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Determinants of Domestic Value Added in Export of China,

Empirical Analysis of Industrial Sector

중국 수출에서 국내 부가가치의 결정요인:

산업부문의 실증분석

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A thesis presented by

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ABSTRACT

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China's gross export has experienced dramatic growth manifesting its active involvement in production network under the conventional advantage in low labor costs. Along with government-back processing trade mechanism as an attempt of dualistic trade policies, foreign investment has spiraled since the opening and reform.

Pervasive processing trade in industries labelled as highly-sophisticated make measure of gross export misleading and further disable any attempt to interpret accurate picture of trade. Furthermore, as critical role of foreign investment is widely recognized as the incentivizing elements of structurally transforming trade and industry.

This thesis attempts to discern special characteristics of trade, increasing domestic value added incurred by import and rising labor cost, positive spillover effects owing to foreign investment and other sector-specific elements from 2001 to 2011 of China on industrial sector level.

The novelty of this thesis can be found in the employment of different level of data, the use of competitive EORA MRIO Input- Output Tables in order to precisely review anecdotal theories and empirics in an efforts of anatomizing determinants in Domestic Value Added.

Keyword:

Domestic Value Added, Factor Intensity, Foreign Investment, Industrial Sectors, Input-Output Table, Spillover Effects

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1. Introduction and purpose of research

1.1. Introduction

Since the open and reform of China, it has integrated deeply into world trade and investment along with widespread trend of globalizing production division. China's economy, trade structure and magnitude has transformed at astound paces. Thus, China's magnitudes and characteristics of its foreign trades in very dynamic tight interconnections with factors that nurture it draw attention from many economists, econometricians and eventually policy makers.

Being the "factory of the world"[1], "made-in-China" products embody inputs of intermediate products all over the world. Its distinctive official processing trade (export), which grant tariff exemption to firms registered as processing ones further reinforce China's natural comparative advantage in inexpensive abundant provisions of labors and government's desire of upgrading technology through their dualism trade and economic development policy.

This dubbing reflects its progressive participation of China in the downstream stages of production and its expanding integration onto world production, specifically

[1]This name was given by Japan's Ministry of Economy, Trade and Industry in 2001 White Paper

manufacture industry.[2] Most important, participation in production network with other Asian economies, especially, the Asian Tigers has allowed "a rapid diversification of China's manufacturing export capacities"[3]. Imported intermediates for processing trade and ordinary trade is conducive for China to rapidly improve high-tech content of foreign trade. Manifesting via advents of Foreign-Invested Enterprises (FIEs), processing trade is said the vehicle of phenomenal high-tech export over recent years. Computers, machinery, precision machinery, processing of metallic products etc… are most expected to benefit from technological spillovers.

This thesis aims to revise the relevancy of anecdotal evidences and previous empirical works on the perspective of value-added in exports of China with much attention to the critical role of Foreign Direct Investment (FDI) and its well-known spillover effects. Possible conjectured channels of this transmission mechanism are also discussed in paper upon setup of analysis model and applicable observation of data.

Industry sectors have attracted around 50% ~ 60% of most total actualized FDI in China on average over the interested period, manufacturing sectors themselves accounts for merely entire FDI in industry sector, near 93%. Along with this wave has been rapid concentrated growth of industry sectors, especially certain manufacture

[2]Hiau Looi Kee and Heiwai Tang (2014) "Domestic value added in Chinese export: Firm-level evidence", R.R American Economic Review

[3] Guillaume Gaulier, Françoise Lemoine, Deniz Ünal-Kesenci, "China's Integration in East Asia: Production Sharing, FDI & High-Tech Trade", CEPII, Working Paper No 2005-09

industries in term of import, export and domestic value added (DVA). Whether Chinese Government's dualism trade policies serving technology, productivity upgrade is strongly associated with FDI are questionable.

Therefore, this thesis focuses solely on China's officially classified industry sectors as to testify a dynamics of industrial production on the recent tide of foreign investment inflows at the detailed level of data collected within my maximum efforts.

This paper is an attempt at relative high level of sector-based aggregation due to limitation of data of deeper disaggregated level. The limitation certainly cause upward bias of estimation. Nevertheless, relatively long panel data of approximate 39 industries may alleviate possible bias of aggregation and promisingly bring about a solid picture of their dynamics which is the focal point of this thesis. In the term of value chains, this thesis tries to disentangle parts of the chain that belong exclusively to China.

In spite of eight-chapter constructed thesis, the content flow could be summarized into (1) theoretical background and reasoning of all measures in use, especially DVA (2) special characteristics of China's trade along with concerns about unpopular issues of China's production in its gradual integration to global production (3) procedure of data maneuvered and empirical analysis to testify some determinants of DVA.

1.2. Purposes of research and contributions to antecedences

The thesis aims to demystify unobservable relations between factor contents of production and value added embodied in exports of China. I consider it an attempt of breakthrough the cleavage between neoclassical researches on factors contents of productions and novel method of recording value (added) grouped by industry or products. This fresh way of accounting for value-added trigger the wide recognition of the latter, which is of critical importance to renovate our perception of world trade on the backdrop of spreading densely globalizing production networks.[4]

There are only handful of researches done by small number of scholars on the application of value added with appropriate employment of Input-Output Table, despite existent theories discuss much about the trade in intermediates, trade fragmentations, offshoring (relocation of productions in other countries) accompanying with trade in parts and components. The prominent reason is lack of data, mismatch of data recorded by different entities under various methodologies, and soundly acceptable arithmetic algorithm of calculating the value added as this concept was officially first introduced by a joint efforts between OECD and World Trade Organization (WTO) in 2013. Before that, value-added had not yet been introduced at national, regional or world level. Despite that some countries might have published individual firm-based data of their business, but concerted efforts to harmonize

[4]OECD's complimentary words regarding the publication of OECD-WTO

industry-based constructions of dataset had not well recognized as we can see nowadays.

Gross export, import and output by products and sectors were once the optimal choice of data for empirical studies on either bilateral or multilateral trade prior to the popularization of IO Table. Utilization of Input-Output table are limited to calculation based on products or sectors then reconciliation categorization difference with other sources of like-purpose data; then country-wise, sector-wise, deterministic trends are compared as to depict a new perspective of actual trading and productions. Basing on derivation of factor-content Cobb-Douglas production function, there are cross-country data regressions on known variables relating to specialization of products and their incentives, pros and cons, but not yet any applications of country-level value added.

There have been countless researching papers on the causes and effects of macroeconomic factors on gross output, import and export of an economy by incorporating rough calculation of data and aged economic indicators, which may oversimplify the reality. However, these types of aggregate data is very widely-know misleading in practice. Furthermore, attempt of using value added as to discern actual production ability usually stop at cross-country industry-based panel data. Heiwai Tang, Hummels, Ishii and Yia or Chen, Cheng and Wang or Dean, Fung and Wang are few influential scholars enthusiastic about value added and I-O Table of China exclusively. Their researches center on China's value added, export sophistication, vertical specialization intensity, spillover incorporating technology upgrade of local firms and

factor intensity of exports. Among those, very few add practical meaningfulness to Domestic Value Added (DVA) in export to anecdotal literatures of FDI, productions factors and production, technological spillovers from FIEs through various known channels. And unfortunately, the results are mixed.

Basing on the belief of consistent input and production across national economy, Leontief Input-Output tables addresses both supply and demand of economics with many somewhat unrealistic assumptions of production and consumption such as homogeneity of products, identical preferences of goods, presumptions on intermediate input products. They indeed made efforts to bridge two economic paradigms.

Unlike majority of short-panel firm or province-level data, this thesis uses relatively longitudinal panel data of industrial sector-level data in best harmonization with China's official classification of industries, the thesis tries to include to best extent vacancy in analysis of DVA by adopting fashion of factor-content decomposing DVA ratio introduced in the aforementioned literatures. In detail, the novelty of this thesis is application of industry sector-based is to demystify the extent that labor cost, capital input, foreign investment and their subsequent spillover effect on Total Factor Productivity (TFP), investment in technology might have on DVA in export of China.

Dissemination and absorption of high technology via the channel of processing trade that serves foreign affiliations and exports is slow. This backward transmitting

mechanism is majorly characterized in tripling from upstream FIEs of higher productivity to downstream domestic firms (suppliers).[5] There is high expectation of increase in factor productivity including labors and capital, spillovers effects of foreign investment on TFP. And they are in concert would affect the DVA or ratio of DVA to export (DVX).

An interested research question is whether there is contribution of widespread vertical foreign investment to China's upgrade of export in term of capital intensity or technology. There has been concern about the possibility of China's technology catch-up when an apparent growth of manufacture in high-technology or capital-intensive trade which is said very "special". [6] Despite seemingly optimistic views on technological progress that China has made, China is still far to divorce from labor-intensive advantages in production. Additionally, majority of mixed results from literatures have not been able to assure a completely revamping technological upgrade in production of China.

[5]Common presumption of domestic firms is to be less high-technology and less productive than FIEs, therefore, they can be named as domestic suppliers.

[6]Francoise Lemoine and Deniz Unal-Kesenci (2004), "Assembly Trade and Technology Transfer: The Case of China", World Development Vol. 32 No.5, 892-850, p.843

2. Theoretical background studies

2.1. Literature review of trade theories

Table 1: Evolution of trade theories

Trade types at industry level	Trade types at commodity level: our empirical framework	Theoretical logics for trade types	Examples of theoretical models	Market structure	Key factors
Inter-industry trade	One-way trade	Traditional comparative	Ricardian model	Perfect competition	Differences in technology
			Heckscher-Ohlin model	Perfect competition	Differences in factor endowments
Intra-industry trade	Vertical IIT	International fragmentation	Jones and Kierzkowski (1990); Arndt and Kierzknowski (2001a, 2001b); Cheng and Kierzkowski (2001); Jones, Kierzknowski and Leonard (2002) Deardorff		International splitting of a product process into two or more production blocks (PBs). Differences in wages and technologies at PB level, service link costs connecting PBs, including transportation costs, coordination cost, trade barriers, and so on
		Vertical product differentiation (for final products)	Falvey (1981); Falvey and Kierzkowski (1987)	Perfect competition	The differentiated product sector is of Heckcher-Ohlin type with CRS technology but a la Ricardo in terms of technology with fixed and different sector intensity at the variety level, and higher quality variety is produced by higher capital-labor-ratio technology with higher price. Demand of individuals at different income levels for different qualities of products with a demand for variety at aggregate level. Differences in factor endowments and income distribution or differences in technology in homogeneous sector and income distribution cause vertical IIT. [Linder (1961) for the link between the quality of product and individual's income]
			Flam and	Perfect	Demand of individuals at different

			Helpman (1987)	competition	income levels for different quality product with a demand for variety at aggregate level. Differences in technology of the differentiated product sector and income distribution cause vertical IIT, where the North with high-tech exports high-quality products and the South exports low-quality products.
			Shaked and Sutton (1984)	"Natural oligopoly"	Unit variable cost does not rise steeply with quality, and the quality improvement depends on fixed (R&D) costs. The number of firms in a Nash equilibrium in prices is limited. In the enlarged market with trade, survived firms enjoy greater marginal returns to R&D expenditure and enhanced economies of scale
	Horizontal IIT	Horizontal product differentiation (for final products)	Lancaster (1979, 1980); Helpman (1981)	Monopolistic competition	"Ideal variety" approach: diversity of preferred "package" among individuals with a demand for variety at aggregate level. Monopolistic competition with economies of scale in the production of every variety. [Hotelling (1929) for diversity of tastes in terms of location: "spatial" differentiation]
			Spence (1976); Dixit and Stiglitz (1977); Krugman (1979, 1980, 1981)	Monopolistic competition	"Love of variety" approach: demand for variety. Monopolistic competition with economies of scale in the production of every variety
			Helpman and Krugman (1985)	Monopolistic competition	Mixed approach: demand for all varieties in every country. Monopolistic competition with economies of scale in the production of every variety. (Chamberlin – Heckscher-Ohlin model) [Chamberlin (1933) for Chamberlinean monopolistic competition] Similarity in factor endowment, similarity in per capita income, difference in market size, large market size of total cause large or relative large amount of vertical IIT.

Source: Mitsuyo Ando (2006), "Fragmentation and vertical intra-industry trade in East Asia", North American Journal of Economics and Finance, 17/257-281 p.268

With regard to the tautology of intermediate inputs involved, there are several alternative terms to indicate this phenomenon, namely "production fragmentation"

(Deardorff and Rybzinski; Jones and Kierknowski), “Intra-product specialization” (Arndt, 1996), intra-industry trade (Grubel and Lloyd, 1975; Balasssa; Krugman, Obstfeld), “offshoring” (Sven W. Arndt) and “trade in task” (Grossman and Rossi-Hansberg, 2008)

Deardorff conceived of definition of “fragmentation”: “the introduction of a technology that permits a splitting of a production process into two or more steps that can be undertaken in different locations but that lead to the same final products”[7]. Definitions of product fragmentation are diverse, but its fundamental agreeably refer to a splitting up of a previously integrated production nexus vertically into two or more components. Each is named “fragments” (Kierzknowski, 2003) in different locations but that lead to the same final products.

With regards to theories of production fragmentation, there are various theoretical studies on the framework of production fragmentation, contingent specializations and a series of derived causes and effects of the dynamics of process. The evolution of theory of production fragmentation, trade theorists have emphasized two aspects of shifts in organization of productions (1) fragmentation of production process and (2) internationalization decisions of multinational firms.[8] These two layers refer to

[7]Alan V. Deardorff (1998), “Fragmentation in Simple Trade Models”, Discussion Paper

[8]Judith M. Dean, Mary E. Lovely, Jesse Mora (2009), “Decomposing China-Japan-U.S trade: Vertical Specialization, ownership and organizational form”, Journal of Asian Economics, 20/ 596-610

different level of perspective on international trade. This thesis is dedicated to the former.

Starting with the prominent neoclassical Ricardian model regarding comparative advantage and consequent trade patterns in the fashion of complete specialization between two countries, two products and one mobile production factor. The rationale of trade is difference in the sole production factor - labor productivity or implicit differences in production technology. And welfare assigned to each country is decided from demand side.

Relaxing the assumption of sole final goods, Deardorff (2004) complicated the classical Ricardian model by adding one intermediate goods. The comparative advantages are defined by ordinal rank of advantage, characteristics of trade costs incurred by the intermediate good.[9]

Starting from supply sides, The Hecker-Ohlin model takes further steps in considering the fundamental cause of trade pattern incorporating factors endowments of labor and capital as input in two products produced between two countries on the assumptions of identical consumers' preference and states of technology between them. A country will export products that use more intensively factor that are relatively more abundant. Factor-content trade theory began to gain foothold from factor endowment. But it ignores economics of scale, endogenous technological advancement, cross-

[9]Alan V. Deardorff, (2004), "Ricardian Comparative Advantage with Intermediate Inputs",

border factor mobility, trade costs and dynamic evolution of trade once these qualitative factors are considered.

Improvement to the two limited theory frameworks could be found in Davis (1994)[10] as he bound both Heckscher-Ohlin and Ricardian theory to partially deal with the above limitations. The essence of intra-industry trade is technological differences and scale of economics is not the key determinant of intra-industry trade. Prior to the advent of expanded trade theory on intermediate products is the Ricardian Model with Continuum of Goods (Dornbusch, Fischer, Samuelson, 1977)[11] by making Ricardian two-two-two model into continuum-two-two model with amendment of trade cost, brief of unilateral technological improvements as to keep theory updated with reality.

Partial analysis of conceptual frameworks center on two inputs (labor and capital), two country and two products. Jones and Kierzknowski utilize factor prices and ratio of factors input on isoquants to explain economics of scale and technological differences of performance of inputs in various countries. They contended that the causes of fragmentation are technological progress in service sectors, improving knowledge of other countries and liberalization of service sectors which intensify competition. And they believed that fragmentation offers opportunities for less developed countries to

[10]Donald R. Davis (1995), "Intra-Industry trade: A Heckscher – Ohlin- Ricardo approach", Journal of International Economics 39, pp.201-226

[11]R. Dornbusch; S. Fischer; P. A. Samuelson (1977), "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods", The American Economic Review, Vol. 67, No. 5. (Dec., 1977), pp. 823-839.

win in participations by taking mixed advantage of factor productivity and factors endowments.

Deardorff (1998) laid further theoretical incentives for fragmentation, which are technology shock(s) and reduction in transaction cost (Benjamin Bridgman, 2012; Johns and Kierzknowski, 2000). The former entails increase in stages of productions which lately manifests in the faster-than-trade growth of FDI flows. Technology shocks make fragmentation of a final products possible as tasks of production with different factor intensity is separable. The later refers to the reduction of transportation cost and tariffs. Tariffs have been universally lowered on the background of proliferating preferential trade agreements, especially rapid drop of import tax on intermediate goods. These stylized facts specifically incentivize consideration of foreign investment in China's industrial productions.

Meanwhile Deardorff (1983) establish a mixed picture of either intuitive or counterintuitive trade patterns with the introduction of transportation cost. By relaxing homogeneous assumptions of demand, counterintuitive trade pattern may have room to arise.

Deardorff made an expansion to the conventional Ricardian and Heckscher-Ohlin model in order to testify consequent gains from fragmentation and income distribution with assumption of cost of fragmentation. With regards to patterns of specialization under the assumption of unequal factor prices, fragmentation is said to be taken place in "across two cones" due to differences in factors endowment and relevant level

factor-intensity of broken production and final product. Fragmentation is said to take place eventually in either event of factor price equalization with costless or costly fragmentation (Deardorff).

Besides, Kierzknowski (2000) proposed a framework of fragmenting production on the backdrop of globalization, in which "role of advances in technology and lowered costs of services in fostering a fragmentation of vertically integrated production processes that may enter international trade". [12] Kierzknowski (2000, 2003) reached the bottom of line of fragmentation as to minimize costs of production and forge production blocks after the process of fragmentation, which are linked by services.[13] He insists increased fragmentation resulting from demand side.[14] Production block may benefit from increasing returns to scale, for possible instance, the Special Economic Zones in China.

Nevertheless, fragmentation may bring about mixed welfare or production effects varying upon portion of fragmented products and relative differences in slope of production possibility which shaped by factors endowment differentials.

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[12]Ronald W. Jones and Henryk Kierzknowski (2000), "A framework for fragmentation", Fragmentation and International Trade, Oxford University Press.

[13]He posted an example of recent division of textile industries to developing countries along with reduction in trade costs due to universal technological upgrade relating to services provided to manufacture

[14]Ronald W. Jones and Henryk Kierzkowski, "The Role of Services in Production and International Trade: A Theoretical Framework" p.31

Apart from Ricardian trade theory, the rest only indicates possible patterns of trade in negligence of trading volume (Chipman, 1988)[15], which is of importance to judge the applicability of these theories to special case of China as this thesis considers most the magnitude rather than directions of trade.

Interestingly, technology is universally treated as exogenous factors to the fragmentation which is taken as given, "technology shock" (Deardorff) since there is "conceptual difficulty" when trying to endogenize TFP (Diego Comin, 2006). This thesis consider technology a simultaneous factors along with factors of productions. It has not yet been properly integrated into the dynamics of fragmentation as an organic factor.

Other derived concepts of production fragmentation that are dominant in assessing trade is "vertical specialization" first used by Balassa and Findlay or Intra Industry Trade Index (Grubel and Lloyd, 1975) etc… Intra Industry Trade (ITT) (P. Krugman) assumes positive return to scale from economics of scale which ultimately results in differentiated products at supply side. ITT trade theory ignores the existence of intermediate inputs which are ready for production input of industry of their definition or other industries. ITT theory paradigm is confined to production side and generalize all of products to be final goods. However, in North-South trading, ITT is defined

[15]John S. Chipman (1988), "Intra-Industry Trade in Heckscher-Ohlin-Lerner-Samuelson Model", Diskussionsbeiträge: Serie II, Sonderforschungsbereich 178 "Internationalisierung der Wirtschaft", Universität Konstanz, No. 72

vertical product differentiation (Marc J. Melitz, 2003). Misleadingly, the theory forecast increasing IIT among countries of close factor endowments and economic size, whereas in reality, IIT in manufacture, parts and components are dominant between North – South. Any use of this index or indicators requires an account of domestic value-added and foreign valued-added in final products to calibrate their upward bias.

In practice, products fragmentation historically originates from inter-industry division to intra-industry division, production line of a product, intra-production line and deepening of fragmenting production. These theories implicitly denote manufacturing trade which grows the fastest compared to other types of trade whilst its share in output has not much growth[16]. Update of theories have been closely followed rapid transformation of trade.

2.2. Relating theories of Foreign Investment

In line with Heckscher-Ohlin's factor-endowment trade theories, Vernon (1966) is known for product life-cycle in which foreign investment is the simple substitute of trade. The theory implicitly condones to unilateral technological shock and consequent perfect technology absorption ability of late comers to follow the technology-leading outsource or offshoring increased technology-sophisticated tasks to less developed countries. The theory deals with demand side for infinite introduction of products

[16]Benjamin Bridgman (2011), "The rise of vertical special trade", Journal of International Economics 86/ 133-140

varieties or in other words. Core assumption of product life-cycle is standardized products, which is believed to be one pace ahead of differentiated-product –based theories. Akmatsu's (1962) "Flying geese model" setting is a specific version of factor-endowment theory explaining trade and vertical labor division in East Asia, in which the technology leader is Japan.

Robert Mundell contends that determinants of FDI flows depend on the trade impediments such as differences in factor endowments and factor prices of homogenous products.

John Dunning's comprehensive theoretical framework of FDI flows combining ownership advantages, location advantages and internationalization advantages etc... in order to synthesize various independent economic theories and to bring them to firm-level. Helpman, Meilitz et.al elaborated on the heterogeneous productivity of firms to partially explain internationalization advantages.[17]

Amongst all candidate factors, resource endowments are most widely-accepted determinants for exported-oriented inflows of foreign investment specifically in the case of China.

The spillover effects may take place if the participation of foreign investment or existence of FIEs contribute to the enhancement of local firms' productivity through

[17] Helpman, Elhanan, Marc J.Melitz, and Stenphen R. Yeaple (2004), "Export Versus FDI with Heterogeneous Firms", American Economic Review, 94(1): 300-316

channel of supplying if technology absorption and utilization of resources are propelled due to the introduction of competition. Especially, most meaningful for developing countries is the backward linkage between FIEs and native suppliers of intermediate inputs. They benefit from technology transfer, increasing demand for intermediate inputs supplied by native firms with possible economics of scale and stricter requirements of quality. Such environment is constructed through external economics of scale that the number of shared suppliers matters. Analysis on garment industries of Bangladesh once legitimized the picture. FDI firm may also apply competitive pressure on native suppliers, therefore, they must increase quality and varieties. Backward vertical spillovers of FDI is a channel of enhancing DVA in export (Gorg and Greenaway (2004). Others known channel of FDI spillover may find in theory of labor mobility among FIEs and domestic firms (Hale and Long, 2007).

3. Input-Output Tables

The rapidly evolving global productions is imperative for new treatment of accounting trade data. Production value chain of a final products which are exhaustively consumed are broken or fragmented into multiple stages within a country. Lower cost of cross-border transaction and gradual standardization of production allow firms to offshore part of production value chain abroad to utilize comparative advantage of host countries. Firms and their affiliations or suppliers located in respective countries produce intermediate inputs, semi-final products or final products in circulation among different economies and customs.

A lopsided old-fashioned term associating with this fact is "intra-industry trade", which frustrates any desire for understanding actual trade. Intermediate goods circulate across industries multiple times until the stage of final consumptions. Trade in intermediate inputs accounts for two third of international trade.[18] Final goods do not only contains embedded values of upstream sectors, but also values from common services that may universally provide to whole value chain as it help calibrate the conventional trade indicators.[19]

[18]Robert C. Johnson, Guillermo Noguera (2011), "Accounting for Intermediates: Production sharing and trade in value added", Journal of International Economics, p.224

[19] World Banks' workshop, Robert C. Johson and Guillermo Noguera (2011), "Accounting for Intermediates: Production Sharing and Trade in Value Added"

3.1. Conceptual design of Input-Output Table

The conceptual dichotomy of identifications constituting the table is level of finalization, purpose of using products (intermediate or final products and export) as well as sources of intermediates (domestic or imported) in the detail level of certain types of products.

The very primitive concept presumes export as completely final consumptions without consequent re-import of exported from other countries to country 2. Import of intermediate goods arrive in Country 2 to be completely consumed without any further re-export to other country. Withstanding the assumption of foreign-content free of domestic intermediate production and domestic content-free imports, the I-O tables presume away complete specialization of country. Each can manufacture all types of products. The interested things in this thesis are capital and labor input and foreign content-free domestic intermediate goods.

This thesis is interested in the basket of B, C and E, which are extracted from EORA I-O Tables and China's Statistical Yearbooks.

Figure 1: Conceptual diagram of Input-Output Table

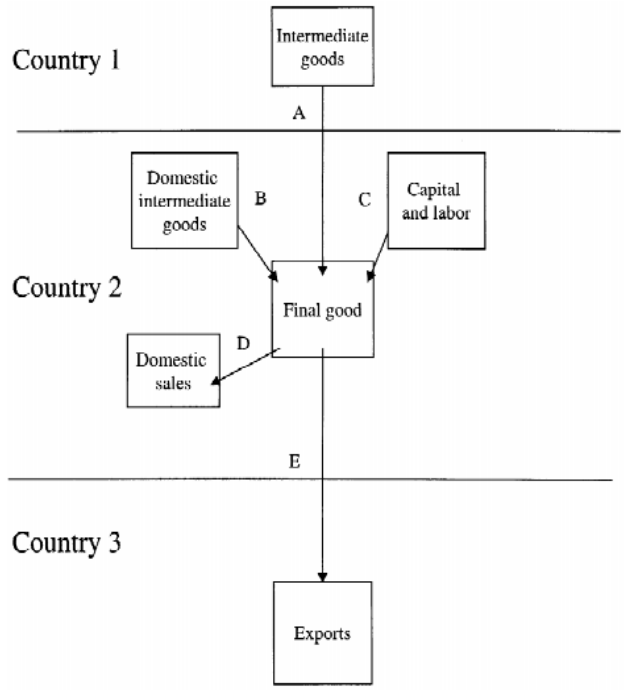


Fig. 1. Vertical specialization.

Source: David Hummels, Jun Ishii, Kei-Mu Yia (2001), "The nature and growth of vertical specialization in world trade", Journal of International Economics 54 (2001) 75-96, p.78

The concept of I-O Table fundamentally originates from input-output economics, in which very primitive attempt is construction of Leontief input-output table.[20] Its basic concept is the dichotomy of revolving products and services among certain well-defined sectors in the design of gross value or input-output coefficients diagonal matrix. In an autarky scenario with assumption of exhaustive production and final

[20]OECD (1999), "Handbook of Input-Output Table Compilation an Analysis" in "Studies in Methods, Handbook of National Accounting", Department of Economic and Social Affairs, Statistics Division

consumption and foreign content-free intermediate inputs, reverse Leontief can be written as following:

$$X_i = (I - A_i^D)^{-1} Y_i$$

In which, i denotes industry category, X_i is total output of industry i, Y_i is final demand which may vary from domestic final consumption, use as capital formation for follow-up round of production to export and most important is A_i^D – an input-output symmetric matrix of intermediate products.

The algorithm of the matrix depends much on level of harmonization among various sources of data, such as firm-level transaction data, bilateral trade data which are very different from country to country. Some I-O tables further make final consumption into more details.

Table 2: Basic structure of I-O Table

	Industries	**Net final demand**	**Total output**
Industries	F	Y	X
Value added (primary inputs)	V		
Total input	X		

Source: OECD Handbook

Above is the most simplified scenario of national I-O Table. It can be expanded to regional and global scale, but still assuming away the merry-go-round of import and export of intermediate goods. Johnson and Noguera (2010b) stated that basic approach to merge national Input-Output tables together using bilateral trade data to form synthetic global Input-Output Table tracking both shipment of final and intermediates good between countries.

"Double bookkeeping"[21] is caused by a country's participation in global value chain when MNEs seek to place partial production chains in other countries.[22] And it incurs an overstatement of value added or the actual domestic value that is added to final exports as the movement of intermediate products is not well tracked. Choi (2013)[23] calculated large contraction in trade balance in value added for all countries. Some countries turned out to be small compared to its gross value. Thus, relaxation of foreign content-free exports and domestic content-free import contributes to the complication of structure of the table. Fortunately, these complicated issues are well recognized. There have been several modified I-O Tables incorporating more layers of concepts and data once presumptions of import export purity are problematized and nation's heterogeneous productions among firms and industries are considered.

[21]Robert C. Johnson, Guillermo Noguera (2011) "Accounting for Intermediates: Production sharing and trade in value added", Journal of International Economics, 86/ 224-236

[22]Prema-chandra Athukorala, Nobuaki Yamashita (2006), "Production fragmentation and trade integration: East Asia in a global context", North American Journal of Economics and Finance (2006) p. 233-256, p.234

[23]Nakgyoon Choi (2013), "Measurement and Determinants of Trade in Value Added", KIEP Working Paper 13-01

3.2. Versions of Input and Output Table

Currently, the most widely used IIO tables are produced by WIOD, the OECD-WTO, Eora MRIO, and IDE-JETRO.[24]

Table 3: Global IIO databases

Database	Data sources	Countries/ Regions	Sectors	Years
World Input - Output Database (WIOD)	National supply-use tables	40	35	1995-2009
OECD-WTO TiVA databse	National Input-Output tables	58 plus China processing trade	37	1995, 2000, 2005, 2008, 2009
UNCTAD-Eora GVC Database	National and regional supply-use and I-O tables plus estimates from UN sources	187	25	1990-2011
GTAP	I-O tables submitted by GTAP members			
Daudin et.al (2011)		66 or 113	55	1997, 2001, 2004
Johnson and Noguera (2012)		94	57	2004
Koopman, Wang, and Wei (2013)		26	41	2004

Source: Lin Jones, Willian Powers, Ravinder Ubee (2013), "Making Global Value Chain Research More Accessible", Office of Economics Working Paper no. 2013-10A, U.S. International Trade Commission, p.5.

World Input and Output Table initiate is funded by European Commission, which is the seventh framework program. It is knowingly the most worldwide comprehensive Input-Output Table analyzing the effects of globalization on trade pattern, environmental pressures and socio-economic development across 27 EU countries and 13 major economies in the world from 1995 to 2009 of 35 industries and around 59

[24] Lin Jones, Willian Powers, Ravinder Ubee (2013), "Making Global Value Chain Research More Accessible", Office of Economics Working Paper no. 2013-10A, U.S. International Trade Commission

products.[25] The concept of national input-output table based on the assumptions that each industry produces only one representative type of product. Production of each product is streamlined into intermediate, labor and capital inputs and these elements are displayed in an asymmetric matrix table. And total use must be equal to total output. The further world input-output table originates from identical concept with breakdown of use and input of a product by their origin. From which how imports, export and intermediates are used and consumed in different purposes, namely intermediates, final consumption (both private and governmental and investment). Basic price and purchaser price are differentiated with each other by trade, transportation margins and net taxes. So, imperfection of trade flow incurring trade cost is considered in this table.

GTAP is non-official I-O Table compiled by Prude University which are most widely used by researchers, namely Johnson and Noguera, Koopman et.al. The data is updated periodically but not annually. And worst, length of window of time is long, usually 3 or 5 years.

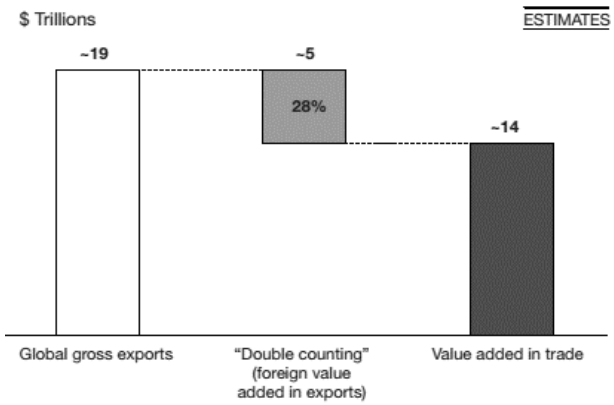
A good example of I-O Table is the current OECD's works using Input-Output Table [26] decomposes export of an industry from a country as (1) Domestic value-added generated in its production either directly by main producing industry literally or through interlocking transactions between industries domestically or externally (2)

[25] Marcel Timmer (2012), "World Input- Output Database (WIOD): Contents, Sources and Methods", Working Paper no. 10

[26] OECD (2011), "Towards Measuring Trade in Value-Added and Other Indicators of Global Value Chains: Current OECD work using I-O tables"

Imported value-added from other country for further use in production. It was calculated that value added in trade is 28% less than global gross export as depicted below.

Figure 2: Value added in global exports, 2010



Source: UNCTAD (2013), "World Investment Report 2013, Global Value Chains: Investment and Trade for Development", United Nations Conference on Trade and Development

EORA MRIO I-O Tables cover the most number of countries, whose industry categorization regime is very alike to respective country, especially in case of China. The constructional framework of this table is well defined. It is also eligible to be national account of any country as it gives separate primary input of factors, final demands, gross import and export besides matrix of intermediate goods.

Neither of above input-output table, constructions of tables can relax overarching assumptions of fixed industry sales structure which is in accordance with implicitly given identical consumers' utility function across sector.

3.3. National Input-Output Tables of China

The national I-O Table of China can be found in the aforementioned I-O Table projects. Apart from that, China's Input-Output Associations complied native Input and Output Table is compiled by the matrix of input-output coefficients in the years ending with 2 and 7 and extended input – output tables were compiled in the years ended with 0 and 5 by Chinese Input and Output Association.[27] Thus, there are periodical records of the year 2000, 2002, 2005, 2007 and 2010. Nevertheless, long interval of compilation disqualifies from lending itself to time series or panel data analysis in spite of Chinese government's sector categorization- compatibility.

Notably, China's Customs classify export processing trade as gross value regardless of domestic contents and imported value of the goods. This type of national accounting is very "misleading and greatly inflate China's exports", especially in high-tech products.[28] Follow-up efforts of relaxing strong assumptions "proportionality" in use of imported products and final products have been made to alleviate the issues.

Dean, Fung and Wang (2007) [29] expanded HIY methods by incorporating further two types of processing trade: "trade associated with processing and assembly" and

[27]The China's Input-Out Associations is under supervision of National Bureau of Statistics, Renmin University, Academy of Mathematics and Systems Science

[28]Yuqing Xing (2012), "The People's Republic of China's High-Tech Exports: Myth and Reality", ADBI Working Paper Series no. 357, p.6

[29]Judith M. Dean, K.C. Fung and Zhi Wang (2007) "Measuring the Vertical Specialization in Chinese trade, U.S. International Trade Commission, Office of Economics Working Papers

"trade associated with processing with imported input",[30] whose data is from China's customs statistics. They are different in ownership of imported material for processing. They detached processing trade from normal imports with references to U.N Broad Economic Categories classifying capital, intermediate and consumer goods as to give accurate accounts of intermediate inputs. The table recognizes multiple stages of intermediate inputs until final productions which generate direct and indirect value added.

Koopman, Wang and Wei[31] (2011) put forth a firm mathematical framework of treating I-O tables of country where processing trade is pervasive on the foundation of non-competitive[32] I-O tables. The structure of table is astoundingly complicated when trying to stratifying how value added is created in interaction amongst sectors.

Chen, Cheng, Fung et.al (2012) structured I-O Tables in similar fashion. The nature of pervasive processing trade is also considered through exclusive treatment for imported intermediate for processing.[33] Direct and indirect DVA are conceptualized as Dean, Fung and Wang (2012) did.

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[30]In Chinese, they are 《来料加工》and 《进料加工》, respectively

[31]Robert Koopman, Zhi Wang, Shang-Jin Wei (2011), "Estimating domestic content in export when processing trade is pervasive", Journal of Development Economics 99 (2012) 178-189

[32] "Non-competitive" means that imported intermediates input are used differently between processing and non-processing trade

[33]Xikang Chen, Leonard Cheng and K.C. Fung and Lawrence J. Lau et.al (2012), "Domestic Value Added and Employment Generated by Chinese Exports: A Quantitative Estimation", China Economics Review, Volume 23, Issues 4, 2012, p.850-864

4. China's export and domestic value added

Export of China is very special in the sense that gross exports ironically display increasingly sophisticated export items, but the account of DVA reverse the Samuelson's version of the Heckscher-Ohlin model with a continuum of goods, in which a country will specialize in and export goods that at close to the end of relative rank of relative advantages.[34] The judgment of factor-endowment trade theories still hold well in China's case of pervasive processing trade.

4.1.Trade of China

Along with extraordinary growth of export of annual approximate 25% over last 10 years, the processing trade-reliant and export-oriented economy has also experienced very rapid increase in gross DVA over the period of 2000-2011 following the China's accession to World Trade Organization. Lower barriers to trade reciprocally promote import of intermediate inputs. China has been the steam engine of growing East Asia's intra-regional trade from 1981 until now. Asian trade turned more centered on "China as a global production base". [35] This "special" importance mainly centers on machinery, electricity, transportation and precision machinery (Fukunari Kimura and Mitsuyo

[34]Alan V. Deardorff (2007), "Ricardian Model" Research Seminal in International Economics, Discussion Paper No.564

[35]Guillaume Gaulier, Françoise Lemoine, Deniz Ünal-Kesenci (2007), "China's emergence and the reorganization of trade flows in Asia", China Economic Review. 18/ 209-243. They also pointed out the gradual concentration of trade in parts and components

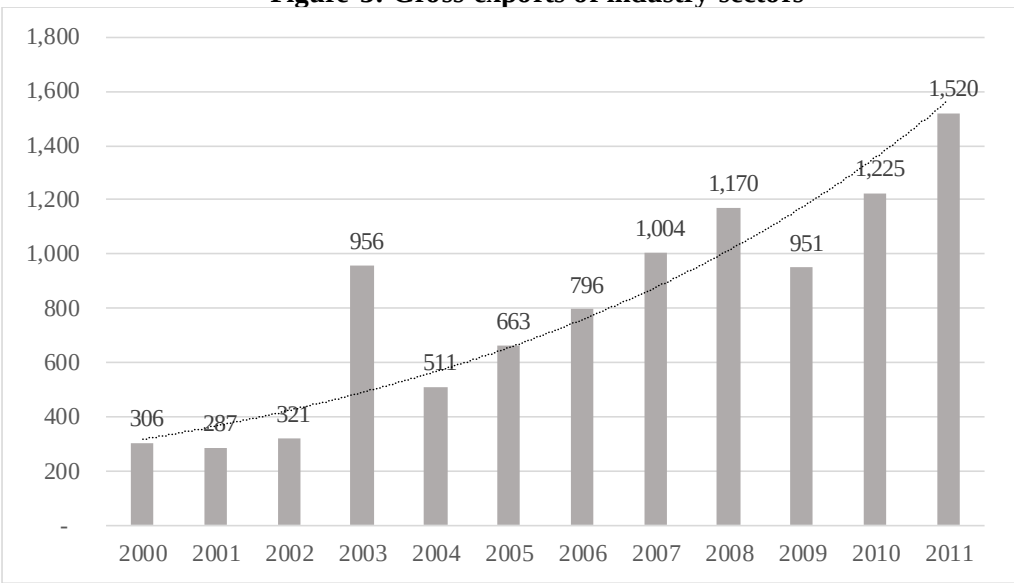
Ando).[36] Widely accepted increasing similarity of China's export structure to developed countries is interpreted to be the convergence of composition of exports and imports, specifically in machinery parts and components trade.[37]

Then, despite that geographical proximity makes intra-regional trade dominant, final goods from China are exported back to other Asian Tigers and Western countries. Increasing demands for varieties and qualities of final products from these export partners have partially driven up the value added in exports of China. Adversely, assuming constant returns to scales, China' export-biased growth model was once predicted to end in so-called immiserizing growth (Paul Krugman) as large volume of export would put downward pressure on world's price and increased demands for intermediate inputs serving exports of final goods would in turn push up price levels of imported goods. Both together make China's terms of trade worse. Expansion of productions majorly for export are accountable for increased remuneration to labors, which are subject to enhanced productivity through technological upgrade and foreign investment.

[36]Fukunari Kimura, Mitsuyo Ando (2005), "Two-dimensional fragmentation in East Asia: Conceptual framework and empirics", International Review of Economics and Finance 14 (2005) 317-348

[37]Gaulier et.al (2007) also pointed out the gradual concentration of trade in parts and components.

Figure 3: Gross exports of industry sectors



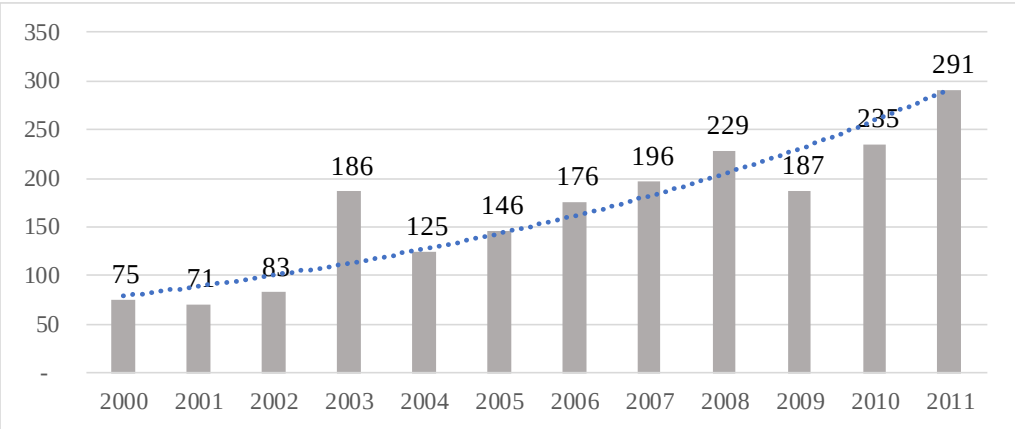
Source: EORA MRIO, and my calculation, unit: billion USD

Regardless of two systemic fluctuations in 2003 and 2009, average growth of gross exports is approximately 25%. Year of 2009 suffered 18.7% of decrease in exports due to global financial crisis which wreaked havoc on export of China as demand side of international trade slipped. The DVA increased from 74 billion USD to 291 trillion over 12 years, which is near 3.9 fold. Increase of DVA in exports could be explained by improvement in production quality of domestic inputs, reduction or dismantling of trade barriers on imported intermediates.

In negligence of to either domestic final consumption, intermediate inputs or exports, alike the pattern of exports, average growth rate of DVA embodied in export is

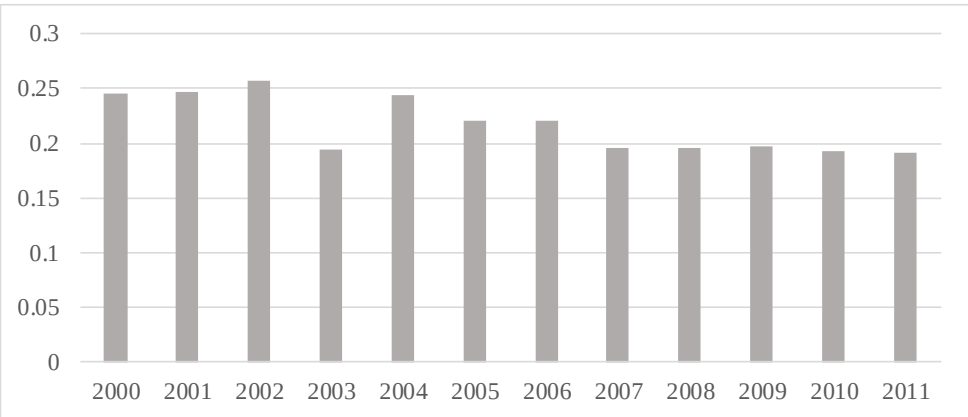
approximately 18.19% from 2000-2011. In Koopman et.al's "How much of Chinese Exports is really made in China"[38] alike calculated a proximately 17% of export value.

Figure 4: Value of DVA embodied in export



Source: EORA MRIO, applied my calculation and adjustment, Unit: billion USD

Figure 5: Share of DVA (DVX) in gross export



[38]Robert Koopman, Zhi Wang, Shang-Jin Wei (2008) "How much of Chinese exports is really made in China? Assessing Domestic Value-Added When Processing Trade is Pervasive", NBER Working Paper No. w14109

Source: EORA MRIO, applied calculation and adjustment of writer.

In sharp contrast with average annual 18% growth of absolute value in DVA embodied in export, share of DVA in export has generally been on decrease from 24.5% in 2000 to 19% in 2011. The underlying reason is integration into world market as effort of acquitting fulfillment after accession to WTO which facilitates substitution of domestic intermediate inputs with imported ones.[39] FIEs, who account for big share of China's export and production of manufacture, tend to import more intermediate goods.[40] Decrease of DVX is due to that export grew faster than DVA which is incurred by surge of FIEs' import. So, there is slight decrease in ratio of DVA to gross export (DVX). And the DVX vary from more than 12% to approximate peak of 17% in 2002 and 2004. Zhang (2013) alike reported much more worrisome decline of DVA.[41] China's accession to WTO membership makes firm more integrated into the world's trade and FIEs in China tend to import more sophisticated intermediate inputs as an attempt of exploiting low labor costs.

Notably, 93.2% of total exports is contributed by manufacture sectors, amongst which, 49% comes from labor-intensive products and 36% comes from hi-tech

[39]Chen Xikang et.al "DVA and employment generated by Chinese export: A quantitative estimation", China Economic Review 23(2012) 850-864

[40]OECD Working Papers on International Investment 2000/04 "Main Determinants and Impacts of FDI on China's economy"

[41]张海燕（2013）《基于附加值贸易测算法对中国出口地位的重新分析》《国际贸易问题》2013年第10期

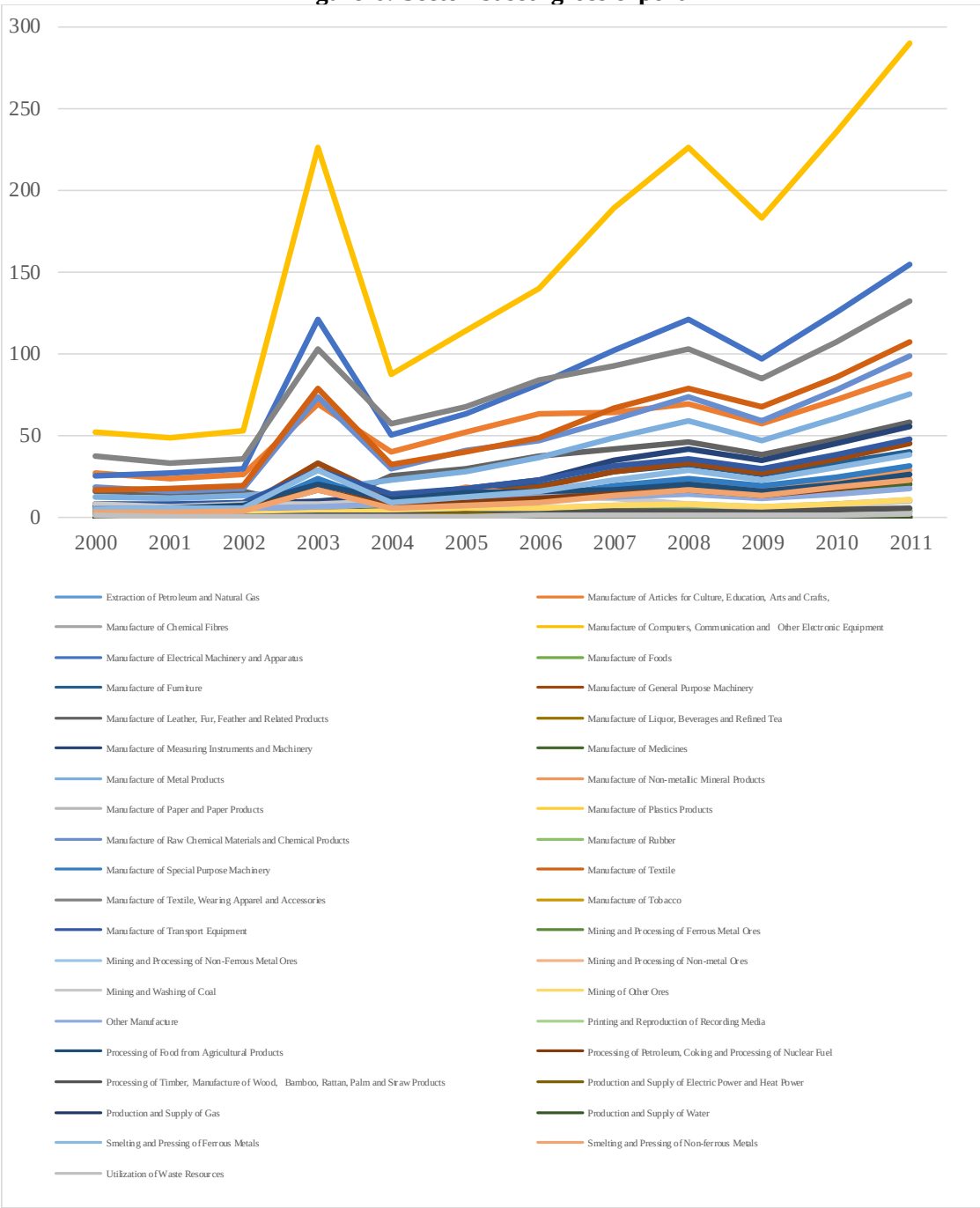
products (calculated by Xu and Lu, 2009)[42]. The pattern of respective sectors identically follows the behavior of country's gross export, which alike weathered two significant hiccups in 2004 and 2009. This fact is due to high concentration of processing trade in "Electrical Machinery", "Machinery" and "Optical, medical and Precision Instrument" (Dean, Fung and Wang, 2007)[43]

Manufacture of computer, communication; electrical machinery; textile of all types, metal products etc... are prevalently on top rank the list of industrial export while exploiting industries are ranked at the lower half. Manufacture of computers, communication equipment, electrical machinery, which are knowingly technology-intensive account for approximate one third of total export.

[42]Calculated by Bin Xu, Jiangyong Lu (2009), "Foreign direct investment, processing trade, and the sophistication of China's exports", China Economic Review 20 (2009) 425–439

[43]Judith M. Dean, K.C. Fung and Zhi Wang (2007) "Measuring the Vertical Specialization in Chinese trade, U.S. International Trade Commission, Office of Economics Working Papers

Figure 6: Sector-based gross export



Source: EORA Input-Output Table, Unit: USD billion

Table 4: Gross exports of industry sectors

Sector	2000	2001	2005	2006	2010	2011
Manufacture of Computers, Communication and Other Electronic Equipment	52,218,080	49,167,729	114,062,248	140,514,698	235,979,600	289,852,340
Manufacture of Electrical Machinery and Apparatus	25,785,320	27,252,964	63,207,233	81,452,806	125,298,147	154,841,646
Manufacture of Textile, Wearing Apparel and Accessories	37,799,164	33,673,323	67,960,989	84,028,790	107,196,020	132,658,670
Manufacture of Textile	16,830,628	17,669,298	40,072,004	49,123,522	86,063,911	107,417,440
Manufacture of Raw Chemical Materials and Chemical Products	19,063,555	15,963,570	40,875,862	47,384,638	78,254,758	98,587,690
Manufacture of Articles for Culture, Education, Arts and Crafts,	27,658,233	24,193,354	52,044,086	63,317,619	71,728,891	87,734,514
Manufacture of Metal Products	12,266,540	12,091,280	28,535,810	37,138,560	60,804,460	75,606,720
Manufacture of Leather, Fur, Feather and Related Products	16,106,690	15,022,730	29,876,610	37,926,070	47,899,080	58,443,690
Manufacture of Measuring Instruments and Machinery	8,515,326	7,445,830	17,729,240	22,882,980	44,929,990	55,834,290
Manufacture of Transport Equipment	8,753,399	8,499,510	18,198,776	22,958,863	38,365,800	48,156,347
Manufacture of General Purpose Machinery	5,833,947	5,837,872	14,420,087	18,789,943	35,859,675	45,108,318
Manufacture of Furniture	7,095,848	6,432,140	16,921,100	19,309,170	33,068,380	40,330,250
Smelting and Pressing of Ferrous Metals	5,156,568	5,372,771	12,867,963	15,656,013	30,817,322	38,769,902
Manufacture of Special Purpose Machinery	3,645,584	3,601,977	12,226,692	12,586,347	25,042,623	31,833,528
Manufacture of Non-metallic Mineral Products	4,993,826	4,545,939	19,087,577	12,708,380	23,194,067	28,934,851
Processing of Food from Agricultural Products	3,194,850	6,070,162	15,281,638	15,858,902	20,589,951	25,980,900
Manufacture of Plastics Products	4,288,674	4,529,449	11,034,350	12,550,850	19,206,180	23,439,950
Manufacture of Foods	4,013,283	4,202,665	11,570,250	12,647,330	18,629,500	23,331,570
Processing of Petroleum, Coking and Processing of Nuclear Fuel	4,552,533	4,330,901	9,555,739	11,358,099	18,226,359	23,191,313
Smelting and Pressing of Non-ferrous Metals	2,741,525	2,887,569	7,071,096	9,173,942	18,399,083	23,179,560
Manufacture of Medicines	6,319,368	4,471,164	9,567,338	11,627,920	16,805,720	20,729,900
Other Manufacture	5,795,633	5,350,442	10,283,770	13,061,400	14,717,470	18,091,280
Mining of Other Ores	2,204,239	2,087,926	4,386,077	5,441,577	8,504,762	10,755,810
Manufacture of Paper and Paper Products	1,943,935	1,951,285	4,672,775	6,018,905	8,606,203	10,670,940
Mining and Washing of Coal	8,213,865	7,004,768	11,897,440	12,749,660	7,836,426	9,936,705
Manufacture of Rubber	1,687,461	1,771,445	3,906,641	5,054,915	7,909,278	9,815,326
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products	2,105,771	870,332	2,110,646	2,695,113	4,454,906	5,577,494
Printing and Reproduction of Recording Media	806,947	859,448	2,033,218	2,597,564	3,784,515	4,720,636
Extraction of Petroleum and Natural Gas	1,459,729	1,027,868	2,403,362	3,132,827	3,205,376	4,153,780
Manufacture of Liquor, Beverages and Refined Tea	964,833	966,734	2,425,702	2,311,158	3,262,885	4,117,012
Mining and Processing of Non-Ferrous Metal Ores	1,084,112	645,510	1,312,965	1,683,870	2,734,387	3,481,612
Utilization of Waste Resources	1,445,772	682,787	869,080	1,056,953	1,490,404	1,879,173
Mining and Processing of Non-metal Ores	239,399	232,024	386,181	447,588	654,879	822,023
Manufacture of Tobacco	342,856	231,677	1,270,436	474,771	608,108	762,273
Production and Supply of Electric Power and Heat Power	49,643	26,554	2,233,152	22,561	192,172	490,969
Production and Supply of Water	46,837	53,749	130,000	168,621	289,382	385,460
Manufacture of Chemical Fibres	176,700	79,984	129,679	157,509	318,301	382,083
Mining and Processing of Ferrous Metal Ores	260,673	8,876	7,718	6,939	58,363	57,120
Production and Supply of Gas	15,008	4,023	283,100	2,108	9,541	12,923

Source: UNCTAD EORA, Unit: USD thousand

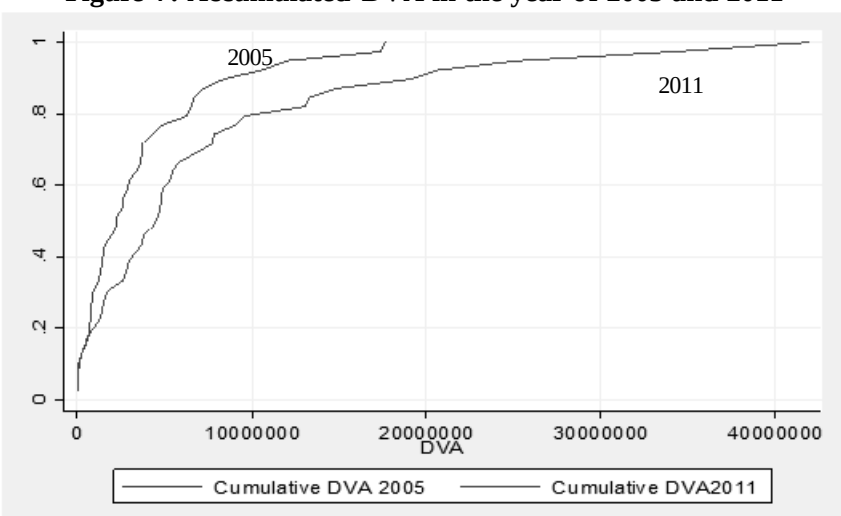
With regards to DVA embedded in industrial export, the picture exhibits here is alike in term of general trend but different in the order of industries. Those industries

that perform well in gross export are not necessarily the ones which assemble highest DVA. Nevertheless, overall, rank of export and DVA are identical. Observation on rank of sectors regarding import, export, DVX and DVA provides several rough implications on characteristics of China's export.

Natural resource-intensive industries, namely ferrous metals, non-metallic mineral products, coal, rubber, petroleum and manufacture of tobacco are ranked top in term of DVX, which do not correspondingly match with neither their ranking in DVA nor ranking of its share in respective export. Mining and processing of non-metal ores, tobacco are at the bottom of gross export.

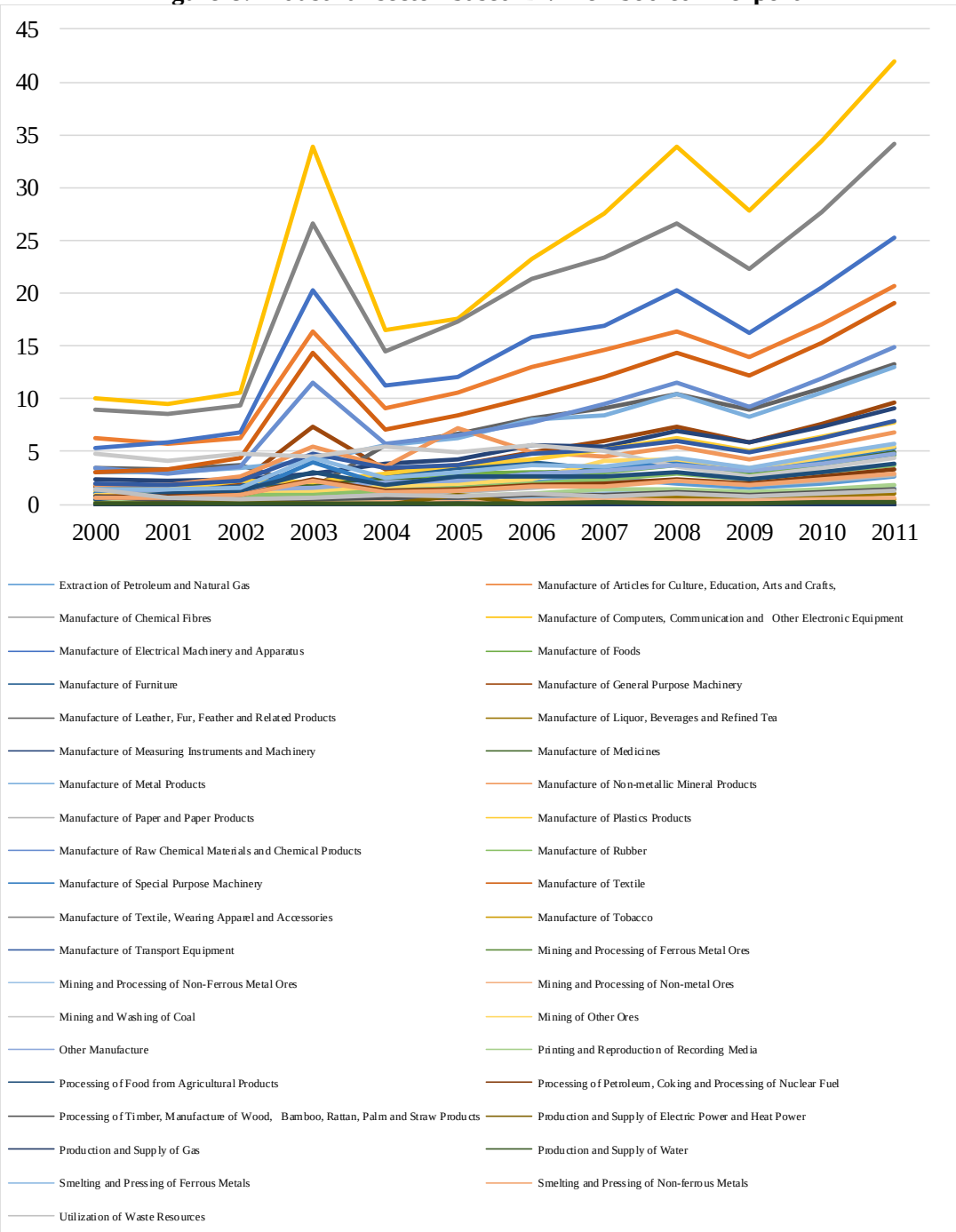
Concentration of DVA can be observed in Figure 8. Left-ward concaved curve show most of DVA are concentrated in sectors of higher DVA in 2011 which is far more apparent than 2005.

Figure 7: Accumulated DVA in the year of 2005 and 2011



Source: my calculation

Figure 8: Industrial sector-based DVA embodied in export



Source: EORA Input-Output Table, unit: billion USD

Table 5: Ranking of export and ranking of DVA in 2011 and 2005

Sector	Import		Export		DVX		DVA	
	2005	2011	2005	2011	2005	2011	2005	2011
Manufacture of Computers, Communication and Other Electronic Equipment	1	1	1	1	37	35	1	1
Manufacture of Textile, Wearing Apparel and Accessories	16	16	2	3	16	15	2	2
Manufacture of Electrical Machinery and Apparatus	5	4	3	2	31	28	3	3
Manufacture of Articles for Culture, Education, Arts and Crafts,	14	14	4	6	28	18	4	4
Manufacture of Textile	13	12	6	4	27	24	5	5
Manufacture of Raw Chemical Materials and Chemical Products	2	2	5	5	36	32	8	6
Manufacture of Leather, Fur, Feather and Related Products	25	20	7	8	23	21	7	7
Manufacture of Metal Products	10	8	8	7	25	25	9	8
Manufacture of General Purpose Machinery	4	5	14	11	18	22	14	9
Manufacture of Measuring Instruments and Machinery	23	21	11	9	20	29	11	10
Manufacture of Transport Equipment	6	6	10	10	29	30	13	11
Manufacture of Plastics Products	8	10	19	17	13	11	12	12
Manufacture of Non-metallic Mineral Products	19	15	9	15	9	17	6	13
Smelting and Pressing of Ferrous Metals	7	3	15	13	22	33	16	14
Mining of Other Ores	32	32	25	23	5	5	22	15
Manufacture of Special Purpose Machinery	9	9	16	14	26	26	19	16
Manufacture of Medicines	18	23	21	21	21	20	20	17
Manufacture of Furniture	31	27	12	12	30	39	15	18
Other Manufacture	33	33	20	22	24	14	21	19
Manufacture of Foods	27	22	18	18	19	23	17	20
Mining and Washing of Coal	12	24	17	25	7	8	10	21
Processing of Food from Agricultural Products	22	19	13	16	34	34	18	22
Manufacture of Rubber	30	29	26	26	8	9	24	23
Processing of Petroleum, Coking and Processing of Nuclear Fuel	3	7	22	19	38	36	25	24
Smelting and Pressing of Non-ferrous Metals	11	11	23	20	33	38	26	25
Manufacture of Paper and Paper Products	15	17	24	24	17	13	27	26
Extraction of Petroleum and Natural Gas	21	28	28	29	3	3	23	27
Printing and Reproduction of Recording Media	29	26	31	28	11	10	31	28
Mining and Processing of Non-Ferrous Metal Ores	35	34	32	31	12	7	34	29
Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products	20	18	30	27	15	16	33	30
Utilization of Waste Resources	28	38	34	32	1	1	32	31
Manufacture of Liquor, Beverages and Refined Tea	34	31	27	30	14	19	30	32
Mining and Processing of Non-metal Ores	37	39	35	33	4	2	35	33
Manufacture of Tobacco	39	37	33	34	2	4	28	34
Production and Supply of Water	36	36	37	36	6	6	36	35
Production and Supply of Electric Power and Heat Power	17	13	29	35	10	12	29	36
Manufacture of Chemical Fibres	24	25	38	37	39	37	38	37
Mining and Processing of Ferrous Metal Ores	26	30	39	38	32	27	39	38
Production and Supply of Gas	38	35	36	39	35	31	37	39

Source: China's Statistic Yearbooks

Above ranking is based on 2011, which is of no much difference from 2010 or 2009. Manufacture of Computers, Electrical Machinery, Textile, Chemicals and Articles for culture, education, arts and craft have been dominant in export structure of China. Manufacture and textile-centric production are induced by popularity of FIEs in "electronics and telecommunication, textile, clothes and other textile industries"[44].

In year of 2011, DVA in export performs best in "Manufacture of Computers, Communication and Other Electronic Equipment", "Textile, Wearing Apparel", "Manufacture of Electrical Machinery and Apparatus" and lying at the bottom are "Mining and Processing of Ferrous Metal Ores" and "Non-metal Ores".

At the meantime, ranking regarding DVX reverses, described as: "Mining and Processing of non-metal Ores, "Manufacture of Tobacco", "Extraction of Petroleum and Natural Gas", "Mining and Processing of Non-Ferrous Metal Ores", "Mining and Washing of Coal", "Manufacture of Rubber", "Petroleum and Natural Gas"; at the lower bottom found Manufacture of Computers, Communication and Other Electronic Equipment", "Manufacture of Chemical Fibres", "Processing of Food from Agricultural Products" and "Smelting and Pressing of Non-ferrous Metals". These sectors pull down overall DVA average and "labor-intensive light manufactures tend to have lower direct DVAs than capital or skill intensive goods" (Xikang Chen et.al,

[44]Yih-Chyi Chuang & Pi-Fum Hsu (2004) FDI, trade, and spillover efficiency: evidence from China's manufacturing sector, Applied Economics, 36:10, 1103-1115

2012)[45]. Along with decent DVX is their remarkable import share of over 20% in total industrial export for "Manufacture of Computers, Communication and Other Electronic Equipment" over 12 years, which are mainly intermediates for processing trade. In conclusion, sectors of exploiting natural resources pose the largest ratio of DVA in export, which unsurprisingly meet the common-sense conclusion of high value added to gross export of Agriculture, Natural Resources-intensive industrial sectors.[46]

Table 6: Spearman's rank correlation between DVA, DVX, import and export

	Import	Export	DVX	DVA
Import	1.0000			
Export	0.7593	1.0000		
DVX	-0.6058	-0.5338	1.0000	
DVA	-0.7033	0.9718	-0.3768	1.0000

Pairwise rank correlation are all found dependence. Source: my calculation

Spearman's rank correlation exhibits highly dependent between imports and intermediate, rho is reported at more than 80% in all sectors. Thus, there is high dependence between ranks of DVX and DVA of sectors.

A poor country can export highly sophisticated good because of multinational firms that export it from the country.[47] Figure 9 tracks amount of non-Chinese contribution[48] to equities in each sector. Correspondingly, being mindful that Join-venture give birth to influential firms in the industry, not wholly-foreign-owned affiliates, each sector displays identical picture to relevant gross export. Ranking of foreign investment has

[45]Robert Koopman, Zhi Wang, Shang-Jin Wei (2008), "Domestic share of processing exports and normal export from 10.9% to 23.4% for all merchandise and similar for manufacturing goods.

[46]Robert C. Johnson, Guillermo Noguera et.al, "Accounting for Intermediates: Production Sharing and Trade in Value Added", World Bank's workshop

[47]Bin Xu (2010), "The sophistication of exports: Is China special?", China Economic Review 21 (2010) 482-493

[48]Taiwan, Hong Kong, Macau and foreign investors included

not been shuffled much over sectors. On top are Manufacture of "Computers, Communication and Other Electronic Equipment", but the rest, unlike DVA or DVX, are "Raw Chemical Materials and Chemical Products", "Transport Equipment", "General Purpose Machinery", "Textile" and Non-metallic Mineral Products". Sectors of high DVX, namely mining industry sectors, receive least foreign investment.

The "Manufacture of Computers, Communication and Other Electronic Equipment", "Manufacture of Raw Chemical Materials and Chemical Products", "Manufacture of Transport Equipment", " Manufacture of Electrical Machinery and Apparatus", "Manufacture of General Purpose Machinery", "Manufacture of Textile", in particular and other export-oriented sectors attract most foreign investment and export the most. The results also depict increasingly overlapping of export structure compared to developed economies that makes export of China "special".[49] And China's high-tech exports staggered at 18% of world's export, which make China lead the market. Therefore, DVA approach is legitimate to account for the reality of China's export. [50] Nevertheless, the data show heavy weight of DVA in capital-intensive sectors, say machinery and processing of non-metallic mineral, rather than conventional labor-

[49]Zhi Wang, Shang-Jin Wei (2008), "What accounts for rising sophistication of China's exports?", NBER Working Paper No. 13771

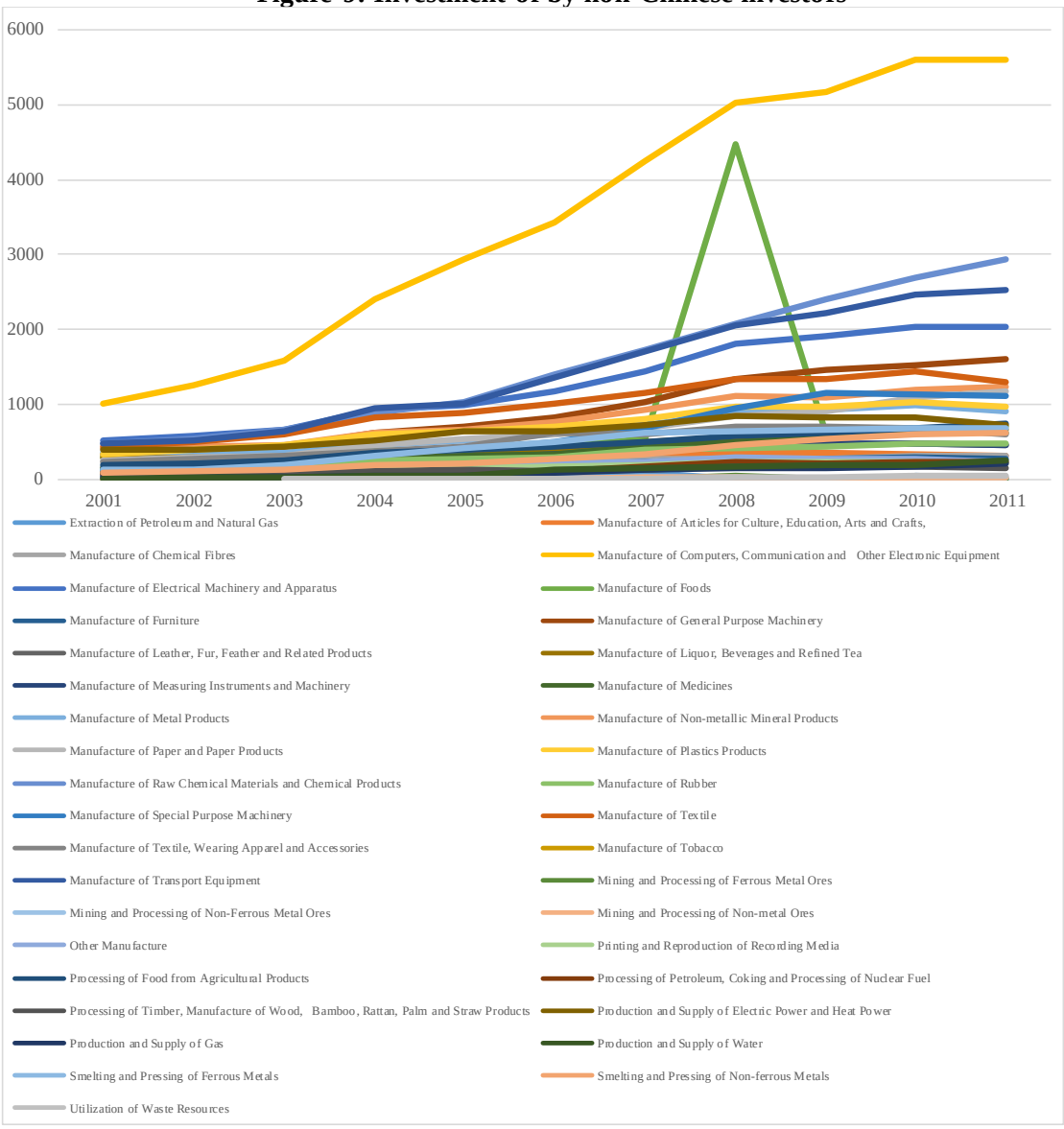
[50]Yuqing Xing (2012), "The People's Republic of China's High-Tech Exports: Myth and Reality", ADBI Working Paper Series no. 357

intensive textile industry. This phenomenon can be translated into upgrade of industrial structure from labor-intensive textile to capital-intensive manufacture.[51]

By the way of conclusion, prominently characterizing in pervasive processing trade, trade pattern is indeed well judged by Hecker-Ohlin model. Sectors of large import and export are associated with decent DVX embodied. This bare fact well discerns the dominance of labor-intensive processing trade in these sectors, where China humbly join in the least value-added part, which are most attractive to foreign investors.

[51]Robert Koopman, Zhi Wang, Shang-Jin Wei (2008), "Domestic share of processing exports and normal export from 10.9% to 23.4% for all merchandise and similar for manufacturing goods.

Figure 9: Investment of by non-Chinese investors



Source: China Statistics Yearbooks, unit: 00,000,000 (hundred billion RMB)

4.2. Domestic Value Added in China's production

Certainly, there are diverse literatures on DVA, DVX, and relating empirical studies employing Cobb-Douglass production functions, anecdotal framework on trade theory

of intermediate inputs as drafted above. The modified and amended Leontief matrix of input and output has been frequently employed to include more facts of China's trades and productions.

Ma Tao[52] well summarized the evolution of perspectives on the application of value added in trade of China (1) technological constructions of trade through Revealed Comparative Advantage, G-L index [53] (2) detachment of domestic contribution to technological contents of exported products as to discern the technology upgrade of production or improvement in value chain of products through participation in international division, such as export similarity index, Trade Specialization Coefficient or Export Structure Index (Su Zhen Dong et. al 2009[54]; Gruble-Lloyd's intra-industry trade index (1975) [55] (3) VSS of exported products and (4) lately value added export by using input-output tables to extract actual domestic contents of exports.

On the understanding of China's unique role of "world's factory", dualism trade policies along with proliferation, calculation of DVA has evolved overtime. And their outcomes vary considerably even though pervasive nature of China's processing is taken into account.

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[52]马涛 （2013），《附加值贸易将还原"真实"的世界贸易》， 中国社会科学院世界经济与政治研究所了国际问题研究系列

[53]Grubel–Lloyd index (1971)

[54]苏振东 周玮庆(2009), 《出口 贸易结构变迁对中国经济增长的非对称影响效应研究》, 世界经济研究

[55] Processing trade, exchange rate

DFW's results showed 35.9% of intermediate content in China's export in 2002 and concluded a rising fragmentation of China's export to the world. And six manufacturing sectors that have total vertical specialization share of excess 50% are plastic, steel processing, communication equipment, general industrial machinery, metal products and electronic computers. These sectors are advertently have the lowest domestic value added. Robert Koopman, Zhi Wang and Shang-Jin Wei (2010) estimated that DVA of China was 50% before WTO membership and 60% later then. Sophisticated products contradictorily have low DVA ratio in export as depicted above in my calculation.

Dean, Koopman (2008)'s calculation showed relative high Vertical Specialization (VSS) of China after special treatment on processing trade while other papers, avoiding the existence of processing trade with assumption of homogeneous domestic production regardless of processing trade or normal trade offer lower VSS result.

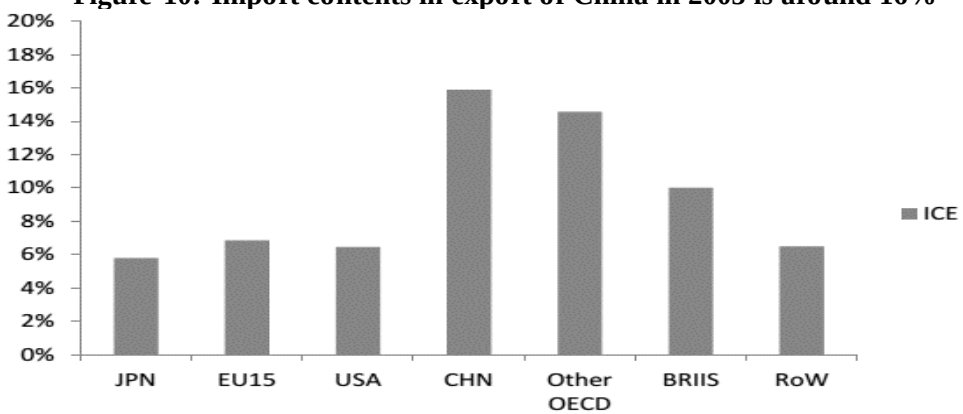
Harmonizing firm-transaction data, domestic content of export between 2003 and 2006 in Upward, Wang and Zheng (2012) increased 7.5%, whose 98% is accounted for within-industry increase.[56]

Foreign affiliates accounted for about 50% of exports and 48% of imports in 2012[57]. Dean, Fung and Wang (2008), in 2005 processing trade accounted for 42% of China's

[56]Richard Upward, Zheng Wang, Jinghai Zheng (2013), "Weighing China's export basket: The domestic content and technology intensity of Chinese exports", Journal of Comparative Economics 41 (2013) 527–543

imports from the world, and 55% of China's export to the world. These trade is concentrated in relatively high-tech products and carried out by foreign firms. The magnitude of processing trade is depicted in Figure 10.

Figure 10: Import contents in export of China in 2005 is around 16%



Source: Sébastien Miroudot, and Norihiko Yamano (OECD) (2011) "Towards Measuring Trade in Value-Added and Other Indicators of Global Value Chains: Current OECD work using I-O tables", "The Fragmentation of Global Production and Trade in Value-Added – Developing new measures of cross-border trade", World Bank

Zhang HaiYan (2013) calculated the value-added in trade by using I-O table and concluded that China's *value-added decreased* rapidly over 15-year period of 1995-2009;less opened sectors perform better in term of value-added and despite leading role of big exporter, but the role diminishes compared with conventional trade records.

Heiwai Tang (2012) set up methodological framework of calculating China's DVA on firms' transaction data. DVA ratio to exports was confirmed to increase from 35%

[57]UNCTAD (2013), "Global Value Chains and Development", United Nations Conference on Trade and Development", p.9

to 49% from 2000 to 2006 on steady growing trend. Three industries with highest DVA ratio to exports are Wood and Articles, Stone, Plaster, and Cement and Beverages and Spirits in 2000, which are all characterized as natural resource-intensive. Three industries with lowest DVA ratio are Precious Metals, Plastics and Rubber, and Animal and Vegetable Oil. Identical to my calculation based on EORA MRIO I-O Table, China's export structure changed dramatically with growing export shares in electronics and machinery and decline in agriculture and apparel.

High export growth of existing products (intensive margin) rather than in new varieties (extensive margin) could be also observed. China increases its supplies of existing varieties on world markets, this is likely to exert downward pressure on world prices of these goods (Amiti and Freund, 2010).[58] The same conclusion can be found in Mehdi Shafaeddina and Juan Pizarrob (2010), in which China has production competitiveness in capital/technology-intensive items.[59]

[58]Mary Amiti and Caroline Freund, "The Anatomy of China's Export Growth" in Robert C. Feenstra and Shang-Jin Wei (2010) "China's Growing Role in World Trade", University of Chicago Press

[59]Mehdi Shafaeddin and Juan Pizarro (2010), "The evolution of value added in assembly operations: the case of China", Journal of Chinese Economic and Business Studies Vol. 8, No. 4, November 2010, 373–397, p.385

5. Problematizing value added in exports of China

Most of anecdotal evidences considering growth of unobservable production-nurturing elements place themselves in the paradigm of Cobb-Douglass production function which dedicate completely to factors contents of products. In specific case of China, foreign investment is acceptably considered the best candidate of determinants to growing TFP which is unobservable in Cobb-Douglass production function. Many papers on spillover effects of foreign investment incessantly keep searching for the most specific model of FTP through mining of data rather than a theorized concrete model. This thesis inevitably falls into this loop.

Albeit of many attempts to manipulate TPF, the interested explained variables used to be total gross output or value-added of all firms. In highly export-dependent economy of China, DVA in exports is of either economic or politic interest because China's trade constituents are very special which is traceable only by DVA. The novelty of this thesis is the trial of replacing variable of crude measurement with more precise ones which reflects the effective production capacity of China.

With regards to sources of products fragmentations, they majorly originate from surrounding countries, falling freight cost alone generate very little trade growth [60] at least in the case of Japanese Multinational Companies in East Asia. Besides, nearly

[60] Benjamin Bridgman (2011), "The rise of vertical specialization trade", Journal of International Economics 86 (2012) 133-140

perfect tariff reduction, especially for FIEs in Special Economic Zones make this thesis less interested in accounting for trade cost mentioned in many theory of products fragmentation and literatures

5.1. Literature reviews of empirical works

Theory of overspill effects of FDI and technology absorption is popularized firsts by "flying geese model by Akamatsu (1961). Most of data imply that technological contents of China's trade has increased. High-tech contents of exports certainly originate from high-tech imports. Subsequently, proportion of domestic value-added is relative low in these sectors. 70% of high-tech import are from Asia. 89% of PRC's high-tech exports were produced by foreign-invested firms.[61] This conclusion partially meets "Root of China's successful in increasing EXPY over time is "consumer electronics.[62] In common sense, countries that have increasingly specialized in exporting goods with high technological content, experienced more rapid growth[63]. There is argument that assembly operation would not lead to substantial increase in manufactured value added automatically and that the infant industry argument applies to both production and exports [64]

[61]Xing Yuqing (2012), "The People's Republic of China's High-Tech Exports: Myth an Reality", ADBI Working Paper Series, No. 357

[62]Dani Rodrik (2006), "What So Special About China's Exports?", NBER Working Paper 11947

[63]Jim Lee (2010), "Export specialization and economic growth around the world", Economic Systems 35 (2011) 45-63

[64]Mehdi Shafaeddin & Juan Pizarro (2010) "The evolution of value added in assembly operations: the case of China and Mexico", Journal of Chinese Economic and Business Studies, 8:4, 373-397, p.374

The dominance of processing trade in machinery may have factor-biased effects on DVA of China. Krugman (2000) contended that when consider trading economies with multiple sectors, factor bias "ceases to have an impact on factor price".[65] Upward, Wang, Zheng (2009) [66] found that DVA is lower in FIEs and firms and processing trade lower DVX. We might expect lower contribution of explanatory variables to DVA if control variable of FIEs is introduced. Their implications are attributed to the labor-intensive chain of the pervasive processing trade. Their empirical specification with dependent variable as DVX and independent variable as firm's level characteristic much inspire this thesis.

With regards to attempts of bridging value added and financial sectors, understanding the heterogeneous top manufacturing sectors and intrinsic characteristics in production fragmentation, Yu and Lin employed the value added to empirically analyze the incomplete pass through of RMB exchange rate. He discovered the positive relationship between trade value-added and elasticity of exchange rate pass-through along with specific effects on each sector. The paper also makes good reasoning of factor-intensity, processing trade of each manufacturing sectors. Labor-intensive and high-tech sectors exhibit the worst DVX. He also mentioned one upgraded element of trade, which manifest through the rise of technology-intensive sectors.

[65]Paul R. Krugman (1999), "Technology, trade and factor prices", Journal of International Economics, 50 /51-71, p.57

[66]Richard Upward, Zheng Wang, Jinghai Zheng (2013), "Weighing China's export basket: The domestic content and technology intensity of Chinese exports", Journal of Comparative Economics 41 (2013) 527–543, p.535

Foreign investment and spillover, productivity, TFP and technology

Literatures agreeably contend with positive spillover effects of foreign investment on native firms to various extents, then the entire broadly-defined industrial sectors, such as Hiau Looi Kee and Heiwai Tang (2012). Evolving technology adoption along with foreign investment is of importance for decision of investment besides factors endowment (Dani Rodrik, 2006)[67], especially China encourage technology transfer through joint-venture FIEs.

Despite FIEs majorly consist of labor-intensive lower stream of value chain [68] what makes FIEs especially important in China has been generally concluded as[69] (1) "FDI has upgraded skills, raised factor productivity, increased technology transfer and encouraged reform of domestic Chinese industries"[70], especially export-oriented industries. (2) FIEs have shifted labor-intensive downstream production to China as an effort of "efficiency-seeking". It is notable that majority of China's inward FDI is from East Asia which is characterized contradictorily to Western-originated market-seeking FDI. High intra-industry trade and intra-firm trade, processing trade has been actualized along with integration of China into the production network. This fact is translated to increasingly capital-intensive exports of China (via more active import of

[67]Dani Rodrik (2006), "What's so special about China's exports?", NBER, working paper 11947

[68]Naughton in Chen et.al (2012), "Domestic value added and employment generated by Chinese exports: A quantitative estimation", China Economic Review 23 (2012) 850-864

[69]OECD (2000), "Main Determinants and Impacts of Foreign Direct Investment on China's Economy", OECD Working Papers on International Investment, 2000/04, OECD Publishing

[70]"FDI in China, what Figures don't tell us" & OECD FDI report (2000)

capital-intensive import) (3) FIEs are more export-oriented than native firms. Active participation in manufacture industries make great contribution to the upgrade of sector productivity and pertaining competitiveness (4) FIEs also impose thrust on structural changes of China's exports since the opening and reform. China is losing predominant foothold in conventional labor-intensive sectors, namely textile, foot wares to more capital intensive processing of steel or computer, machineries. Dualism nature of China's growth is expected to bring about fruitful technological upgrade in export. Below empirical analysis will elaborate on this story.

Upward et.al (2013) confirms Chinese exports are dominated by less human capital and technology intensive sectors, and processing trade brings about increase in skill intensity.[71] He found negative relation between DVX and DVA even other control variables are added.

Following Rodrik (2006)'s findings of very high export sophistication which may be induced by sophisticated import and in shift from low-productivity goods to higher ones. Xu and Lu (2009) conducted empirics on industry-level FDI,[72] processing trade and export sophistication. Surprisingly, they failed to find effects of overall FDI on sophistication of China's export. The direction of relations depend on origin of FDI and share of processing export in FIEs or in native firms. In their empirical

[71]Richard Upward, Zheng Wang, Jinghai Zheng (2013), "Weighing China's export basket: The domestic content and technology intensity of Chinese exports", Journal of Comparative Economics 41 (2013) 527–543, p.538

[72]Bin Xu, Jiangyong Lu (2009), "Foreign direct investment, processing trade, and the sophistication of China's export", China Economic Review 20 (2009) 425-439

specifications, inclusion of technology, capital and human capital were concluded to be absorbed by industry dummy variables. Or, FDI is not the cause of China's upgrade in export structure if interested elements in Cobb-Douglass productions function are considered. A supporting evidence is that "the lower China's export prices are, the higher share of processing exports in industry's total export". Increase in value-added shares are robust to inclusion of firm and industry-level characteristics. The increase is a within-industry phenomenon. Nevertheless, Yao Shunli (2009) criticized Rodrik's trade sophistication indicator as it assume too many presumptions and misinterpretation from the index.

The relation between foreign export spillover and product sophistication is documented by Florian Mayneris and Sandra Poncet (2011)[73] as assistances from FIEs to native ones in adoption of technology and increase productivity and quality possible through FIEs' competition pressure imposed on domestic suppliers. Higher sophistication product are likely to benefit more from spillovers.

Hale and Long (2006) proved positive spillover effects of FDIs on domestic firms in the same industry as well as in same city. Constant presences of FDI induces this effects through channel of resources movement, namely labor or capital and through network. They used firm-level logarithm of value added, capital and labor input (value of fixed assets and number of employees), constructed variable of FDI and other firm-

[73]Florian Mayneris and Sandra Poncet (2011), "Export performance of China's domestic firms: the role of foreign export spillovers", CEPII, WP No 2010 – 32

characterizing variables such as education level of employee, their average ages, skill level as ratio of higher skilled ones to lesser one, absorptive capacity as the comparison of individual TFP to highest TFP of the industry.[74] The scope of spillover is TFP and labor productivity. Hale and Long (2011) addressed the selection-biased, sector-level aggregation by appointing a priori weight and giving cursory remedy to the endogeneity of FDI by using instrument variables which are firm-specific.[75]

Increase in productivity of native firms in the channel of back-forth labor mobility between firms of different ownership under the widely-accepted assumption that FIEs are technology-superior and more productive than native firms. The process take place within respective industries.[76] And Rodriguez-Clare's empirical works on back and forward linkage between firms proves positive effects of spillover effects from FDI.

This thesis purposefully overlooks the effects of exchange rate because exchange rate fluctuation "does not seem to matter in determining firm DVAR" at individual firm-level data.[77] Most critical determinants of China's DVA is spillover effects of vertical foreign investment.

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[74] Galina Hale and Cheryl Long (2006), "What determines technological spillovers of Foreign Direct Investment: Evidence from China", unpublished

[75] Galina Hale and Cheryl Long (2011), "Are There Productivity Spillovers from Foreign Direct Investment in China?", Pacific Economic Review, 16/135-153

[76] Andrea Fosfuri, Massimo Motta and Thomas Ronde (2001), "Foreign direct investment and spillovers through workers' mobility", Journal of International Economics, 2001, vol. 53, issue 1, pages 205-222

[77] Hiau Looi Kee and Heiwai Tang (2014) "Domestic value added in Chinese export: Firm-level evidence", R.R American Economic Review

Joachim Jarreau and Sandra Poncet (2009) [78] revamped **Hausmann**'s export sophistication to suggest that sophistication drive growth which is limited to "ordinary export activities taken by domestic firm, not processing or foreign firms, even though these are main contributors to global upgrading of China's exports". Basing on provincial data, their results expressly confirm no spillover effects in processing trade, but ordinary trade. The effects are stronger in sophisticated products, for instance proximity to foreign exporters might help domestic exporters to upgrade their exports. Effects are weaker when gap between foreign and domestic firms is large. That supports the conclusion that labor-intensive processing trade in high-tech final exports.

Following-up papers attempted to find explanation for this income-content indicator of China. **Bin Xu** (2010) found strong relation between R&D intensity and sophistication/similarity index, which reflect technology – content of exports, but the quality of exports overall is judged to be relatively low.

Exclusively for high-tech exports, embracing on the regression of output on possible production factors presumed in Cobb-Douglass equation, Zhao Yong (2012) [79] conducted simple regression of city-based high-tech export on fixed capital investment, expenditure on R&D, FDI and miscellaneous control variables of financial

[78]Jerome He ricourt and Sandra Poncet (2009), "FDI and credit constraints: Firm-level evidence from China", Economic Systems 33 (2009) 1–21

[79]赵勇 (2012),《理解中国出口技术结构的变化》，中国人民大学经济研究所

factors. Agreeably, the result implied positive role of FDI and FIEs in high-tech export due to introduction of competiveness and solution to the limited financing.

Closest anecdotal empiric is from Hiau Looi Kee and Heiwai Tang (2012). They conducted regression of similar dependent variable – DVAR (or DVA in export in my word) on fixed effects of firms, years; material-to-sale ratio and logarithm of wage rate and labor cost share [80] as to discern the myth of rising labor cost which incurs rising DVX. If FDI were not to have influences on DVX of individual firm, FDI would lower DVX as more productive firms import more intermediate inputs or reduce mark-up price due to stiff competition. Human capital is a factor adding to the increase of DVA. In another paper, Heiwai Tang concluded that increase in firm DVAR is due to domestic input varieties from upstream sectors partially caused by FDI into downstream sector. And increase in DVA in exports is due to rise in DVA in processing exports, in which imported materials are substituted with domestic ones along with rising demand for labor and upgrade of variety and quality. Their unified use of year fixed-effect exclusively suggests within-firm increase in DVX is broad-based over all industries.

Yue Ma, Heiwai Tang, Yifan Zhang (2014) conducted research on how phenomenal concentration on core products of exporters affects factor intensity and TFP. These questioned factors will be received treatment in this paper. They found a drop in capital

[80]Heiwai Tang (2012), "Domestic value added in Chinese exports – Firm-level evidence"

intensity of their existing products on firm-level data and also within a "narrowly defined industry" as an act of utilizing advantage in labors. Firm benefits from allocation of resources from capital-intensive to labor-intensive products when TFP increased – a so-called "product churning".[81] This paper used TFP or capital intensity as dependent variable and other firm-specific factors as independent variables.

Wage and labor

To analyze the impact of production fragmentation on relative wages and labor demand, R. Helg, L. Tajoli established an expression of short-run cost function consisting of wages, fixed input (eg. Capital), output and given technology parameters [82]. Ratio of skilled to unskilled employment are constructed with fragmentation index, gross output, and capital stock.

With regards to labor, Chen, et.al [83] increase in labor productivity is said the key factor of decrease in effects of exports on employment. Non-processing export and traditional manufacturing sectors generate more employment. Higher employment pertain to higher DVA ratio, compared to other sectors. R.Koopman et.al also concluded same results.

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[81] Yue Ma, Heiwai Tang, Yifan Zhang (2013), "Factor Intensity, Product Switching, and Productivity: Evidence from Chinese Exporters", Journal of International Economics 92 (2014) 349–362

[82] Rodolfo Helg, Lucia Tajoli (2005), "Patterns of international fragmentation of production and the relative demand for labor", North American Journal of Economics and Finance, 16-233-254, p.244

[83] Chen Xikang, Leonard K. Cheng, K.C. Fung, Lawrence J. Lau, Yun-Wing Sung, K. Zhu, C. Yang, J. Pei, Y. Duan (2012), "Domestic value added and employment generated by Chinese exports: A quantitative estimation", China Economic Review 23 (2012) 850–864

X. Chen (2012) contends that processing exports used more imported inputs than non-processing ones due to the linkage with domestic suppliers.[84] Considering the increasing processing export, it is predictable that exports exert negative effects on employment due to increased productivity and rising domestic final demand. This conclusion is closely linked to Lee and Tang (2012) as said afore.

In negligence of DVA effectively embedded in the export, Wang and Wei (2008)[85] used the data of city-based gross export and relating explanatory variables to infer that increasing resemble of China's export attributes to the "improved level of local human capital, government policy". So there has been explosive export of high-tech but low-DVA products. Spill-over effects of foreign-invested firms stipulate domestic firms' development.[86] In case of China, the surge of processing trade in high-tech exports is very tempting to draw a spurious implication of positive spillover effects from foreign investment to DVA.

[84] X. Chen et.al (2012), "Domestic Value Added and employment generated by Chinese exports: a quantitative estimation", China Economic Review, Volume 23, Issues 4, December 2012, Pages 850-864

[85] Zhi Wang, Shang-Jin Wei (2008), "What Accounts for the Rising Sophistication of China's Exports?", NBER Working Paper No. 13771

[86] 赵勇 (2012), "理解中国出口技术结构的变化 —来自高技术产品出口的证据", China Renmin University

5.2. Research questions

In 2007, 82% of processing-trade export and 91% of high-tech processing-trade came from foreign firms.[87] Koopman (2008) also found a very high foreign share (50%) in China' export. Processing trade carried out by foreign-invested business entities is an evidence of vertical FDI activity. [88] Foreign affiliates accounts for important role of growing China's foreign trade, 55% of total volume of trade in 2005. It is appealing to review foreign presence within industries. Foreign elements in all industries, especially pervasive processing trade in dominant export industries alike are expected to drive up DVA.

The thesis is an attempt of discerning determinants of DVA, which are possibly foreign investment, technology upgrade, factor intensity, remuneration to labors and TFP. This thesis do not try to disentangle endogeneity of these factors. Fragmentation is the manifestation of globalization and technology combined, especially over recent three decades.[89] Therefore, effects of technology advancement and its contribution to DVA needs a treatment recipe, which is Total Factor Productivity (TFP). Additionally,

[87]Joachim Jarreau, Sandra Poncet (2009), "Export sophistication and economic growth: Evidence from China", Journal of Development Economics 97 (2012) 281 –292

[88]Judith M. Dean, Mary E. Lovely, Jesse Mora (2009), "Decomposing China–Japan –U.S. trade: Vertical specialization, ownership, and organizational form", Journal of Asian Economics 20 (2009) 596–610

[89]Alan V. Deardorff (1998), "Fragmentation in Simple Trade Models", Research Seminar in International Economics, Discussion Paper No.422

China's export is reportedly weight towards less technical-intensive industries.[90] This thesis attempts to testify that increase in technology expenditure is assigned to processing trade and mostly within industry (intensive growth) and consequent aggregation would exhibit within-industry growth of DVA due to technological upgrade.

International fragmentation has been driven by "differences in factor prices, and labor cost differentials"[91]. Incorporating factor price equalization, I can expect that rising average labor has negative effects on DVX, but not DVA. However, there is possibility that rising DVA is driven by substituting imported materials with domestic substitution, not rising production cost.

[90] Richard Upward, Zheng Wang, Jinghai Zheng (2013), "Weighing China's export basket: The domestic content and technology intensity of Chinese exports", Journal of Comparative Economics 41 (2013) 527–543

[91] Rodolfo Helg, Lucia Tajoli (2005), "Patterns of international fragmentation of production and the relative demand for labor", North American Journal of Economics and Finance 16 (2005) 233–254

6. Empirical analysis on determinants of Domestic Value Added

6.1. Empirical model

Borrowing from Hale and Long (2011), the following specification is commonly used among in factor-content analysis after shaving off city-specific and firm-specific subscripts because level of analysis is different in my thesis:

$$Y_{it} = \alpha_{it} + \alpha_{ct} + \beta_1 L_{it} + \beta_2 K_{it} + \beta_3 FI_{it} + \tau Z_{it} + \epsilon_{it}$$ [92] **(1)**

Subscripts i and t denote industry sector and time, respectively. L and K denote natural logarithm of labor and capital input of a sector in a year, respectively. FI refers to foreign shares in the total equities hold, or in other words, effective foreign investment. Z is a combination of various sector-specific characteristics, namely import intensity, production factor intensity, skill intensity etc… which are alike control variables of above setting in order to reach correct specification of above setting. a_{it} serve the fixed effect of sector and a_{ic} serve as time (year) dummy variables.

Residuals of above specification are assigned to the unobservable effects TFP. The residuals of natural log regression of output on natural log of capital and labor input factors are defined as TFP (Solow growth indicator) which is the part of production unable to be explained by production inputs.

[92] Galina Hale and Cheryl Long (2011) "Are There Productivity Spillovers from Foreign Direct Investment in China". This paper use firm-level data, this thesis reuses this widely-used model on industry-level data with references to procedure of Aggregation in Marc J.Melitz (2003)

$$Y_i = AK^{\alpha}L^{(1-\alpha)}$$

Dividing both sides by L

$$\frac{Y}{L} = A\left(\frac{K}{L}\right)^{\alpha}$$

Then take log of both sides again

$$Log\left(\frac{Y}{L}\right) = Log(A) + \alpha Log\frac{K}{L} \qquad \textbf{(2)}$$

Or

$$\mathbf{Log}(\boldsymbol{Y}) = \boldsymbol{Log}(\boldsymbol{A}) + \boldsymbol{\alpha Log}(\boldsymbol{K}) + (\mathbf{1} - \boldsymbol{\alpha})\boldsymbol{Log}(\boldsymbol{K}) \quad \textbf{(3)}$$

In this thesis, TFP serves to discover a possible mechanism of spillovers from foreign investment through improving productivity, then DVA and DVX of each sectors. Some papers explicitly attribute improvement of TFP to technological advancement, eventually capital input. Above equation offers another perspective of TFP through productivity and capital intensity. Additionally, there is probable positive spillover effects of foreign investment to TFP and contingent transmission to DVA or DVX. Fixed effects and pool data are queried in order to distinguish between within or between transmission mechanisms.

6.2. Description of variables and data

6.2.1. Calculation procedure of Domestic Value Added in exports of China

The raw data was collected from Input and Output Table initiated by EORA. The full set of EORA I-O table covers 187 countries represented by more than 15,900

sectors over the period of 2000 to 2011. [93] I found that EORA's country-based Input and Output whose raw data drawn from UN Comtrade, Eurostat, IDE/JETRO are most suitable for the purpose of this research because this thesis is only interested in DVA of China and its exports. Its methodology of construction is pledged to originate from U.N's "Handbook of Input-Output Table Compilation and Analysis". Its fundamental assumption is the proportional equivalence of all output produced by all establishments of entire economy and input of the products. The dataset provides high resolution of output, import, export, final demand and disaggregation of value added in each sector including both manufacturing, service at sector – aggregate level disregarding the problem of intermediate inputs and re-import and export.

This "competitive" I-O Tables do not distinguish difference of coefficients of intermediates input between normal trade and pervasive processing trade. Additionally, "from a single country perspective total exports (i.e. including intermediates) are considered as exogenous final demand in line with national accounting and the aim is to measure value added which is created domestically due to its total exports" (Neil Foster-McGregor, Robert Stehrer, 2013) [94]

Calculation of data is based on national account of intermediate input, output, and final demand as following

[93] http://worldmiro.com

[94] Neil Foster-McGregor and Robert Stehrer (2013), "Value added content of trade: A comprehensive approach", Economics Letters 120 (2013) 354–357

Value added + Intermediate Inputs + Import = Intermediates Outputs + Domestic Final Demand + Export

Then, within an economy, intermediates input and outputs are conceptually equal, return:

Value added + Import= Domestic Final Demand + Export

In which, value added is the sum of (1) compensation of employees (wage, for short); (2) subsidies on products incurred by machinery deprecation, lease etc… or capital input for short and (3) taxes on productions which nurture the regulatory environments of country's business.

Disregard of sector-specific intermediate inputs or outputs, intermediate inputs of the entire economy in general are interpreted as the products for non-final consumptions, but for the further process in their own sectors or the other sectors. Intermediate goods are constructed as matrix of cross-sector input-output matrix. Simple gesture of transformation can bring us about the inverse-Leontief matrix of production.

Imports include either imports of intermediate goods or final goods. In the view of exporting country, imports of another country are deemed as goods of final demand of exporting countries. Exports are seen as final demands either in form of intermediate goods or final goods because those goods quit the circulation of a country's production.

Final demands are composed of household, non-profit institutions serving households, government, gross capital formation[95], changes in inventories and acquisitions less disposal of valuables.

Withholding these definitions, sector-based value added is calculated effortlessly through accounts of Primary Input at the bottom of EORA MRIO input-output table. Understanding that outputs of entire economy serve domestic final demands and exports, DVA content in exports is a part of total value added. It is calculated by the weight of export to total output. In other words, DVA in export is assumed to follow identical constitution of final demand. In other words, value added is distributed homogeneously between final demand and export[96]. Heiwai Tang (2014) broadly simplify domestic value added (DVA) as the differences between values of final output and imported materials. Additionally, Cheng, Chen, Wei (2012) found that simple averages of processing and non-processing are equal in term of "direct, indirect and total effects of total exports on DVA and imports".[97] So the trouble of China's pervasive processing trade can be intentionally ignored in here.

And there has been also convergence of DVA between exports and domestic final demand as well as factor content of trade. Intermediate goods share of trade is roughly

[95]Gross Capital Formation is in the account of final demand due to their characteristic of inter-temporal use. Capital formed in a certain year is saved for following fiscal year.
[96]Comments on standard structure model of Input-Output table
[97]Chen Xikang, Leonard K. Cheng, K.C. Fung, Lawrence J. Lau, Yun-Wing Sung, K. Zhu, C. Yang, J. Pei, Y. Duan (2012), "Domestic value added and employment generated by Chinese exports: A quantitative estimation", China Economic Review 23 (2012) 850–864".

unchanged (Bridgman, 2011).[98]The proportionality assumption is eligible to be applied at this point. Therefore, arbitrarily, DVA (in exports) is given identity of

$$DVX_i = (Ex_i / X_i)\ (DVA_i)$$ [99]

i denotes respective industrial sectors. DVX_i is ratio of DVA to gross export, Ex_i is gross export, X_i is total output of industry i, DVA is defined afore - DVA of industry i.

Following DVA in exports calculated from the I-O Tables is the aggregation of sub-sector into sector-categorization system that matches China's statistical yearbooks. References of aggregating procedures are from detailed industrial sectors classification officially issued by Bureau of Statistics coded GB/T4754-2011. Industrial sector level of aggregate data help avoid the problem of product-based substitution or complementarity.

Additionally, EORA MRIO I-O Table in use is a competitive I-O table which ignores the existence of processing trade and normal trade as Chen, Cheng, Fung, Lau (2001) or Koopman, Wang, Wei (2012) elaborated because there is difficulty in decomposing factor contents reported in China' yearbooks. There are researches on empirics of fragmentation with use of sector-based aggregation, namely R Helg, L.

[98]Benjamin Bridgman (2011), "The rise of vertical special trade", Journal of International Economics 86/ 133-140, p.134

[99]Definition of DVX in this paper is identical to VAX ratio given in Robert C. Johnson and Guillermo Noguera (2011) "Accounting for intermediates: Production sharing and trade in value added", Journal of International Economics 86 (2012) 224-236, p.226

Tajoli[100]. And it was supportively concluded that "symmetric I-O Tables of the industry-by-industry type will most probably be more useful" than product-by-product-type commented by Timmer (2012)[101]. High level of aggregation possibly cause upward bias in estimation; however, much of interest surrounds the existence of determinant factors rather than their magnitude, upward bias is tolerable. The conversion table harmonizing EORA RMIO I-O Tables and China's Statistical Year Book and China's is in Appendix 1.

Limitation of data

The latest data from China's National Bureau of Statistics is available until 2013 whilst data from EORA I-O Tables can only excerpted until 2011. Withholding much attention to China's industrial sectors, especially, manufacturing sectors which accounts for more than 95% of China's gross export, this thesis is confined to only 39 industrial sectors covering the time span of 12 years from 2000 to 2011. However, the panel data is highly balanced.

6.2.1. Explanatory variables

Other data of average wage, equities in the sectors by types, number of employments, fixed assets, depreciation, expenditure on Science and Technology,

[100]Rodolfo Helg, Lucia Tajoli (2005), "Patterns of international fragmentation of production and the relative demand for labor", North American Journal of Economics and Finance 16 (2005) 233–254

[101]Marcel P. Timmer et.al, "The World Input-Output database: Contents, Sources and Methods", WIOD working paper no. 10, p.39

invention patents, expenditure on import of technology etc… were extracted from China Statistics Yearbooks of Industrial Sectors, China Statistics Yearbooks on Science and Technology and China Statistics Yearbooks on Population & Employment. Data cover firms of above certain scale defined by the National Bureau of Statistics. Those firms account for 98% of China's exports. [102]

Working capital (working_cap) is the asset liquefiable, salable or consumable within certain business cycle. It can be broadly understood as production inputs other than depreciation of fixed assets. Accumulated depreciation refers to accumulation of depreciation on fixed asset[103]. In Chuang and Hsu (2006), working capital is used as proxy for intermediate inputs.

Foreign presences refers to the ratio of FIEs to the total number of firms within an industry. Certainly, those industries, in which processing is pervasive tends to exhibit higher ratio.

Total capital hold is the all types of capital invested into a firm, which is also regulated to be equal to chartered capitals. One important segment of total capital hold is part of capital hold by Hong Kong, Macau, Taiwan and other foreign investors. Their summation apparently represents foreign investment in a firm. Capital hold may be in form of cash, fixed assets or intangible assets.

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[102] 戴觅，余淼杰 Madhura Maitra (2014), "中国出口企业生产率之谜： 加工贸易的作用", China Economic Quarterly, vol. 13. No.2

[103] China's National Bureau of Statistics, http://www.stats.gov.cn/tjsj/zbjs/201310/t20131029_449443.html, official definition

Intramural expenditure on science and technology is officially defined as actual expenditure on activities relating to science and technology, such as services, research management, non-infra fixed assets or basic science and likewise. Nevertheless, it does not include expenditure on direct production, liabilities payment.

Blonigen and Ma (2007)[104] theorized and problematized the relations between cost (ease) of technology transfer from foreign firms located in China in relation with relative price and market share. They also pointed that decision of inward FDI to China depends on cost-saving and cost of technology transfer, specifically expenditure on import of technology in interaction with FDI. It was found that joint-venture, a FDI-discouraging policy does not result in catching-up effects of export sophistication. Instead of using "product differentiation" and R&D intensity, this thesis uses expenditure in technology renovation, technology import and science and technology activities along with interaction terms to revise this argument. Expenditure on technology absorption (or its proportion in expenditure on technology) is expected that higher absorption capacity benefit more from foreign investment.

Heiwai Tang (2012) used firms (log) wage rate or ratio of labor cost to sale as to testify conventional view that the rising DVX is driven by rising labor costs. In this thesis, it is represented by total salary, average salary (remuneration) and annual average employment. Annual average employment, by default is calculated as the

[104]Bruce Blonigen and Alyson Ma (2007), "Please pass the catch-up: The relative performance of Chinese and Foreign firms in Chinese exports", NBER Working Paper No. 13376

arithmetic simple average of number of employed at the end of over 12 months. Average wage is sometimes used as the proxy assisting perception of skilled-labor intensity (Xu and Lu, 2009)[105].

The norms of elements intensity were used frequently in Fernandes and Heiwai Tang (2012) to describe the characteristics of observed unit(s) in panel data. This thesis employs a handful of element intensity indicators, namely (1) capital intensity of sectors as capital input per employment (2) skill intensity as ratio of personnel to total employment; Skill-intensity indicator is defined as ratio of technology, education-related to gross production values in Upward, Wang and Zheng (2013) (3) import intensity as ratio of import to total output under my previous assumption of foreign content-free export.

List of variables is found in full length in Appendix 2.

[105]Bin Xu, Jiangyong Lu (2009), "Foreign direct investment, processing trade, and the sophistication of China's export", China Economic Review 20 (2009) 425-439

7. Empirical results

7.1. General specification

This part shows general trend of DVA in export, and gives common sense of contribution factors to the DVA and DVX on the morale of bridging two paradigms of factor-content economics and value added. This part is dedicated to simple OLS and fixed- effect regression of available data as to demonstrate the most perceivable understanding of DVA and DVX regardless of an accurate specification of the model.

With regard to rough amount of DVA, the results are all statistically significant for all of critically important variables, namely average employment, accumulated depreciation, working capital, share of foreign equities (representation of foreign presence in the industry). Average employment is found positively relate to amount DVA in export, which firmly reassure a bare contribution of labor. Meanwhile, total capital input, broadly speaking has negative effects on DVA, but amongst depreciation and working capital, the former has much stronger negative magnitude than the later. It is roughly agreeable that labor is critical to the rise of DVA in export, which reflect conventional comparative advantages in (abundant) labor endowment and labor-intensive fragmented parts of productions that are assigned to China as predicted by theories. One additional unit of labor input certainly increase DVA by 1.5 ~ 1.7 in sharp contrast with negative contribution of capital input to DVA. Increase in

depreciation of fixed capital input exhibits negative relation with DVA, but not working capital which can be generalized into raw materials for production.

Also, as predicted, one unit increase in average salary increase merely equal amount of DVA remarkably. This finding partially explains recent rising labor cost due to enhancement of productivity.

Furthermore, upon the addition of foreign investment in (4) and (8), they all appear statistically positive significant whilst average employment and depreciation stay consistent over (1), (2), (3) and (4).

Unlike the use of dependent variable DVA, DVX reverses the signs of above coefficient due to existence of negative correlation between DVA and DVX as described in part 4. Average employment, working capital drag DVX down along with negative sign of foreign presence and foreign investment. Nevertheless, average salary remains positive to DVX. More employment conclusively reduce value of domestic content compared to exports which might contribute to pervasive processing trade characterizing in labor-intensiveness. Overall increased labor costs adds more weight of DVA in total export.

Table 7: OLS results of general specification

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	ln(DVA)	ln(DVA)	ln(DVA)	ln(DVA)	DVX	DVX	DVX	DVX
ln_avrg_employment	1.159***	0.885***	1.385***	1.749***	-0.0639***	-0.0391***	-0.0223	0.00842
	(0.128)	(0.137)	(0.198)	(0.193)	(0.00933)	(0.0100)	(0.0146)	(0.0151)
ln_accu_depreciation		-0.987***	-1.064***	-1.137***		0.0544***	0.0518***	0.0430***
		(0.153)	(0.153)	(0.134)		(0.0112)	(0.0113)	(0.0105)
ln_working_cap		0.755***	0.295	0.340		-0.0710***	-0.0864***	-0.0739***
		(0.206)	(0.243)	(0.232)		(0.0151)	(0.0180)	(0.0181)
ln_total_capital	-0.448 ***				0.00487			
	(0.116)				(0.00840)			
ln_avrg_salary			1.019***	0.906***			0.0342	0.0390*
			(0.294)	(0.270)			(0.0217)	(0.0211)
ln_foreign_investmnet				0.192***				-0.0427***
				(0.0664)				(0.00520)
Observations	424	424	424	411	424	424	424	411
R-squared	0.232	0.287	0.307	0.507	0.245	0.287	0.291	0.411

Above is OLS regression. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The role of import (Table 8)

As proxy for imports of intermediate goods for either processing trade or final demand, this important control variable is added to above specification in order to stylize China's pervasive processing trade pertaining to large import and export. Imports optimistically enable China to create more domestic values without causing any harms to domestic productions as final consumptions are not confined within the country. Therefore, this part is dedicated to the role and extents of import in domestic production as trade theories are only able to predict pattern of trade, but not the volume.

Firstly considering (1) to (5) of Table 8 where ln(DVA) is dependent variable, there is not significant changes of pattern in interested variables in term of magnitude or sign. 1% Increase in import overall increase DVA at around 0.2% as seen in (3).

After appending foreign factors (foreign share in total capital hold of the sectors), the positive coefficients of imports do not change sign as seen in (1), (2), (3) and (4). Import is a very important determinant of DVA.

Foreign investment is not found significant in most cases of ln(DVA) as dependent variable, but it is not consistent in all specifications except for (5). In (5) it is very interesting to find that share of foreign investors in a sectors significantly reduce DVA even though foreign investments contribute less than that even though foreign investment is positive significant. So there is a ceiling of accommodating foreign investment to generate increase in DVA. On the other hand, interaction term between import and share of foreign investors is found significantly positive in (5), (9) and (10).

Except for the concrete importance of foreign factors and imports to DVA, average salary, employment remain positive relation to DVA.

Therefore, FIEs induce imports, understandably, intermediate inputs which lead to further increase of value of domestic production. Further labor-intensive process increases demands for labors along with consequent rising remunerations to labors and DVA.

Secondly, observing DVX from (6) to (10), signs of coefficients virtually reserve. More import asserts downward pressures on proportion of DVA in export. Despite that imports certainly increase gross value of DVA as demonstrated above, in revert it imposes heavy punishment on relative value of DVA to exports. Processing trade accommodates value of imports in associated exports. So, there is not much improvement of China in the production value over years. Foreign presence in a sector drag down DVA and DVX found in (5), (9) and (10); however, in case of fixed effects foreign investment contribute positively to DVA and DVX.

OLS and fixed effects (Table 8)

The construction of statistical significances is not changed if the fixed effects is applied, but remarkable change in the magnitude of respective coefficient. The phenomenon is attributable to unobservable characteristics of each sector.

Firstly, the case whose dependent variable is natural logarithm of DVA, questionable large difference between OLS and fixed effects of sector further gives cue to problem of between and within variation in pairwise regression of (2)-(3), (4)-(5), (7)-(8) and (9)-(10) demonstrate that in each sector, import, salary and interaction term

between share of foreign investors and import survive the fixed effects. Share of foreign capital contributions remain negative, associated positive spillovers of foreign investment is proved to exist.

Secondly, in the same table, when DVX is dependent variable, the fixed effect surprisingly change the positive sign of foreign investment compared to OLS, but other variables are quite robust. Negative coefficients of share of foreign investors as proxy of foreign presence in each industry is seen larger in magnitude. It persuasively conveys the nature of foreign investment in each sector. In short, FIEs and their investment incur reduction of DVX in the mechanism of utilizing inexpensive labors who are only capable of generating decent DVA compared to exported goods to which FIEs contribute large shares.

Positive coefficients of interaction term between import and share of foreign investors imply that presence of foreign investors are likely to encourage industry sectors to import more,[106] thus contributes more to the DVX, particularly sectors of pervasive processing trade. The magnitude of negative effect of import is enlarged when interaction between import and share of foreign capital is introduced.

Therefore, simple conclusion can be drawn that sectors in which foreign firms import more intermediates goods cause reduction of DVX due to activities of importing. On the other hand, FIEs improves both DVA and DVX, but the heavy weight of share of foreign investors reduce DVA and DVX.

[106]The data show that industry which import more aggressive are likely those in which there are more ubiquitous presence of FIEs

Table 8: Inclusion of Imports to general specification

VARIABLES	(1) ln_export_va2	(2) ln_export_va2	(3) ln_export_va2	(4) ln_export_va2	(5) ln_export_va2	(6) DVX2	(7) DVX2	(8) DVX2	(9) DVX2	(10) DVX2
ln_avrg_employment	0.742***	1.456***	0.0347	1.474***	-0.0516	-0.0280***	0.0304**	-0.00728	0.0281**	-0.0184*
	(0.119)	(0.194)	(0.144)	(0.194)	(0.148)	(0.00851)	(0.0139)	(0.0110)	(0.0139)	(0.0112)
ln_accu_depreciation	-0.904***	-0.948***	0.289*	-0.938***	0.175	0.0480***	0.0443***	-0.00783	0.0430***	-0.0226*
	(0.132)	(0.141)	(0.161)	(0.141)	(0.168)	(0.00948)	(0.0101)	(0.0123)	(0.0101)	(0.0127)
ln_working_cap	0.195	0.180	-0.420**	0.191	-0.361**	-0.0277**	-0.0347**	-0.0126	-0.0362**	-0.00499
	(0.184)	(0.230)	(0.163)	(0.230)	(0.164)	(0.0132)	(0.0165)	(0.0124)	(0.0165)	(0.0124)
ln_avrg_salary		0.556**	0.579***	0.567**	0.654***		0.0535***	0.0214	0.0520***	0.0313**
		(0.272)	(0.178)	(0.272)	(0.180)		(0.0195)	(0.0136)	(0.0195)	(0.0136)
ln_foreign_investment		-0.0441	0.0823	-0.0725	0.116*		-0.0335***	0.00813*	-0.0297***	0.0125***
		(0.0835)	(0.0607)	(0.0871)	(0.0622)		(0.00600)	(0.00464)	(0.00623)	(0.00470)
share_foreign		1.001**	-0.169	5.891	-6.928**		0.0782**	-0.0152	-0.569*	-0.890***
		(0.434)	(0.165)	(4.330)	(3.016)		(0.0312)	(0.0126)	(0.310)	(0.228)
ln_import_share_foreign				-0.308	0.428**				0.0408**	0.0554***
				(0.272)	(0.191)				(0.0194)	(0.0144)
ln_import	0.850***	0.476***	0.221***	0.544***	0.109	-0.0656***	-0.0683***	-0.0467***	-0.0773***	-0.0613***
	(0.0702)	(0.0913)	(0.0584)	(0.109)	(0.0767)	(0.00504)	(0.00655)	(0.00447)	(0.00782)	(0.00578)
Constant	2.080**	-0.796	5.737***	-2.063	7.282***	1.336***	0.798***	0.951***	0.965***	1.151***
	(0.843)	(2.227)	(1.132)	(2.490)	(1.319)	(0.0605)	(0.160)	(0.0865)	(0.178)	(0.0995)
Observations	424	411	411	411	411	424	411	411	411	411
R-squared	0.472	0.544	0.404	0.546	0.412	0.493	0.541	0.514	0.546	0.533
Number of id			39		39			39		39
Fixed effects			YES		YES			YES		YES

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Inclusions of sector-specific variables (Table 9)

Table 9 appends other sector-specific characteristics. Similar procedures of regression were repeated after adding control variables of sector-specific elements and applied OLS and fixed-effects regressions.

In fixed effects, behaviors of variables are predictable, sectors that import more aggressively results in higher DVA. Depreciation of fixed capital assets and working capital are respectively in positive and negative relation with DVA. In other words, fixed assets contribute more to growth of DVA. In case of ln(DVA) as dependent variable, capital intensity of sectors is not found significant in (2) and (4). Thus, any increase of DVA does not depend on capital intensity of sectors.

Skill intensity place lifting force on DVA, which is interpreted that enhancement of labor force benefits growth of DVA, specifically when labor-intensive processing trade is concentrated in highly sophisticated sectors. Consequently, higher skill intensity results in higher productivity and remuneration. Supportively, upon the inclusion of the interaction term employment turned negative significant in fixed effect (6). The known advantage in abundance of labor does not contribute to DVX, but their improved productivity and skill.

Alike natural log of DVA, when DVX is dependent variable as seen in (5) to (8), intensity of imports remains robust manifesting in positive significance in fixed-effect model. And as expected, higher productivity help sector increase more claim in DVA of export. However, it is interesting to find negative coefficient of capital intensity. The

Table 9: Inclusion of sector-specific elements to general specification

VARIABLES	(1) ln(DVA)	(2) ln(DVA)	(3) ln(DVA)	(4) ln(DVA)	(5) DVX	(6) DVX	(7) DVX	(8) DVX
share_foreign	0.923***	-0.0330	1.266***	-0.220	-0.0719***	-0.000288	0.0774***	-0.0213
	(0.333)	(0.125)	(0.420)	(0.170)	(0.0252)	(0.0100)	(0.0293)	(0.0136)
ln_avrg_employment	1.884***	0.0551	1.875***	0.00890	0.0268*	-0.0139	0.0226	-0.0191*
	(0.203)	(0.137)	(0.203)	(0.140)	(0.0153)	(0.0110)	(0.0141)	(0.0111)
ln_avrg_salary	0.776***	0.303	0.693**	0.325	0.0927***	-0.00578	0.0565***	-0.00333
	(0.278)	(0.217)	(0.285)	(0.217)	(0.0210)	(0.0173)	(0.0198)	(0.0173)
import_intensity	2.650	3.241*	3.014	3.346*	-0.506***	0.395***	-0.348**	0.407***
	(2.187)	(1.705)	(2.202)	(1.702)	(0.165)	(0.136)	(0.153)	(0.136)
ln_accu_depreciation	-0.620***	0.660***	-0.632***	0.663***	0.0497***	0.00226	0.0443***	0.00259
	(0.144)	(0.177)	(0.144)	(0.177)	(0.0109)	(0.0142)	(0.0100)	(0.0141)
ln_working_cap	-0.0897	-0.357**	-0.0272	-0.398**	-0.129***	-0.0197	-0.102***	-0.0244*
	(0.246)	(0.165)	(0.250)	(0.166)	(0.0186)	(0.0132)	(0.0174)	(0.0132)
skill_intensity	3.354	4.109***	4.142	3.875***	-0.329	-0.0446	0.0147	-0.0710
	(3.187)	(1.186)	(3.238)	(1.192)	(0.241)	(0.0949)	(0.226)	(0.0950)
productivity	49.38**	5.187	55.15**	4.698	-11.25***	2.560***	-8.735***	2.505***
	(22.81)	(11.81)	(23.19)	(11.78)	(1.725)	(0.945)	(1.615)	(0.939)
sector_capital_intensity	-121.6**	6.694	-135.7**	14.12	13.81***	-7.501***	7.674*	-6.666***
	(56.82)	(23.20)	(57.73)	(23.59)	(4.297)	(1.856)	(4.021)	(1.881)
ln_tech_absorb_share_foreign			-0.0142	0.0120			-0.00621***	0.00135**
			(0.0107)	(0.00741)			(0.000742)	(0.000591)
ln_tech_absorb	0.168***	-0.0207	0.134**	0.00322	0.0104**	-0.000996	-0.00469	0.00169
	(0.0584)	(0.0222)	(0.0638)	(0.0266)	(0.00441)	(0.00178)	(0.00444)	(0.00212)
Observations	392	392	392	392	392	392	392	392
R-squared	0.606	0.460	0.608	0.464	0.439	0.386	0.527	0.396
Number of id		37		37		37		37
Fixed effect		YES		YES		YES		YES

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

more capital intensive the sector is, the less DVX it is due to heavy weight of top DVA sectors which pose low DVX. Structural improvement in value of production ironically took place in less capital-intensive or natural resource-intensive sectors.

Role of technological advancement and foreign investments

Technology advancement is perceived to be inherited from FIEs, the following broadest specification appends interaction term between capability of absorbing new technology and foreign factors (share of foreign investors).

$$\ln(DVA)_{it} \text{ or } DVX_{it} = \alpha_{it} \ln(\text{avrg\_employment}) + \beta_{it} \ln(\text{avrg\_salary}) + \gamma_{it} \text{ import\_intensity} + \delta_{it}\ln(\text{accu\_depreciation}) + \zeta_{it}\ln(\text{working\_cap}) + \eta_{it}\text{sector-specific characteristics} + \theta_{it}\ln(\text{expenditure on technology}) + \iota_{it} \text{ share\_foreign} + \kappa_{it} \ln(\text{expenditure on technology*share\_foreign}) + \lambda_{it} \text{ share\_foreign} + \varepsilon_{it}$$

Foreign investment failed significant tests in these specifications when technology is introduced into this specification. The inclusion of technology absorption capacity survive in OLS only, but not fixed effects when ln(DVA) is dependent variable (1) ~ (4).

Interaction term of tech absorption and foreign presence turn positively significant in (8) as DVX is dependent variable. Interaction term between expenditure on technology absorption and presence of FIEs is positive to DVX, which can be interpreted that FIEs to some extent bring about technology upgrade, then a positive contribution to the increase share of domestic contents in final exports. Better absorptive capacities from FIEs in a sector produce substitution effects from imported intermediate goods to domestic suppliers' ones as the magnitude of import intensity reduces when the interaction term is included.

Productivity of labors remain positive statistically significant as seen in (6) and (8).

Being mindful that even though there is positive sign of interaction term in (8), but sector capital intensity is found negative significant. Thus, less capital intensive sectors that receive more foreign investment and retain better absorption capacity contribute more to DVX. Therefore, we can expect spillover effects of foreign elements that happen selectively across industrial sectors.

Notably, when the interaction term between technology absorption and share of foreign investors is appended, the magnitude of import intensity, is enlarged. Import is a channel for FIEs and domestic firms improve value of domestic production added to exports.

In order to affirm the consistency of specifications afore, the gross values of DVA were regressed on non-log values of explanatory variables, which returns a virtually identical pattern of signs.

7.2. Spillover effects of foreign investments on Domestic Value Added

This strategy of analysis has been widely applied throughout my literature reviews. Javarcik (2004) suggested that unobserved (total factor) productivity is the function of

observable investment and capital.[107] Or Hale and Long (2011) consider it as the residual of regression of firm's value-added on labor and capital input from popular Cobb-Douglass production equation.[108] The residuals of regression are generalized to represent technological progress.

Being derived from above empirical model:

$$\text{Log (total output)} = \alpha_i \log(K_{it}) + \beta_i \log(L_{it}) + a_{it} + \varepsilon_{it} \quad \textbf{(4)}$$

In this setup, the a_i, as residual of above setting captures all possibility of unobservable effects contributing to DVA that is neglected by capital and labor input. Along with error term, a_i is called TFP. The model will make further specification of a_i (Hale and Long, 2012) in order to understand any possible spillover effects of foreign investment to TFP.

If we attribute a_i to the direct result of foreign investment and other sector-specific elements as summarized in literature reviews, the specification of TFP is:

$$a_i = \text{foreign investment}_i + \text{other sector-specific explanatory variables}_i + \varepsilon_i$$

Following empirical setting serves to learn about the growth pattern of TFP is:

$$a_i = \alpha_i \text{ year}_i + \beta_{it} \text{ sector}_i + \gamma_i \text{ foreign investment}_i + \theta_i \text{ sector-specific explanatory variables}_i + \varepsilon_i$$

[107] Beata Smarzynska Javorcik (2004), "Does FDI increase productivity of Domestic Firms – in Search for Spillovers through Backward Linkages", The American Economic Review, Vol. 94, No. 3, p605-627

[108] Galina Hale and Cheryl Long (2011), "Are There Productivity Spillovers from Foreign Direct Investment in China?", Pacific Economic Review, 16/135-153

in which, $year_h$ and $sector_i$ are fixed effect of year and sector, respectively. The year fixed effects is applied in (3) and (6) only. With 2001 as base period, coefficients of year fixed effects had been statistically significant on the rise over time. Following table looks into the cause of TFP growth.

This regression was conducted in Heiwai Tang's fashion. The pattern of results is quite consistent in either case. Observing the OLS, fixed effects and fixed effects with year-fixed effects, Improvement in TFP can be concluded to happen within sector and TFP growth very steadily over years in each sector with few outliers.

Table 10: Determinants of a_i or TFP

VARIABLES	(1) ln(DVA)	(2) ln(DVA)	(3) ln(DVA)	(4) ln(DVA)	(5) ln(DVA)	(6) ln(DVA)
ln_foreign_investment	0.137***	0.215***	0.108***	0.133*	0.365***	0.177***
	(0.0267)	(0.0217)	(0.0131)	(0.0711)	(0.0503)	(0.0297)
sector_capital_intensity	102.5***	68.66***	13.35***	102.5***	71.70***	15.58***
	(8.164)	(5.979)	(4.019)	(8.175)	(5.968)	(4.080)
ln_tech_import	0.145***	-0.0164	0.0217***	0.143***	0.0628**	0.0548***
	(0.0176)	(0.0127)	(0.00785)	(0.0394)	(0.0271)	(0.0150)
ln_import	0.338***	0.451***	0.0975***	0.338***	0.444***	0.0990***
	(0.0353)	(0.0340)	(0.0289)	(0.0357)	(0.0336)	(0.0287)
ln_tech_import_foreign_investment				0.000473	-0.0161***	-0.00721**
				(0.00731)	(0.00489)	(0.00280)
Observations	392	392	392	392	392	392
R-squared	0.774	0.878	0.964	0.774	0.882	0.965
Number of id		38	38		38	38
Sector fixed effect	NO	YES	YES	NO	YES	YES
Year fixed effect	NO	NO	YES	NO	NO	YES

This table does not report the year-fixed effect in full length.
Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Foreign investment is also found all positive significant along with capital intensity of sector and import of technology. Thus, TFP growths faster in more capital-intensive

sector, and sectors with more foreign investment. The role of foreign investment, capability of importing technology is critical to growth of TFP as associated coefficients are respectively positive significance due to very robust results in any model above. Interaction term between technology import and foreign investment is negatively significant.

If the argument of positive spillovers from foreign investment works through mechanism of improvement in TFP as priori, aforementioned regression in table (9) and (10) were repeated to check its magnitude of contribution to the growth of DVA.

Table 11: Spillover effects of foreign investment on DVA through TFP

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	**ln(DVA)**	**ln(DVA)**	**ln(DVA)**	**ln(DVA)**	**ln(DVA)**	**ln(DVA)**
resi_fe	0.306***	0.504***	0.352***	0.559***	1.260***	0.327***
	(0.0912)	(0.0511)	(0.108)	(0.0540)	(0.218)	(0.108)
ln_foreign_investment	0.428***	0.00821	0.360***	-0.0105	0.814***	-0.215*
	(0.0726)	(0.0476)	(0.0730)	(0.0475)	(0.268)	(0.126)
import_intensity	10.75***	1.876	10.11***	2.972*	11.35***	3.087*
	(2.467)	(1.413)	(2.575)	(1.697)	(2.474)	(1.693)
ln_tech_import			0.146***	0.00361	0.0481	0.00549
			(0.0559)	(0.0248)	(0.0554)	(0.0249)
TFP_foreign_investment (a)					-0.0736**	0.0251*
					(0.0318)	(0.0134)
sector_capital_intensity					-164.7***	20.98
					(27.64)	(13.49)
Observations	411	411	392	392	392	392
R-squared	0.321	0.356	0.357	0.385	0.419	0.395
Number of id		39		38		38

Standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Coefficient of TFP is found positive significant in all cases and the coefficients are relatively robust amongst same-kind regression. And coefficient of interaction term between TFP and foreign investment is positive in case of fixed effect only. Any

increase in TFP is translated directly into increase of DVA despite that within industry, heavy weight of foreign investment in sectors that knowingly have pervasive processing trade lowers DVA remarkably regardless of foreign investment.

Sector capital intensity and technology import lost its significance in (6) and all of coefficients experience reduction in magnitude except for intensity of import when interaction term is included. However, foreign investment is adversely the cause of improved TFP as *combined effect of interaction term (a)* and *TFP is always positively significant* in any specification. So, foreign investment and FIEs are indeed an important channel of improving domestic content of exports through spillover effects as long as TFP growth over time.

8. Conclusion

The account of DVA is found helpful in discerning actual production of China. Exports of China fail to show their colossal magnitude if the pervasive nature of labor-intensive processing trade is taken into account. Calculation of value added on sector level reverts the widely increased sophistication of China's trade. China's comparative advantage in labor has been never seen to cease, eventually in those industry sectors which are tagged high sophistication. China's integration to global economics upon accession to WTO would drive down DVX albeit of rising DVA. Therefore, China's value of domestic proportion in exports has been on slight decrease. However, there is seeable urge of upgrading technology and TFP in order to climb up in the value chains along with certain improvement of skill, productivity and remuneration to labors.

Considering pervasive processing trade, the recalculated value of China's DVA embedded in export contracts significantly due to participation in low value-added fragments of sophisticated products. Export-leading industries, namely Manufacture of Computers and Electronic equipment, machinery of all types etc… are those which import most as the consequence of reduction in tariffs and transaction costs.

This thesis is at best efforts of collecting data and managing the relation between two paradigms of factor contents and value added. The Input-Output Table is found helpful in stratifying actual values generated in each sector. Proactive participation of China in production network make the record of gross export err in further implication from impacts of trade. DVA and DVX are two in-use dependent variables serving two

different concepts, the former is absolute mass value and latter refers to structural improvement in production of sector.

Application of Input-Output Table has helped refine the picture of China's special characteristic of export. DVA has been on steady rise in contrast to slight decrease in DVX as presence of foreign firms increase import of intermediate goods for processing trade. In sequence, increasing demand for imported input pulls up demand and import price while supply of export increase. Rising remuneration to labors as the cost of enhanced skills and productivity is a critical contributor to either DVA or DVX. However, despite that foreign presence in industry sectors indeed brings about positive effects of expenditure on technology which then return in DVA and DVX, but there is an intangible threshold of foreign investment in a sector. Upgrade of technology brings about increase of domestic contents in gross export but to a certain extent. Technology upgrade induces FIEs to substitute imported intermediate with domestic ones. Conclusively, if less capital intensive sector has better capacity of technology absorption and receive foreign investment, it will generate more value of domestic production in exports (higher DVX). This is a cue to structural upgrade of domestic production reaching higher value added.

Furthermore, this thesis also indirectly establishes connection between FIEs, their investment and spillover effects upon TFP. Foreign investment indeed help the growing TFP over time. Incorporating with foreign investment, effects of TFP is enlarged remarkably. Increasing TFP is found the constructive factors to the

improvement of DVA and DVX, somewhat through FIEs and their investments. But this thesis cannot forge in-depth algorithm of transmission due to complex accounts of upstream and downstream sectors, but succeed in pinpointing critical determinant factors of DVA.

Most important, even though imports may be criticized to hurt those infant industries, but China's pervasive processing trade is so special that import indeed contribute much to upgrade of domestic production via FIEs, foreign investments and pertaining technology, skill and productivity upgrade.

Through flexible use of control variables, this thesis redefines several determinants of Domestic Value Added despite structural and conceptual limitation of data. Findings are, still agreeably in line with reviewed trade theories albeit of limited data.

The limitation of this thesis is much attributed to lack of comprehensive data at deeper level of disaggregation of sectors, say at 2 or 3 digit as seen in China's Economic Census Yearbook and in-detail data of different identities of economic entities such as SOEs, private, foreign-invested as their natures and characteristic vary significantly. Firm-based data is also in need in order to set up mechanism of spillover effects from upstream FIEs to downstream domestic firms.

Appendix 1. Conversation table of EORA I-O Table to China's NBR

Industries classified in EORA I-O Table	**Industries classified in sector classification of China's national economy (GB/4754-2011) (Chinese)**	**Industries classified in sector classification of China's national economy (GB/4754-2011) (English)**
Coal mining and processing	煤炭开采和洗选业	Mining and Washing of Coal
Crude petroleum products and Natural gas products	石油和天然气开采业	Extraction of Petroleum and Natural Gas
Ferrous ore mining	黑色金属矿采选业	Mining and Processing of Ferrous Metal Ores
Non-ferrous ore mining	有色金属矿采选业	Mining and Processing of Non-Ferrous Metal Ores
Salt mining	非金属矿采选业	Mining and Processing of Non-metal Ores
Non-metal minerals and other mining	其他采矿业	Mining of Other Ores
Grain mill products	农副食品加工业	Processing of Food from Agricultural Products
Feeding stuff production and processing		
Vegetable oil and forage		
Sugar refining		
Slaughtering , meat processing, eggs and dairy products		
Prepared fish and seafood		
Other food products	食品制造业	Manufacture of Foods
Wines, spirits and liquors	酒、饮料和精制茶制造业	Manufacture of Liquor, Beverages and Refined Tea
Non-alcoholic beverage		
Tobacco products	烟草制品业	Manufacture of Tobacco
Cotton textiles	纺织业	Manufacture of Textile
Woolen textiles		
Hemp textiles		
Other textiles not elsewhere classified		
Knitted mills	纺织服装、服饰业	Manufacture of Textile, Wearing Apparel and Accessories
Wearing apparel		
Leather, furs, down and related products	皮革、毛皮、羽毛及其制品和 制鞋业	Manufacture of Leather, Fur, Feather and Related Products
Sawmills and fibreboard	木材加工和木、竹、藤、棕、草制品	Processing of Timber, Manufacture of Wood, Bamboo, Rattan, Palm and Straw Products
Furniture and products of wood, bamboo, cane, palm, straw, etc.	家具制造业	Manufacture of Furniture
Paper and products	造纸和纸制品业	Manufacture of Paper and Paper Products
Printing and record medium reproduction	印刷和记录媒介复制业	Printing and Reproduction of Recording Media

Cultural goods	文教、工美、体育和娱乐用品制造业	Manufacture of Articles for Culture, Education, Arts and Crafts,
Toys, sporting and athletic and recreation products		
Cultural and office equipment		
Arts and crafts products		
Petroleum refining	石油加工、炼焦和核燃料加工业	Processing of Petroleum, Coking and Processing of Nuclear Fuel
Coking		
Raw chemical materials	化学原料和化学制品制造业	Manufacture of Raw Chemical Materials and Chemical Products
Chemical fertilizers		
Chemical pesticides		
Chemicals for painting, dying and others		
Synthetic chemicals		
Chemicals for special usages		
Chemical products for daily use		
Medical and pharmaceutical products	医药制造业	Manufacture of Medicines
Chemical fibers	化学纤维制造业	Manufacture of Chemical Fibres
Rubber products	橡胶制品业	Manufacture of Rubber
Plastic products	塑料制品业	Manufacture of Plastics Products
Cement and cement asbestos products	非金属矿物制品业	Manufacture of Non-metallic Mineral Products
Glass and glass products		
Pottery, china and earthenware		
Fireproof products		
Other non-metallic mineral products		
Iron-smelting	黑色金属冶炼和压延加工业	Smelting and Pressing of Ferrous Metals
Steel-smelting		
Steel-processing		
Alloy iron smelting		
Nonferrous metal smelting	有色金属冶炼和压延加工业	Smelting and Pressing of Non-ferrous Metals
Nonferrous metal processing		
Metal products	金属制品业	Manufacture of Metal Products
Boiler, engines and turbine	通用设备制造业	Manufacture of General Purpose Machinery
Metalworking machinery		
Other general industrial machinery		
Agriculture, forestry, animal husbandry and fishing machinery	专用设备制造业	Manufacture of Special Purpose Machinery
Other special industrial equipment		
Railroad transport equipment		
Motor vehicles	交通运输设备制造业	Manufacture of Transport Equipment
Vehicles fittings production		
Ship building		
Other transport machinery		
Generators	电气机械和器材制造业	Manufacture of Electrical Machinery and Apparatus
Household electric appliances		
Other electric machinery and equipment		
Communication equipment	计算机、通信和其他电子设备制造业	Manufacture of Computers, Communication and Other Electronic Equipment
Electronic computer		
Other computer devices		

Electronic element and device		
Electronic appliances		
Other electronic and communication equipment		
Instruments, meters and other measuring equipment	仪器仪表制造业	Manufacture of Measuring Instruments and Machinery
Other manufacturing products	其他制造业	Other Manufacture
Scrap and waste	废弃资源综合利用业	Utilization of Waste Resources
Electricity and steam production and supply	电力、热力生产和供应业	Production and Supply of Electric Power and Heat Power
Gas production and supply	燃气生产和供应业	Production and Supply of Gas
Water production and supply	水的生产和供应业	Production and Supply of Water

Appendix 2. List of variable abbreviation

Abbreviation	Remarks
accu_depreciation	accumulated depreciation of an industry
avrg_employment	average employment in an industry
avrg_salary	average salary
DVA	domestic value added in export of an industry
DVX	ratio of DVA to gross export of an industry
foreign equity	equity hold by foreigners in an industry
foreign_presence	ratio of number of FIEs to total number of firms in an industry
import_intensity	ratio of import to total output in an industry
import_share_foreign	interaction term between import and share of equity hold by foreign investors
productivity	value of products produced by an employee of an industry
science_intensity	ratio of expenditure on science and technology to total output in an industry
sector_capital_intensity	ratio of total capital to total remuneration to employees
share_forein	share of equity hold by foreigner investors in an industry
skill_intensity	ratio of total number of science and technology personnel to total employment in an industry.
tech_absorb	expenditure on absorbing new technology
tech_import	expenditure on importing technology
tech_ren	expenditure on technology renovation of an industry
tech_ren_foreign_presenc e	interaction term between expenditure on technology renovation and presence of FIEs in an industry
total_capital	sum of working capital and fixed asset
working_cap	working capital of an industry
ln_*	is the natural logarithm of any of variables above

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국문초록

중국 수출에서 국내 부가가치의 결정요인:
산업부문의 실증분석

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중국은 저렴한 인건비로 생산 네트워크에 적극적으로 진입함으로써 전체수출의 급속한 성장을 할 수 있었다. 또한 二元적인 무역정책에 대한 시도로 인하여 중국정부의 지원을 받으면서 가공(加工)무역 체재를 실현해온 바, 중국의 개혁개방(改革開放)후 외국투자가 연속적으로 증대하고 있다.

산업의 무역이 전 세계에 널리 퍼지면서 무역 수출총액을 측정하는 것이 매우 복잡해졌고 더 나아가 이는 무역에 대한 정확한 그림을 그리는 것을 어렵게 하고

있다. 더불어, 외국인 투자가 무역과 산업을 구조적으로 변화시키려는 요소로써 인정받으면서 그 역할이 강조되고 있다..

본 논문은 산업부문의 측면에서 2001 년부터 2011 년까지의 외국인 투자 및 다양한 산업부분으로 인한 수입과 인건비의 증가, 긍정적인 스필오버 효과로 발생하여으며 이로 인해 생긴 특별한 무역의 특징과 국내 부가가치의 증대에 대해 설명하고 있다. 독특한 무역의 특징, 수입 및 인건비 일으키는 국내의 부가가치의 증가, 외국인 투자의 누출 효과 및 기타 산업부문의 요소에 대하여 설명하자고 한다.

본 논문은 역대 이론과 국내부가가치의 결정요인을 분석하는데 노력하였으며 실증결과를 정확하게 재검토하기 위하여 다양한 수준의 데이터와 경쟁적인 “EORA MRIO 투입-생산 테이블”을 사용함으로써 차별성을 보여주고 있다.

주요어

국내 부가가치, 요수의 밀집도, 외국인 투자, 투입-생산 테이블, 누출 효과

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