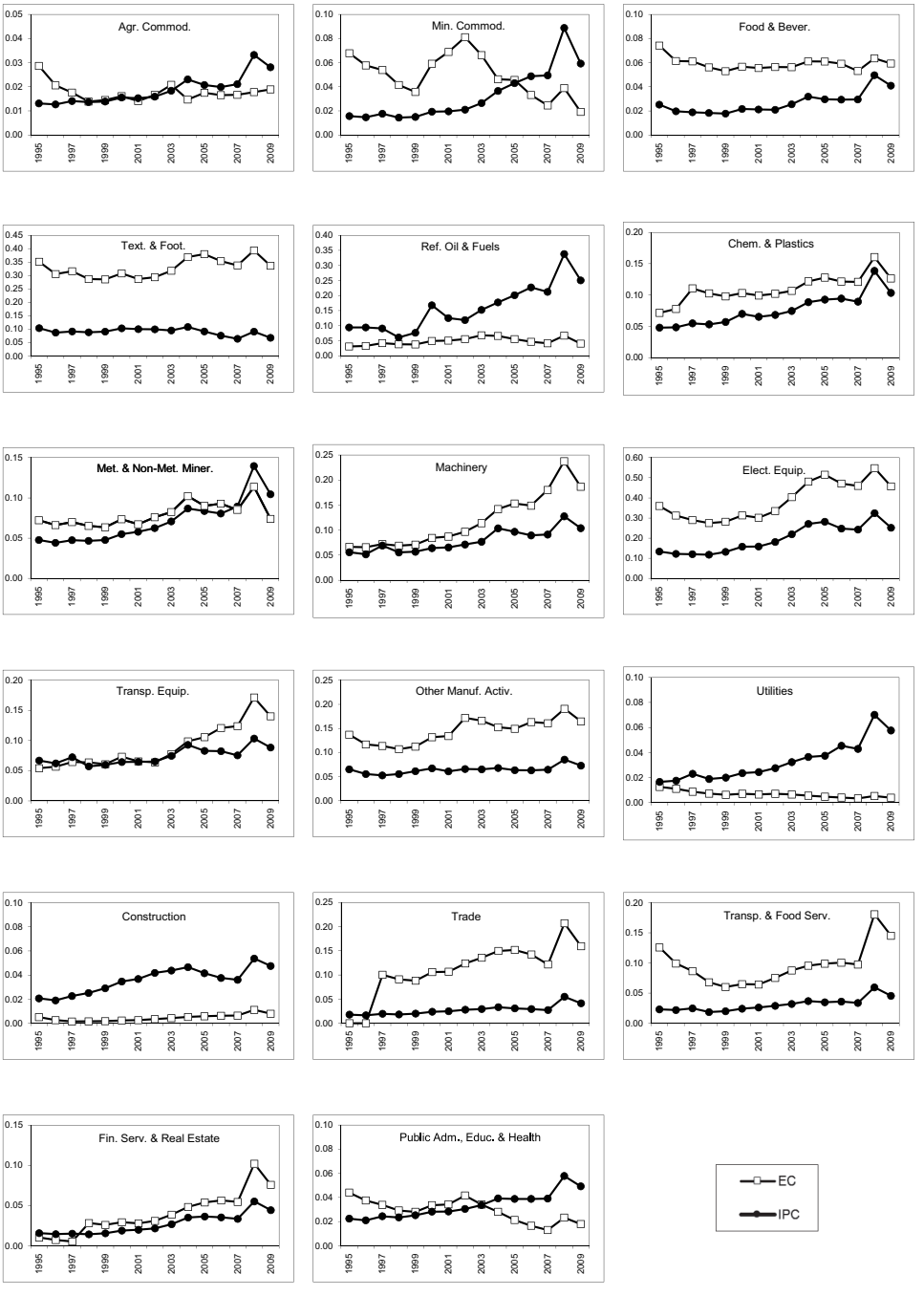

Figure 7. China – trade coefficients by sector, 1995–2009. Source: Author's elaboration based on WIOD Chinese tables. Note: EC = Export Coefficient; IPC = Import Penetration Coefficient.

5. Conclusions

This paper provides a perspective on China's sustained growth trajectory based on Kaldorian-Structuralist contributions. These approaches emphasise the importance of the consolidation of a large, diversified and integrated industrial base as central to economic growth without facing balance-of-payments constraints. Higher demand multiplier effects over the domestic economic system depend on the organisation of the productive structure in terms of sectoral composition, interindustry linkages, and domestic and foreign supply.

These dimensions were addressed through input-output analysis of the Chinese economy, which allowed the identification of major structural changes over the years. Results showed evidence for understanding China's growth pattern as associated with diversification and deeper integration of domestic industrial production.

Key economic sectors of the Chinese productive structure were large industrial sectors. In general, they presented the highest output multipliers and the strongest interindustry linkages, such as the case of 'transport equipment', 'electrical equipment', 'textiles and footwear' and 'machinery'. Furthermore, the strengthening of interindustry linkages, particularly between industrial sectors, reveals that the Chinese economy became more diversified and industrial production, more integrated, between 1995 and 2009.

The process of structural change that China experienced in its productive structure towards larger industrial sectors and stronger industrial linkages was reflected in its trade pattern, breaking with the particular Kaldorian-Structuralist concern for developing economies of balance-of-payments constraints on long-term economic growth. The share of manufacturing exports substantially increased over time, while the share of manufacturing imports reduced indicating the changes in the sectoral composition of production. Trade coefficients also showed that, in spite of an increasing need of imports, as expected in the case of a growing and changing economy such as China, the economy as a whole and most of its sectors were able to raise exports. In general, export coefficients raised faster than import penetration coefficients for most sectors. That meant they were able to assure necessary foreign exchange to meet the need of imports and continue the process of strengthening domestic industrial production. An interesting exception was the case of 'refined oil and fuels', a sector whose import penetration coefficient raised significantly and proved to be lesser integrated than other sectors in the domestic productive structure, pointing to a structural bottleneck and a rising Chinese concern in a more recent energy transition scenario that is the country's reliance on foreign supply of fuels and other commodities.

Therefore, for the period under analysis the Chinese economy succeeded in promoting a sustained growth trajectory without facing balance-of-payments constraints. This success can be largely attributed to important changes made towards the consolidation of a large, diverse and integrated industrial productive structure. New challenges, however, may lie ahead, including to address the need for a transition of the economy towards environmental sustainability, and to manage the complex Chinese economy in a world that is continuously and rapidly changing.

Notes

1. For details of these two different approaches, see Blankenburg, Palma, and Tregenna (2008) and Sanchez-Ancochea (2007).

2. Period when tables at both current prices and previous year's prices were available at: http://www.wiod.org. For more information about WIOD tables, see Timmer (2012).
3. For more details, see Miller and Blair (2009).
4. See Miller and Blair (2009) and Guilhoto (2009) for detailed explanation on the calculations of these linkages.
5. These constraints were further reduced when considering the large amount of capital inflows that occurred in the period, particularly in the form of foreign direct investments.

Disclosure statement

No potential conflict of interest was reported by the author.

Funding

The work was supported by the CAPES [5687/10-1].

ORCID

Roberto Alexandre Zanchetta Borghi http://orcid.org/0000-0001-5471-9705

Data availability statement

The data that support the findings of this study are derived from the World Input-Output Database (WIOD), originally available at http://www.wiod.org and currently held on https://www.rug.nl/ggdc/valuechain/wiod/.

References

Aglietta, M., and G. Bai. 2013. *China's Development: Capitalism and Empire*. London and New York: Routledge.

Araujo, R. A., and G. T. Lima. 2007. "A Structural Economic Dynamics Approach to Balance-Of-Payments-Constrained Growth." *Cambridge Journal of Economics* 31 (5): 755–774. doi:10.1093/cje/bem006.

Bibow, J. 2010. "How to Sustain the Chinese Economic Miracle? The Risk of Unraveling the Global Rebalancing." Levy Economics Institute Working Paper, n. 617, September Levy Economics Institute of Bard College.

Blankenburg, S., J. G. Palma, and F. Tregenna. 2008. "Structuralism." In *The New Palgrave Dictionary of Economics*, edited by S. Durlauf and L. Blume, 69–74. Vol. 8. Basingstoke: Palgrave Macmillan.

Brandt, L., and T. G. Rawski. 2008. "China's great economic transformation." In *China's Great Economic Transformation*, edited by L. Brandt and T. G. Rawski, 1–26. Cambridge: Cambridge University Press.

Branstetter, L., and N. R. Lardy. 2008. "China's Embrace of Globalisation." In *China's Great Economic Transformation*, edited by L. Brandt and T. G. Rawski, 633–682. Cambridge: Cambridge University Press.

Chenery, H. B. 1980. "Interactions Between Industrialisation and Exports." *The American Economic Review* 70 (2): 281–287.

Dixon, R., and A. P. Thirlwall. 1975. "A Model of Regional Growth-Rate Differences on Kaldorian Lines." *Oxford Economic Papers* 27 (2): 201–214. doi:10.1093/oxfordjournals.oep.a041312.

Fang, C., D. Yang, and W. Meiyan. 2009. "Crise ou oportunidade: resposta da China à crise financeira global." *Revista Tempo do Mundo* 1 (1): 97–119.
Felipe, J., U. Kumar, N. Usui, and A. Abdon. 2013. "Why Has China Succeeded? And Why It Will Continue to Do so." *Cambridge Journal of Economics* 37 (4): 791–818. doi:10.1093/cje/bes058.
Flassbeck, H. 2005. "China's Spectacular Growth Since the Mid-1990s – Macroeconomic Conditions and Economic Policy Changes." In *China in a Globalising world*, 1–44. New York and Geneva: UNCTAD.
Gouvea, R. R., and G. T. Lima. 2010. "Structural Change, Balance-Of-Payments Constraint, and Economic Growth: Evidence from the Multisectoral Thirlwall's Law." *Journal of Post Keynesian Economics* 33 (1): 169–204. doi:10.2753/PKE0160-3477330109.
Guilhoto, J. J. M. 2009. *Análise de insumo-produto: teoria, fundamentos e aplicações*. São Paulo: FEA-USP.
Hirschman, A. O. 1958. *The Strategy of Economic Development*. New Haven: Yale University Press.
Hirschman, A. O. 1987. "Linkages." In *The New Palgrave: A Dictionary of Economics*, edited by J. Eatwell, M. Milgate, and P. Newman, 206–211. London: Macmillan.
Jeon, Y. 2009. "Balance-Of-Payment Constrained Growth: The Case of China, 1979-2002." *International Review of Applied Economics* 23 (2): 135–146. doi:10.1080/02692170802700476.
Kaldor, N. 1966. *Causes of the Slow Rate of Economic Growth of the United Kingdom*. Cambridge: Cambridge University Press.
Kaldor, N. 1968. "Productivity and Growth in Manufacturing Industry: A Reply." *Economica* 35 (140): 385–391. doi:10.2307/2552347.
Kaldor, N. 1970. "The Case for Regional Policies." *Scottish Journal of Political Economy* 17 (3): 337–348. doi:10.1111/j.1467-9485.1970.tb00712.x.
Kaldor, N. 1977. "Capitalism and Industrial Development: Some Lessons from Britain's Experience." *Cambridge Journal of Economics* 1 (2): 193–204.
Kaldor, N. 1981. "The Role of Increasing Returns, Technical Progress and Cumulative Causation in the Theory of International Trade and Economic Growth." *Économie Appliquée* 34 (4): 593–617.
King, J. E. 2009. *Nicholas Kaldor*. Basingstoke: Palgrave Macmillan.
King, J. E. 2010. "Kaldor and the Kaldorians." In *Handbook of Alternative Theories of Economic Growth*, edited by M. Setterfield, 157–172. Cheltenham and Northampton: Edward Elgar.
Kuczynski, P. P., and J. Williamson. 2003. *After the Washington Consensus: Restarting Growth and Reform in Latin America*. Washington: Institute for International Economics.
Lardy, N. R. 2002. *Integrating China into the Global Economy*. Washington: The Brookings Institution.
Lin, J. Y. 2012. *Demystifying the Chinese Economy*. Cambridge: Cambridge University Press.
Liu, H., K. R. Polenske, and J. J. M. Guilhoto. 2010. "China and Brazil Productive Structure and Economic Growth Compared: 1980s to 2000s." Paper presented at the 57th Annual North American Meetings of the Regional Science Association International, November Denver.
Lo, D., and Y. Zhang. 2011. "Making Sense of China's Economic Transformation." *The Review of Radical Political Economics* 43 (1): 33–55. doi:10.1177/0486613410383952.
Magacho, G. R., and J. S. L. McCombie. 2017. "Verdoorn's Law and Productivity Dynamics: An Empirical Investigation into the Demand and Supply Approaches." *Journal of Post Keynesian Economics* 40 (4): 600–621. doi:10.1080/01603477.2017.1299580.
Magacho, G. R., and J. S. L. McCombie. 2018. "A Sectoral Explanation of per Capita Income Convergence and Divergence: Estimating Verdoorn's Law for Countries at Different Stages of Development." *Cambridge Journal of Economics* 42 (4): 917–934. doi:10.1093/cje/bex064.
McCombie, J. S. L., and M. Roberts. 2002. "The Role of the Balance of Payments in Economic Growth." In *The Economics of Demand-Led Growth: Challenging the Supply-Side Vision of the Long Run*, edited by M. Setterfield, 87–114. Cheltenham: Edward Elgar.
Miller, R. E., and P. D. Blair. 2009. *Input-Output Analysis: Foundations and Extensions*. 2nd ed. Cambridge: Cambridge University Press.
Molero-Simarro, R. 2015. "Functional Distribution of Income, Aggregate Demand, and Economic Growth in the Chinese Economy, 1978-2007." *International Review of Applied Economics* 29 (4): 435–454. doi:10.1080/02692171.2015.1016404.

Naughton, B. 2007. *The Chinese Economy: Transitions and Growth*. Cambridge and London: The MIT Press.
Nurkse, R. 1953. *Problems of Capital Formation in Underdeveloped Countries*. Oxford and New York: Oxford University Press.
OECD. 2011. *Technology Intensity Definition – Classification of Manufacturing Industries into Categories Based on R&D Intensities*. July. Paris: OECD Directorate for Science, Technology and Industry.
Pacheco-López, P., and A. P. Thirlwall. 2014. "A New Interpretation of Kaldor's First Growth Law for Open Developing Economies." *Review of Keynesian Economics* 2 (3): 384–398. doi:10.4337/roke.2014.03.07.
Prebisch, R. 1950. *The Economic Development of Latin America and Its Principal Problems*. Lake Success: United Nations.
Rasmussen, P. 1956. *Studies in Intersectoral Relations*. Amsterdam: North Holland.
Romero, J. P. 2019. "A Kaldor-Schumpeter Model of Cumulative Growth." *Cambridge Journal of Economics* 43 (6): 1597–1621. doi:10.1093/cje/bez003.
Romero, J. P., and G. Britto. 2017. "Increasing Returns to Scale, Technological Catch-Up and Research Intensity: Endogenising the Verdoorn Coefficient." *Cambridge Journal of Economics* 41 (2): 391–412. doi:10.1093/cje/bew030.
Romero, J. P., and J. S. L. McCombie. 2016. "The Multi-Sectoral Thirlwall's Law: Evidence from 14 Developed European Countries Using Product-Level Data." *International Review of Applied Economics* 30 (3): 301–325. doi:10.1080/02692171.2015.1102207.
Rosenstein-Rodan, P. N. 1943. "Problems of Industrialisation of Eastern and South-Eastern Europe." *The Economic Journal* 53 (210/211): 202–211. doi:10.2307/2226317.
Sanchez-Ancochea, D. 2007. "Anglo-Saxon versus Latin American Structuralism in Development Economics." In *Ideas, Policies and Economic Development in the Americas*, edited by E. P. Caldentey and M. Vernengo, 208–226. London: Routledge.
Sonis, M., and G. J. D. Hewings. 1989. "Error and Sensitivity Input-Output Analysis: A New Approach." In *Frontiers of Input-Output Analysis*, edited by R. E. Miller, K. R. Polenske, and A. Z. Rose, 232–244. New York: Oxford University Press.
Sonis, M., and G. J. D. Hewings. 1991. "Fields of Influence and Extended Input-Output Analysis: A Theoretical Account." In *Regional Input-Output Modelling: New Developments and Interpretations*, edited by J. H. L. Dewhurst, R. C. Jensen, and G. J. D. Hewings, 141–158. Avebury: Aldershot.
Thirlwall, A. P. 1979. "The Balance of Payments Constraint as an Explanation of International Growth Rate Differences." *Banca Nazionale del Lavoro Quarterly Review* 128: 45–53.
Thirlwall, A. P. 1983. "A Plain Man's Guide to Kaldor's Growth Laws." *Journal of Post Keynesian Economics* 5 (3): 345–358. doi:10.1080/01603477.1983.11489375.
Thirlwall, A. P. 2002. *The Nature of Economic Growth: An Alternative Framework for Understanding the Performance of Nations*. Cheltenham: Edward Elgar.
Timmer, M., edited by. 2012. *The World Input-Output Database (WIOD): Contents, Sources and methods*, *Version 0.9*. Groningen: University of Groningen.
Williamson, J. 1990. "What Washington Means by Policy Reform." In *Latin American Adjustment: How Much Has Happened?*, edited by J. Williamson, 7–20. Washington: Institute for International Economics.
World Bank. 1996. *World Development Report 1996: From Plan to Market*. New York: Oxford University Press.
Wu, J. 2005. *Understanding and Interpreting Chinese Economic Reform*. Mason: Thomson South-Western.
Yunling, Z. 2010. "China's Economic Rise and Its Impact." In *The Rise of China and Structural Changes in Korea and Asia*, edited by T. Ito and C. H. Hahn, 43–64. Cheltenham and Northampton: Edward Elgar.
Zhu, A., and D. Kotz. 2011. "The Dependence of China's Economic Growth on Exports and Investments." *The Review of Radical Political Economics* 43 (1): 9–32. doi:10.1177/0486613410383951.

Appendix

Appendix 1. Map of sectoral aggregation for China

1. Agricultural Commodities:
1. Agriculture, Hunting, Forestry and Fishing

2. Mineral Commodities:
2. Mining and Quarrying

3. Food and Beverages:
3. Food, Beverages and Tobacco

4. Textiles and Footwear:
4. Textiles and Textile Products
5. Leather, Leather and Footwear

5. Refined Oil and Fuels:
8. Coke, Refined Petroleum and Nuclear Fuel

6. Chemicals and Plastics:
9. Chemicals and Chemical Products
10. Rubber and Plastics

7. Metals and Non-Metallic Minerals:
11. Other Non-Metallic Mineral
12. Basic Metals and Fabricated Metal

8. Machinery:
13. Machinery, Nec

9. Electrical Equipment:
14. Electrical and Optical Equipment

10. Transport Equipment:
15. Transport Equipment

11. Other Manufacturing Activities:
6. Wood and Products of Wood and Cork
7. Pulp, Paper, Paper, Printing and Publishing
16. Manufacturing, Nec; Recycling

12. Utilities:
17. Electricity, Gas and Water Supply

13. Construction:
18. Construction

14. Trade:
19. Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel
20. Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles
21. Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods

15. Transport and Food Services:
22. Hotels and Restaurants
23. Inland Transport
24. Water Transport
25. Air Transport
26. Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
27. Post and Telecommunications

16. Financial Services and Real Estate:
28. Financial Intermediation
29. Real Estate Activities
30. Renting of M&Eq and Other Business Activities

17. Public Administration, Education and Health:
31. Public Admin and Defence; Compulsory Social Security
32. Education
33. Health and Social Work
34. Other Community, Social and Personal Services
35. Private Households with Employed Persons

Source: Author's classification transforming original 35-sectors matrix into 17-sectors aggregated matrix.