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Export-driven Growth Pattern Rediscovery: the Decomposition of China's Imports for 1997-2005

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Abstract

China's import grows very fast, and its total vertical specialization (VS) share increases almost 90 percent in the period of 1997 and 2005, which in fact reflects the truth that import content embodied in export goes up and indicates export-driven pattern in import growth. Therefore, in order to China's import growth sources over this period, structural decomposition analysis (SDA) is applied. We decompose imports as follows: the effects of coefficients changes (four components) and the effects of macro-economic factors changes (two components). It is found that, not surprisingly -- since import growth being analyzed in nominal terms -- macro-economic factors are the most important components. Meanwhile, for coefficients changes, import pattern changes account for over one-fifth, which indicates substantial changes occur in the mode of import from sector to sector in the concerning period; and the other three components that relate to coefficient changes are relatively small, however, still, technology changes being over eight percent, while significantly and widely different between sectors, which shows that there are clear potentials for both technology promoting and for effective sector policies. In addition, meta-analysis is performed on a set of SDA studies to compare our results with other peer investigations. The research enriches empirical analysis of SDA, and likely serves as policy recommendations for China's foreign trade policy.

Keywords: import growth, vertical specialization share, structural decomposition analysis, macro-economic factor, trade pattern, technology coefficient, meta-analysis.

1. Introduction

China's import has seen rapid growth since 1997, yet the sources have been largely neglected or misinterpreted. While structural decomposition analysis (SDA) has been widely used to study economic changes over time within an input-output (IO) framework, such as value added, income changes (Oosterhaven and van der Linden 1997) by mapping the changes in some comparative static changes in key sets of variables. Since all the periods we need in SDA are only the starting year/period and the end year/period, which makes this tool extremely useful especially for studying changes as well as interpreting economic meanings (Rose and Casler 1996)[1]. Just as discussed already, the SDA has been applied in many fields, so will be in China's import growth investigation. For recent literature, there are value added and income changes for an inter-country perspective (Oosterhaven and van der Linden 1997; Oosterhaven and Hoen 1998), sensitivity analysis (Dietzenbacher and Los 1998) that gives scientific proof of using arithmatic mean of two polar decompositons to get sound result (while *De Boer* (De Boer 2008) provides another alternative method, namely Montgomery approach), components should be independent in order not to yield bias-estimation (Dietzenbacher and Los 2000), disaggregation of trade goods as three parts, namely intermediate, consumption, and capital to study the structural change (Los and Oosterhaven 2006), as well as consumption growth (Dietzenbacher, de Groot et al. 2007), labor productivity (Oosterhaven and Broersma 2007), and environment and energy related (Diakoulaki and Mandaraka 2007; Kagawa, Kudoh et al. 2008; Wing 2008). These studies not only serve solid economic foundation for contemporary work, but also inspire new theoretical as well as empirical applications, with which this paper comes into being.

In the same time, the processing trade[2] in China dominates (take processing export for example, it accounts for 51% of total export in 2007) its trade pattern, as mentioned in the definition of processing trade, the imports are imported to export, in other words, import-growth in China seems to be export-driven, which is also applicable to East-Asia countries that are on similar situation of being manufacturing bases (Coxhead 2007). In turn, the vertical specialization (VS) measurement (Hummels, Ishii et al. 2001), which points out the growing tendency of vertical specialization share in world trade, apart from this, similar method like import dependence of foreign trade (Yang and Pei 2007), which also highlights the significant content of import comprised in China's export, are proposed to detect contemporary relationship between import and export. As a matter of fact, China's total VS share grows nearly 90 percent in this period[3], which serves as quantitative proof of China's export-driven import-growth. Given all that, the SDA

[1] They present a detailed review.
[2] Processing trade refers to the business activities of importing, for the purpose of exporting, all or parts of raw and auxiliary materials, parts and components, accessories, and packaging materials from abroad duty-free, and re-exporting the finished products after processing or assembling by enterprises within Mainland China. Imported goods under the item of processing trade (usually called processing import) can only be used to produce exported goods in which case known as processing exports, but not allowed for other purposes, otherwise would be considered to violate the regulations. In addition, processing exports can be divided into two categories: Processing and Assembling (P & A) exports and Processing with Imported Materials (PIM) exports, all relate to import.
[3] Detailed discussion will be given in section 3.

method is applied to investigate China's import growth aiming at revealing how its determinants, besides export, work. Meanwhile, the export (so do the imports) does not grow evenly across China's regions (Rodrik 2006; Schott 2006) indicating the room for interregional study, which is beyond the scope of this paper; to be frank to China's statistics, although still some problems exist, re-export via Hong Kong (Feenstra, Hai et al. 1999; Feenstra and Hanson 2004; Fung, Lau et al. 2006) in the export is not taken into account.

In addition, as a transition economy, China may experience tremendous technology progress, which will be seen in the changes of its technology coefficient. This change could be introduced by export orders via importing intermediate goods which lead to technology spillovers. On the other hand, the consumption preferences may change from time to time which indicates the possibility of changing patterns in final demands that lead to import growth. Therefore, it is of importance to focus the study on disaggregating such effects in the beginning instead of using aggregated effects, as is done in most other cases; then, relating the import growth to those effects, which, in our case, extends the formula of *Oosterhaven and van der Linden 1997*, to study the forty-one sectors over the period of 1997 and 2005.

The next section presents the data and model description which we will use, including their constraints, the assumptions and our processing method. Section 3 applies measure of total VS share in China, and shows its decomposition results. Section 4, one step further, presents detailed formula procedure of import, from the standard to the specific one and at last the formula we will apply in this paper. Section 5 shows the empirical results at both aggregated and detailed levels, where meta-analysis is performed, and the last section concludes and discusses as regards the implication to China and potential implications to countries to be like China.

2. Data processing and model description

2.1. The dataset

Since China's IO tables, released by National Bureau of Statistics of China, change over time, we have to make some adjustments to make them comparable. Based on the 2005 IO table[4], the 1997 IO table is aggregated from 124 sectors to 41 sectors[5], among which sector 22 (Scrap and waste) being merged into sector 21 (Other manufacturing products), concerning the economic meaning. Detailed descriptions of the sectors are presented in Appendix A1.

The unit in each table is nominal term, i.e. current price, namely ten thousand RMB (Chinese currency: *Renminbi*). The reasons why we do not adjust the table to constant price are twofold: firstly, the adjustment exists the problem of arbitrary which may even weaken our analysis; secondly, four out of six of our elements involving the

[4] We owe appreciation to National Bureau of Statistics of China for providing unpublished 2005 IO table.
[5] We would like to thank MSc Chunlin Yu for providing unpublished work dealing with comparisons between 1997 IO table and 2002 IO table (2005 IO table is extension of 2002's), based on which we get compatible tables of 1997 and 2005.

measurement are coefficients which may not be influenced regardless either current price or constant price would be adopted.

There are six sectors with no imports at all both in 1997 and 2005, which are sectors 24, 29, 32, 35, 36, and 38. As can be seen from description in Appendix A1, those sectors are belonging to tertiary industry. And since no useful information would be added or lost by keeping or removing them from the analytical tables, as shown afterwards, thus these sectors will be omitted in our analysis. In addition, there is error item in the IO table which is economic nonsense, so for economic interpretation consideration we just remove it from our empirical results directly while keep other effects as they are. Consequently, the summation of all effects presented in the paper is not equal to 100 percent.

2.2. IO Table layout

Z	*F*	*e*	*-m*	*x*
v	*0*	*0*	*0*	
x	*f*	*s'e*	*-s'm*	

Figure 1. China's input-output table: *Z*, matrix of aggregated, i.e. domestic and imported flow of input from *i* to *j*; *F*, matrix of aggregated, i.e. domestic and imported final demands (including: consumption - rural household, urban household, and government; gross capital formation - fixed capital formation, changes in inventory); *e*, column vector of exports; *m*, column vector of import; *v*, row vector of value-added (depreciation, compensation of labors, net taxes on production, operating surplus); *f*, row vector of macro-economic factors – domestic final demands; *s'*, transposed *s*, denotes the row summation vector (*1*, …, *1*) of appropraite length.

As is shown in Figure 1 that there is only one column of import in the table, which constraints our further disaggregating. The table constitutes of, partly, intermediate demands and final demands that contain both domestic and imported. By adopting the proportional method, we assume that both intermediate and final demands share the same imported input structure, which is a column of ratios of import to sum of total intermediate demands and total final demands (including subtotal of consumption and subtotal of capital formation), per sector. Then, the import share matrix can be obtained by making the diagonalization of the import-ratio column, with import-ratios on-diagonal and zeros off-diagonal.

2.3. IO equations

Apparently, the following equations hold in the row-wise from Figure 1:

$$Z = A\hat{x} \tag{1}$$

$$m = t^m (Ax + sF) \tag{2}$$

Here, *A* is an *n***n* matrix of technology coefficients (a_{ij}), and it is the need for products *i* per unit of output of sector *j*; t^m is a column of trade coefficients ($t^m_{i.}$), which, with diagonal coefficients equal to ratios of import to sum of total intermediate demands and total final demands (including subtotal of consumption and subtotal of capital formation), per sector, and off-diagonal zeros.

3. Vertical specialization (share): indexes and decompositions

Vertical specialization (VS) is defined narrowly and strictly by Hummels (Hummels, Ishii et al. 2001), according to whom it involves 'those imported goods that are used as inputs to produce a country's export goods', so it will provide insight to China's import growth in the point of view of 'imports content embodied in export'.

3.1. Two indexes

Two indexes are proposed based on the VS definition within the IO framework: namely VS value and VS share in their paper. VS value is the amount of imported intermediate inputs in producing exported products; while VS share is the ratio of imported intermediate inputs to total exports value, which is the weighted average of the direct import coefficients, using gross exports as weights. The following formulas concerning VS share (formulas of VS value are omitted for simplicity's sake) are cited from Hummels et al. paper and revised by us.

3.1.1. Direct VS share

As stated above, VSs (VS export share of total exports) is an gross-export-weighted average measurement. *VSs* can be expressed as formula (3) in matrix notation within IO framework:

$$VSs = s(\hat{t}^m A)b^{ex} = t^{m'} A b^{ex} \qquad (3)$$

Here, b^{ex} represents export composition or share structure; $t^{m'}$ is transposed t^m.

3.1.2. Total VS share

Total VS export share of total exports includes both direct and indirect VSs and is used as main measure of VS in Hummels *et al.* paper. In fact, Leontief inverse helps us obtain total VSs by conducting infinite geometric sum, which actually allows the product to 'circulate through all sectors of the economy, including the service sectors'.

$$TVSs = t^{m'} A\left[I - \left(I - \hat{t}^m\right)A\right]^{-1} b^{ex} \qquad (4)$$

3.2. Decompositions (polar)

Total VS share formula, i.e. equation (4) gives, on the one side,

$$\Delta TVSs =$$

$$t_{05}^{m'} A_{05}[I-(I-\hat{t}_{05}^m)A_{05}]^{-1} b_{05}^{ex} - t_{05}^{m'} A_{97}[I-(I-\hat{t}_{05}^m)A_{97}]^{-1} b_{05}^{ex} \qquad (C1)$$

$$+t_{05}^{m'} A_{97}[I-(I-\hat{t}_{05}^m)A_{97}]^{-1} b_{05}^{ex} - t_{97}^{m'} A_{97}[I-(I-\hat{t}_{97}^m)A_{97}]^{-1} b_{05}^{ex} \qquad (C2)$$

$$+t_{97}^{m'}A_{97}[I-(I-\hat{t}_{97}^{m})A_{97}]^{-1}b_{05}^{ex}$$
$$-t_{97}^{m'}A_{97}[I-(I-\hat{t}_{97}^{m})A_{97}]^{-1}b_{97}^{ex} \qquad \text{(C3)}$$

Their counterparts are given by the following formulas on the other side:

$\Delta TVSs =$

$$t_{97}^{m'}A_{05}[I-(I-\hat{t}_{97}^{m})A_{05}]^{-1}b_{97}^{ex}$$
$$-t_{97}^{m'}A_{97}[I-(I-\hat{t}_{97}^{m})A_{97}]^{-1}b_{97}^{ex} \qquad \text{(D1)}$$

$$+t_{05}^{m'}A_{05}[I-(I-\hat{t}_{05}^{m})A_{05}]^{-1}b_{97}^{ex}$$
$$-t_{97}^{m'}A_{05}[I-(I-\hat{t}_{97}^{m})A_{05}]^{-1}b_{97}^{ex} \qquad \text{(D2)}$$

$$+t_{05}^{m'}A_{05}[I-(I-\hat{t}_{05}^{m})A_{05}]^{-1}b_{05}^{ex}$$
$$-t_{05}^{m'}A_{05}[I-(I-\hat{t}_{05}^{m})A_{05}]^{-1}b_{97}^{ex} \qquad \text{(D3)}$$

Now, the decompositions are as follows:

$\Delta TVSs =$

[(C1)+(D1)]/2 reflecting the ΔA -effect
+ [(C2)+(D2)]/2 reflecting the Δt^m -effect
+ [(C3)+(D3)]/2 reflecting the Δb^{ex} -effect

3.3. Decompositions results

	VSs (97)	VSs (05)	Percentage Growth	ΔA	Δt^m	Δb^{ex}
Values; %	0.1481	0.2779	87.64	**28.35**	**44.88**	**26.77**

Table 1. China's total VS share change

The trade pattern change accounts for the most, which shows big changes from sector to sector and there must be some sector policy change in those years. As mentioned above, being a transition economy, China indeed makes a lot technology progress. And export share structure change represents varying preference to some extent.

Astonishingly, China's total VS export share of gross exports grows 88 percent within one decade, in contrast to 28 percent over twenty years from 1970 to 1990 for the 14-country sample in Hummels et al. paper, which in fact reflects the truth that import content in export goes up quickly and dramatically. There is twofold meaning for this change: firstly, even if the total exports were not change at all, other things being equal, the import were supposed to increase approximately 90 percent to satisfy the need for export; secondly, import growth is driven by export to large extent.

Precisely, the substantial increase in total VS share indicates the increasingly important role the export played in import growth. Moreover, export growth, among others, is one of the major reasons that import increases as stated above. Therefore, in turn, instead of studying export growth in China, we decompose import in very detailed way.

4. Import growth decompositions

4.1. Formula Procedure:

In China's specific case, the following equation, derived from equations (1) and (2) and extended from the formula of ***Oosterhaven and van der Linden 1997***, is applied to investigate sources of import growth:

$$m = (\hat{t}^m A)[I-(I-\hat{t}^m)A]^{-1}[(I-\hat{t}^m)B^f f' + B^{ex+}e^{+}'] + \hat{t}^m B^f f' \qquad (5)$$

Here, B^f is an $n*q$ matrix of 'bridge' coefficients (b^f_{iq}), indicates which fraction of this final demand for product *i* that is exercised by sector *q*, in fact, it reflects final demand composition or preference structure; B^{ex+} is an $n*2$ matrix, represents export (error item is included) composition or share structure; e^+ is an $1*2$ row vector which also an macro-economic factor of total export (as well as the error item).

In addition, given the fact that imported trade coefficients (t^m) and domestic ones (supposed to be t^d or something else) are completely dependent, only one can be entered in the formula to avoid bias-estimation (Dietzenbacher and Los 2000) and the former one is selected in our case.

Indeed, both B^f and f contain five different items, respectively, which are rural houshold consumption, urban houshold consumption, government consumption, fixed capital formation and changes in inventory; analogy with B^f and f, B^{ex+} and e^+ contain separate items respectively, i.e. exports and error item. For the sake of simplicity, only the aggregated form is shown in the equation, and to simplify things those aggregated items will be treated as appropriate forms in the formulas in the following sub-sections.

4.2. SDA Procedure:

By adopting the so-called polar SDA method and by using the arithmetic mean of the two polar decomposition equations (Dietzenbacher and Los 1998), we can get quite sound estimation, which actually eliminate the priority given to either Laspeyres or Paasche indexes (Skolka 1989).

Recall the equation (5), i.e. $m = (\hat{t}^m A)[I-(I-\hat{t}^m)A]^{-1}[(I-\hat{t}^m)B^f f' + B^{ex+}e^{+}'] + \hat{t}^m B^f f'$,

this gives:

$$\Delta m =$$

$$(\hat{t}^m_{05} A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05} f_{05}' + B^{ex+}_{05}e^{+}_{05}'] \\ -(\hat{t}^m_{05} A_{97})[I-(I-\hat{t}^m_{05})A_{97}]^{-1}[(I-\hat{t}^m_{05})B^f_{05} f_{05}' + B^{ex+}_{05}e^{+}_{05}'] \qquad (E1)$$

$$+(\hat{t}^m_{05}A_{97})[I-(I-\hat{t}^m_{05})A_{97}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}f_{05}'+B^{ex+}_{05}e^+_{05}']+\hat{t}^m_{05}B^f_{05}f_{05}'$$
$$-(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{05}f_{05}'+B^{ex+}_{05}e^+_{05}']-\hat{t}^m_{97}B^f_{05}f_{05}' \quad \text{(E2)}$$

$$+(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{05}\hat{f}_{05}+B^{ex+}_{05}\hat{e}^+_{05}]+\hat{t}^m_{97}B^f_{05}\hat{f}_{05}$$
$$-(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}\hat{f}_{05}+B^{ex+}_{05}\hat{e}^+_{05}]-\hat{t}^m_{97}B^f_{97}\hat{f}_{05} \quad \text{(E3)}$$

$$+(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}\hat{f}_{05}+B^{ex+}_{05}\hat{e}^+_{05}]+\hat{t}^m_{97}B^f_{97}\hat{f}_{05}$$
$$-(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}\hat{f}_{97}+B^{ex+}_{05}\hat{e}^+_{05}]-\hat{t}^m_{97}B^f_{97}\hat{f}_{97} \quad \text{(E4)}$$

$$+(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}\hat{f}_{97}+B^{ex+}_{05}\hat{e}^+_{05}]$$
$$-(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}\hat{f}_{97}+B^{ex+}_{97}\hat{e}^+_{05}] \quad \text{(E5)}$$

$$+(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}\hat{f}_{97}+B^{ex+}_{97}\hat{e}^+_{05}]$$
$$-(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}\hat{f}_{97}+B^{ex+}_{97}\hat{e}^+_{97}] \quad \text{(E6)}$$

Their counterparts are given by:
$\Delta m =$

$$(\hat{t}^m_{97}A_{05})[I-(I-\hat{t}^m_{97})A_{05}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}f_{97}'+B^{ex+}_{97}e^+_{97}']$$
$$-(\hat{t}^m_{97}A_{97})[I-(I-\hat{t}^m_{97})A_{97}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}f_{97}'+B^{ex+}_{97}e^+_{97}'] \quad \text{(F1)}$$

$$+(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{97}f_{97}'+B^{ex+}_{97}e^+_{97}']+\hat{t}^m_{05}B^f_{97}f_{97}'$$
$$-(\hat{t}^m_{97}A_{05})[I-(I-\hat{t}^m_{97})A_{05}]^{-1}[(I-\hat{t}^m_{97})B^f_{97}f_{97}'+B^{ex+}_{97}e^+_{97}']-\hat{t}^m_{97}B^f_{97}f_{97}' \quad \text{(F2)}$$

$$+(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}\hat{f}_{97}+B^{ex+}_{97}\hat{e}^+_{97}]+\hat{t}^m_{05}B^f_{05}\hat{f}_{97}$$
$$-(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{97}\hat{f}_{97}+B^{ex+}_{97}\hat{e}^+_{97}]-\hat{t}^m_{05}B^f_{97}\hat{f}_{97} \quad \text{(F3)}$$

$$+(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}\hat{f}_{05}+B^{ex+}_{97}\hat{e}^+_{97}]+\hat{t}^m_{05}B^f_{05}\hat{f}_{05}$$
$$-(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}\hat{f}_{97}+B^{ex+}_{97}\hat{e}^+_{97}]-\hat{t}^m_{05}B^f_{05}\hat{f}_{97} \quad \text{(F4)}$$

$$+(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}\hat{f}_{05}+B^{ex+}_{05}\hat{e}^+_{97}]$$
$$-(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}\hat{f}_{05}+B^{ex+}_{97}\hat{e}^+_{97}] \quad \text{(F5)}$$

$$+(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}\hat{f}_{05}+B^{ex+}_{05}\hat{e}^+_{05}]$$
$$-(\hat{t}^m_{05}A_{05})[I-(I-\hat{t}^m_{05})A_{05}]^{-1}[(I-\hat{t}^m_{05})B^f_{05}\hat{f}_{05}+B^{ex+}_{05}\hat{e}^+_{97}] \quad \text{(F6)}$$

Now, the decompositions are as follows:

$\Delta m =$

[(E1)+(F1)]/2	reflecting the ΔA -effect
+ [(E2)+(F2)]/2	reflecting the Δt^m -effect
+ [(E3)+(F3)]/2	reflecting the ΔB^f -effect
+ [(E4)+(F4)]/2	reflecting the Δf -effect
+ [(E5)+(F5)]/2	reflecting the ΔB^{ex+} -effect
+ [(E6)+(F6)]/2	reflecting the Δe^{+} -effect

As stated above, the effects of ΔB^f and Δf contain five different items, respectively; while the effects of ΔB^{ex+} and Δe^{+} contain two separate items, respectively. To simplify things those items are shown in aggregated forms in the formulas. By using the averages of the two polar-SDA formula, we are likely to get the closest estimation of sources of China's import-growth. In the next section, the empirical results will be given according to these formulas.

5. Empirical decomposition results

The above sectors serve databases and formula, based on which we estimate the effects of coefficient changes and macro-economic factors changes in determining the import-growth. Since constant prices for China's IO Tables are not available, the prices used in the research are nominal terms. Table 2 gives most aggregated level overview results; and Table 3 compares results by performing the meta-analysis; then, Table 4 and Table 5 show the results in detailed levels, both sectors and changes.

5.1. Selected empirical decomposition results and meta-analysis:

Table 2 presents the results in most aggregated level over the period of 1997 and 2005.

Aggregated estimation 10,000 RMB (%)

	m(97)	m(05)	Percentage Growth	□A	□t^m	□B	□F	□e
Agg.	1.28e+08	6.1e+08	377.46	**8.13**	**20.15**	**5.47**	**42.97**	**22.98**
w-abs dev				**11.73**	**17.15**	**12.74**	**18.76**	**12.07**
stand dev				**19.83**	**69.66**	**21.85**	**48.07**	**22.60**
a-abs dev				**14.88**	**40.38**	**16.76**	**35.13**	**16.99**

Table 2. Results in most aggregated level (average of the two polar-SDA)

Note: 1. Percentage growth is calculated by using equation: 100%*[m(05) - m(97)]/ m(97); 2. △B is a further aggregated effect of 'bridge' effects of final demands ΔB^f, and of export Δb^{ex} (error item is excluded from ΔB^{ex+}); △e is the pure macro-economic effect of export, which also excludes the error item; thus the summation of these presented effects is not equal to 100%; 3. Agg. is the abbreviation form of aggregated of the whole economy or all the 41 sectors; and *w-abs dev* stands for import-weighted absolute deviation, which is weighted by imports summation [m (97) + m (05)] share structure; *stand dev* indicates standard deviation; and *a-abs dev* indicates average absolute deviation; 4. Sectors are described in Appendix A1.

At first sight, it is seen from Table 2 that the exogenous variables account for about 65 percent, in other words, coefficients contribute one-third to import growth. Obviously, trade pattern, analogous to VS share, plays important role in import growth with 20 percent contribution. Along with the statement previously, China has made great progress in terms of technology change, precisely, import growth dues 8 percent to technology change. Meanwhile, import summation share-structure-weighted absolute deviation and standard deviation as well as average absolute deviation are given in Table 2. In order to have a thorough understanding of the meaning of our findings, meta-analysis is conducted below.

Meta-analysis is one of the most commonly used method in empirical analysis (Stanley 2001), such as the recent application to export growth hypothesis test (Mookerjee 2006). As the case stands, to conduct the meta-analysis, SDA results are grouped roughly into two categories, namely changes in coefficient and in exogenous variables, respectively. In fact, the combination of meta-analysis and SDA method is likely to serve better interpretations for our findings.

The papers listed in Table 3 are taken from *Econ Lit* and *Economic Systems Research* after a search with keywords ‘structural decomposition analysis’. Some papers in the original sample are discarded either because there is no empirical analysis or unavailable.

Dependent variable	Coefficients	Exogenous	Studies (date sequencing)
Value added	-3.4	103.4	*Los & Oosterhaven (2006)*
Output	17.2	82.8	*Andreosso-O'Callaghan & Yue (2002)*
Output	3.5	96.5	*Roy, S., T. Das, et al. (2002)*
Imports (Mixed)	-3.2	103.2	*Dietzenbacher & Los (2000)*
Imports (Competitive)	0.0	100.0	*Dietzenbacher & Los (2000)*
Imports (Non-Competitive)	-13.3	113.3	*Dietzenbacher & Los (2000)*
Output	28.4	71.6	*Liu & Saal (2001)*
Output	8.0	92.0	*Albala-Bertrand (1999)*
Output	29.3	70.7	*Liu (1998)*
Value added	-2.2	102.2	*Oosterhaven & Hoen (1998)*
Value added	-2.3	102.3	*Oosterhaven & van der Linden (1997)*
Output	26.4	73.6	*Skolka (1989)*
Employment	33.8	66.2	*Skolka (1989)*
Average	**9.4**	**90.6**	
Standard deviation	15.0	15.0	

Table 3. Meta-analysis of SDA results (percentage-point)

It can be seen from Table 3 the predominant role that exogenous variables played in explaining changes in dependent variables. From this point, one may expect the conclusion that changes cause by exogenous factors, whereas technology change hardly influence the dependent variable. However, it is not the case for China. As illustrated above, technology coefficients account for 17 percent and 19 percent of China's output growth from 1987-97 (Andreosso-O'Callaghan and Yue 2002) and 1987-92 (Liu 1998), respectively. Although two exceptions which are similar to China, South Africa from 1975-93 (Liu and Saal 2001) and Austria from 1964-76 (Skolka 1989), the latter of which is not very comparable since its time period far earlier. It suggests detailed results and specific analysis need to be performed, as is given next.

5.2. Detailed coefficients changes:

Table 4 gives detailed empirical decompositions results for coefficients changes for 41 sectors over the period of 1997-2005.

Code	△A	△t^m	△B^f					△b^{ex}
			△b^{fr}	△b^{fu}	△b^{fg}	△b^{fc}	△b^{fi}	
1	2.94	61.35	-7.09	-10.96	-0.04	-1.65	3.01	-2.89
2	22.13	42.95	0.19	1.14	0.06	-0.94	-16.13	-0.10
3	30.41	-76.81	1.58	2.80	-0.16	-3.86	10.87	2.01
4	1.91	39.93	0.01	0.10	0.15	-0.15	13.74	1.35
5	-18.88	78.73	-0.19	-0.60	0.06	-5.00	-7.61	0.07
6	9.95	6.95	-7.40	-28.44	-0.17	-0.51	27.25	-4.17
7	-69.96	26.08	-5.28	-11.37	-1.83	-1.57	-17.57	-38.19
8	0.57	-20.31	-7.38	-32.14	-0.49	-0.64	20.97	-10.58
9	11.37	-7.74	-2.32	-11.70	-1.64	-11.29	-20.22	4.23
10	-9.67	-19.24	0.44	-0.61	-0.74	-1.70	-0.42	-2.68
11	20.85	28.64	0.63	1.00	0.01	-0.99	4.27	0.45
12	11.16	16.56	-0.22	-0.92	0.55	-1.10	-7.19	-0.54
13	-33.52	46.22	-0.12	-2.61	-0.11	-16.08	-2.37	2.89
14	21.79	-5.48	0.09	0.44	0.18	-0.97	-3.68	4.11
15	-19.59	36.16	-0.68	-0.82	0.18	3.72	-38.15	4.09
16	-9.93	3.91	0.29	0.66	0.18	11.25	-7.64	1.79
17	6.64	5.56	1.36	0.70	-0.06	-6.97	18.96	1.26
18	1.06	37.61	-0.18	1.20	0.34	1.59	-2.76	3.21
19	13.20	11.98	0.01	0.92	0.73	5.34	2.25	10.44
20	13.82	28.66	0.33	1.06	0.18	7.69	4.56	1.43
21	-45.02	92.72	-0.83	1.17	-0.06	0.24	-0.88	0.33
22	24.26	42.07	0.15	0.52	0.05	-0.46	-1.25	-0.04
23	-23.49	271.38	-0.99	-50.85	0.63	0.43	0.86	-1.01
25	-2.57	12.39	0.32	0.77	-0.09	-27.39	-0.03	0.03
26	17.76	39.86	0.99	2.36	0.88	0.94	0.07	-0.04
27	25.72	-28.80	24.72	-5.40	-0.76	0.09	-0.39	-1.05
28	19.02	21.81	1.55	8.67	-0.08	2.26	-0.70	0.21
30	11.35	29.35	1.39	9.28	-0.04	-0.07	-0.45	-0.37
31	2.29	52.30	1.43	4.06	0.09	0.13	-0.34	0.15
33	29.13	14.74	0.53	5.86	0.66	-0.87	0.10	0.11
34	-16.32	229.10	6.33	101.93	-124.60	-29.89	0.02	23.01
37	5.03	64.74	3.84	2.60	-5.93	-0.09	-0.37	0.03
39	-11.41	275.39	-18.79	-32.44	-19.80	-0.02	0.17	-0.05
40	15.08	33.33	1.64	-2.75	1.27	-0.13	-0.26	-0.48

41	0.00	-10.87	0.00	0.00	-12.11	0.00	0.00	0.00
Agg.	**8.13**	**20.15**	**-0.11**	**-0.26**	**0.58**	**2.37**	**0.30**	**2.60**
w-abs dev	**11.73**	**17.15**	**1.04**	**3.15**	**0.76**	**4.21**	**6.63**	**4.71**
stand dev	**19.83**	**69.66**	**5.48**	**20.06**	**19.42**	**7.35**	**10.50**	**7.53**
a-abs dev	**14.88**	**40.38**	**2.46**	**8.35**	**4.61**	**5.19**	**5.88**	**4.27**

Table 4. Detailed results for coefficients changes for 41 sectors (average of the two polar-SDA)

Note (cont.): 5. The meaning of each item that share the same form is the same as in equation (3), and as explained in DATA section, several sectors are omitted in our tables ; 6. b^{fr} indicates the 'bridge' effects of rural household consumption, analogously, b^{fu}, b^{fg}, b^{fc}, b^{fi} and b^{ex}, stand for the 'bridge' effects of urban household consumption, government consumption, capital formation and changes in inventory, and export, respectively.

It is clear that the effect of trade pattern change is significant among these nine items, with the aggregated percentage of over twenty as mentioned above. Effects among sectors, however, change from one to another. For example, the largest percentage change is 275 in sector 39 (Health service, social guarantee and social welfare), whereas the least is MINUS seventy-seven percent in sector 3 (Crude petroleum and natural gas products). As stated above, the effect of technology change accounts for more than eight percent of aggregated effect and varies much from sector to sector. For instance, the biggest effect occures in sector 3 of thirty percent, and the smallest in sector 7 (Textile goods) of MINUS seventy percent. As for 'bridge' effects, the aggregated are relatively small, and two of them are negative, which are rural household consumption and urban household consumption. Similar to technology effect and trade pattern effect, these seven 'bridge' effects also vary much from sector to sector. Take 'bridge' effect of capital formation for example, the biggest percentage among sectors appears in sector 16 (Common and special equipment) of eleven, and the smallest one in sector 34 (Tourism) of MINUS thirty.

Since China's import is more like to be export-driven pattern, as discussed previously, it is necessary to analyze effects relate to export. The aggregated 'bridge' effect of export is approximately three percent, with big differences among sectors. The largest percentage is found in sector 34 with twenty-three, and the least in sector 7 with MINUS thirty-eight. And there are one-third sectors present negative effects, which signify structure or preference changes in those years despite the relatively small figures.

From sector to sector point of view, coefficients changes show different features. First, technology coefficient is found to shift (the most) from textile goods (sector 7, -70%) and other manufacturing products (sector 21, -45%) to sector 3 and sector 33 (+30% and +29%, respectively). Second, trade pattern change, not alike technology coefficient, shifts from sector 3 (-77%) and sector 27 (-29%) to sectors 39, 23, and 34 (+275%, +271%, and +229%, respectively). Thirdly, 'bridge' effects of rural houshold consumption and urban houshold consumption shift to the effect of capital formation, which indicates government's emphasizing on the formation of capital. Last but not least, 'bridge' effects of export presents the shift from sector 7 (-38%) to sector 34 (+23%), and so forth.

5.3. Detailed macro-economic factors changes:

Table 5 lists the empirical decomposition results of macro-economic factors changes in detailed level over the period of 1997-2005.

Code	△F					△e
	$\triangle f^r$	$\triangle f^u$	$\triangle f^g$	$\triangle f^c$	$\triangle f^i$	
1	1.73	25.22	2.90	12.13	0.05	13.05
2	0.37	10.72	4.63	17.61	-0.14	17.48
3	0.78	20.31	10.62	44.24	0.06	47.91
4	0.14	3.85	1.74	19.33	0.12	17.42
5	0.20	5.30	2.31	32.99	-0.05	13.33
6	3.00	65.05	4.86	7.17	0.23	15.18
7	1.72	52.74	13.24	22.65	0.09	128.74
8	1.85	94.98	6.09	11.93	0.29	35.10
9	0.89	30.38	13.61	62.30	-0.08	33.57
10	1.00	31.29	23.25	30.13	0.06	47.70
11	0.32	8.20	4.16	17.05	0.05	15.33
12	0.77	18.13	7.70	20.22	-0.01	32.89
13	0.30	10.07	4.13	78.13	0.02	16.50
14	0.28	7.61	3.38	43.26	-0.03	29.73
15	0.52	14.44	6.40	63.40	-0.21	32.05
16	0.26	7.03	4.31	72.48	-0.03	15.66
17	0.54	10.37	4.59	42.19	0.15	14.51
18	0.36	11.70	2.73	26.01	-0.01	17.57
19	0.19	7.44	2.24	16.72	0.01	28.35
20	0.18	5.55	3.19	23.15	0.03	10.44
21	0.36	13.01	3.37	19.38	0.00	16.09
22	0.25	7.54	3.00	11.56	-0.01	12.02
23	-0.23	-62.69	-7.90	-12.58	-0.01	-12.31
25	0.05	1.36	2.16	111.73	0.00	1.18
26	0.34	9.53	3.92	12.95	0.01	10.47
27	2.71	31.95	25.47	10.04	0.01	14.59
28	0.25	14.65	5.30	17.95	0.00	9.45
30	0.55	21.57	10.61	7.86	0.00	8.64
31	0.49	16.71	3.53	9.39	0.00	10.09
33	0.35	12.48	5.08	16.33	0.01	15.87
34	-0.51	-67.88	-3.10	-0.47	0.00	-18.10
37	0.65	14.57	2.53	5.29	0.00	7.02
39	-0.27	-38.79	-51.68	-1.21	0.00	-1.03
40	0.56	17.27	20.22	6.40	0.00	7.46
41	0.00	0.00	122.98	0.00	0.00	0.00
Agg.	**0.44**	**12.35**	**4.47**	**25.69**	**0.02**	**22.98**
w-abs dev	**0.35**	**8.59**	**2.53**	**13.73**	**0.04**	**12.07**
stand dev	**0.72**	**26.48**	**21.34**	**25.20**	**0.08**	**22.60**
a-abs dev	**0.47**	**15.71**	**8.24**	**20.10**	**0.05**	**16.99**

Table 5. Detailed results for macro-economic factors changes for 41 sectors (average of the two polar-SDA)

Note (cont.): 7. *F* represents the macro-economic factor of final demands, and f^r shows the macro-economic effect of rural household consumption, analogously, f^u, f^g, f^c, f^i, stand for the macro-economic effects of urban household consumption, government consumption, capital formation and changes in inventory, respectively, while error item effects (both the coefficient and macro-economic factor) are excluded, thus the summation of all effects in both Table 2 and 3 are not equal to 100%.

As announced previously, the decomposition of China's import-growth is conducted in nominal terms, not surprisingly, macro-economic factors found to be the largest effects among others. Nevertheless, slight differences are found in these six macro-economic effects, for example, aggregated changes in inventory is small enough to be negligible, only zero point-zero-two, while over one-fourth for changes in capital formation. In addition, the effects vary little among sectors for changes in inventory. Similar situation exists for macro-economic changes in rural household consumption.

Apparently, capital formation has significant impact on the growth of import, with aggregated effect of more than one-fourth as mentioned in the previous paragragh. As can be seen in Table 5, only three out of forty-one sectors show negative effects, which are sector 23, sector 34 and sector 39 that being of small weight. The macro-economic effect of export ranks the second, accounts for twenty-three percent, and show similar feature as the macro-economic effect of capital formation. Last but not least, urban household consumption changes reach twelve percent and show big variations among sectors.

Analogous to the analysis in coefficients part, macro-economic factors are analyzed from respective sector perspective, which gives different picture compared with coefficients. On the one hand, macro-economic factors of consumption (including consumption by rural houshold, urban household, and government) and capital formation have been shifting away from sector 23, sector 34 and sector 39, not unlike the circumstance in export. On the other hand, the shifting is targeting totally different sectors. Take the capital formation and export for example, the former one shifts to sector 25 (+112%) and sector 13 (+78%); the latter shifts to sector 7 (+129%), sector 3 (+48%), and sector 10 (+48%) mostly.

6. Conclusion and discussion

Three sub-analysis are done in order to investigate sources of China's import growth: VS share and its decompositions, then import decompositions, and meta-analysis. In line with those results, the following conclusion holds. As presented above, total VS share of China increases around 90 percent from 1997 to 2005, suggesting export-driven pattern of import growth. While for import growth, not surprisingly, macro-economic demands in final demands and exports are found to be the most important components since import growth being analyzed in nominal terms. Whereas, according to meta-analysis, coefficients changes turn to be relatively important components for interpreting the import growth.

In turn, to be precise, import pattern changes account for over one fifth, which indicates substantial changes occur in the mode of import from sector to sector over the period of 1997 and 2005. In addition, the other three components that relates to coefficient changes are relatively small, however, still, technology changes being over eight percent, while significantly and widely different between sectors, which shows that there are clear potentials for both technology promoting and for effective sector policies.

In the same time, concerning China's 'dual-track' economy (Lau, Qian et al. 2000) reality, the central government planning still plays important role in China's policy-making either internal or external. Obviously, this existing fact in China will serve possibilities for macro-economic policy setting, which is different from EC countries (Oosterhaven and van der Linden 1997) in this case.

For further studies, since macro-economic demand in export seems to be of importance, more accurate result might be obtained upon taking re-export effect via Hong Kong into account; in the same time, interregional research would sharpen the result by taking into account the diversity among regions.

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Appendix:

A1. China's 1997/2005 IO Table sectors description

IO Code	Description	IO Code	Description
1	Agriculture	22	Electricity and heating power production and supply
2	Coal mining, washing and processing	23	Gas production and supply
3	Crude petroleum and natural gas products	24	Water production and supply
4	Metal ore mining	25	Construction
5	Non-ferrous mineral mining	26	Transport and warehousing
6	Manufacture of food products and tobacco processing	27	Post
7	Textile goods	28	Information communication, computer service and software
8	Wearing apparel, leather, furs, down and related products	29	Wholesale and retail trade
9	Sawmills and furniture	30	Accommodation, eating and drinking places
10	Paper and products, printing and record medium reproduction	31	Finance and insurance
11	Petroleum processing, coking and nuclear fuel processing	32	Real estate
12	Chemicals	33	Renting and commercial service
13	Nonmetal mineral products	34	Tourism
14	Metals smelting and pressing	35	Scientific research
15	Metal products	36	General technical services
16	Common and special equipment	37	Other social services
17	Transport equipment	38	Education
18	Electric equipment and machinery	39	Health service, social guarantee and social welfare
19	Telecommunication equipment, computer and other electronic equipment	40	Culture, sports and amusements
20	Instruments, meters, cultural and office machinery	41	Public management and social administration
21	Other manufacturing products	**Agg.**	Aggregated effect