Emphasis on domestic value added in export in the era of global value chain: Evidence from Thailand

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Abstract

This paper examines the appropriateness of using the share of domestic value added (value added ratio) of exports in assessing the effectiveness of trade and industrial policy in promoting a pro-poor gain from export. The formal empirical analysis adopts Thailand as a case study, and employs a mixture of input-output analysis and panel econometrics to model the relationship between value added ratio and export performances indicators. The findings fail to support the relationship between value added ratio and net-export earnings and export-induced income. The results also suggest that value added ratio is negatively related with the labor income share.

JEL Classification Codes: O19, D57, F13, F16
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1. Introduction

Cross-border dispersion of production processes within vertically integrated global industries, which we label 'global production sharing (GPS)' in this study,[1] has been an increasingly important structural feature of economic globalization in recent decades. This phenomenon opens opportunities for countries to specialize in different slices (tasks) of the production process in line with their relative cost advantages, instead of producing a given product entirely within its national boundaries. As the production processes are finely sliced across a wide range of industries, driven by improvements in production technology, innovations in transportation and communication, new opportunities for specialization are created for specialization within global production networks (Antràs, 2016; Athukorala, 2014; Baldwin, 2016; Feenstra, 2009; Jones, 2000; Jones and Kierzkowski, 2001; Helpman, 2011).

With the rise of GPS, many countries have seen the decline in the domestic value added in exports (value added ratio). Policy makers in many developing countries are now worrying about falling value added ratio (as a result of joining global production networks) and aspiring to increase domestic value added contribution to export (Dollar et al., 2019). Such concern may originate from the view that a lower domestic content of export means less total value added of exports and thus smaller Gross Domestic Product (GDP). Examples are Thailand's 20-year National Strategy (NESDB, 2018), Malaysia's national policy on industry 4.0 (commonly known as Industry4WD), and Indonesia's medium-term development plan (RPJMN). Nevertheless, these policies aimed at strengthening value

[1] This phenomenon is variously known as 'global production sharing,' 'international production fragmentation,' 'vertical specialisation,' and 'slicing up the value chain'. Henceforth, global production sharing (GPS) is used throughout the paper.

added ratio could result in higher degree of protectionism in the form of restrictions on intermediate goods imports (Athukorala and Patunru, 2019).

This paper aims to examine the justification of using domestic value added ratio as a policy guidance to promote economic growth in the era of economic globalisation through a case study of Thailand. Thailand is an excellent case study of this subject at hand because of the degree of engagement in global production networks and the availability of data covering a period of sufficient length for the empirical analysis. The analysis is based on domestic value added ratio and two export performances (net-export earnings and export-induced income) and two developmental gains (the ratio of wage to total value added and the ratio of wage to profit) calculated by applying the input-output technique to Thailand input-output tables for 1990, 1995, 2000, 2005 and 2010.

Of course, generalization from a single case has its pitfalls, but the insights gained from the study would be useful for economic analysts and policy makers in other countries in assessing employment and equity implications of engagement in global production networks in the process of export-led industrialization. Multi-country, cross-sectional studies are only a means of testing validity of generalization. Individual-country case studies have an important complementary role to play in broadening our understanding of the underlying process of growth and structural adjustment in order to inform the policy debate.

This paper finds little empirical support for the view that value added ratio is a crucial determinant of net-export earnings and export-induced income. The results also suggest that an increase in value added ratio is associated with a decrease in the share of wage in total value added and the share of wage to profit, which can run counter economic development. In the meantime, this paper stresses that global production network is a critical influence in export performances.

The paper is structured as follows: Section 2 sets out analytical framework of domestic value added ratio. Section 3 illustrates Thailand's engagement in global production sharing. Section 4 shows methodology and discusses data. Section 5 reports the empirical results. Section 6 concludes.

2. Emphasis on value added ratio and global production sharing

In the literature of trade and development, emphasis on value added ratio dates back to the period after World War II when the concept of import substitution was shared widely among economists and policy makers. Hirschman (1958) proposed an unbalanced growth strategy that involves promoting selected industries which have particularly strong linkage ('key sector'). This strategy is believed to foster economic growth among developing countries. This proposition implicitly emphasizes the importance of domestic value added in export which is held across many developing countries in the current day.

Backward and forward linkage are used for identifying 'key sectors' for specific policy focus (Acharya and Hazari, 1971; Hazari, 1970; Rasmussen, 1956). The key sectors are considered more capable of contributing to growth through their spread effects, compared to low-linkage industries (Yotopoulos and Nugent, 1973). This provides the justification for erecting trade barriers or imposing strategies aimed at utilising domestic industries (Goldin, 2018). These linkages are substantial when interrelatedness among domestic industries is strong. When a country has to produce from beginning to end to engage in the world market, value added is generated within the boundary. Emphasis on industries/activities with high per-unit domestic value added is justified.

Recent decades have witnessed a radical change in international trade driven by the process of global production sharing (GPS): splitting the production process into discreate activities that are carried out across countries. One of classic example is the production of the 'Ford Escort' whose components are produced in several countries, for instance, fan belt (Denmark), radiator and heater hoses (Austria), fuel tank (Germany), and glass (Canada) (Dicken, 1986; World Bank, 1987). As noted by Arndt and Kierzkowski (2001, P. 2), "intra-product specialisation can only take place where the various phases of a production process are physically separable, that is, where the manufacture of a product is amenable to fragmentation." An essential facet of GPS is that it expands the choice of country to pursue export-oriented industrialization. Without GPS, countries have to be proficient in all components of production in order to compete in the global market. However, GPS allows developing countries to join the production networks and to grow from exports by specializing in a few tasks in the production process.

GPS is driven by relative production cost differences among countries (Antras et al. (2017) and Chor (2019). For example, Intel, the world's leading firm in chips manufacturing, has separated the production of computer chips into wafer fabrication and assembly test. Wafer fabrication (the process of making chips) typically requires skilled workers engaging in cutting-edge R&D. Therefore, these activities are located in the United States (Oregon, Arizona, and New Mexico), Ireland (Leixlip), Israel (Haifa), and China (Dalian) where skilled labor are relatively abundant. Intel sends the finished wafers to assembly and testing facilities located in countries where labor is relatively abundant such as Vietnam (Ho Chi Minh), Malaysia (Kulim), and China (Chengdu) (Intel, 2018).

Costs of communication and coordination used to play an important role in shaping spatial separation of the production process (‘service link cost’), but these costs fell remarkably due to advances in transportation and telecommunications technologies and reductions in restrictive trade policies. Thus, GPS is powered by absolute and comparative advantage, and a reduction in service links cost (Arndt and Kierzkowski, 2001; Caves et al., 2007; Fort, 2017).

The emphasis on value added as a share of gross export (value added ratio) as a policy criterion is questionable because, in this era of GPS, developing countries do not necessarily have to produce the product from beginning to end in order to reap gains from international trade. GPS means total value added is spread across different locations. However, low-per-unit-value-added activities can employ a significant amount of worker through a ‘volume effect’: a larger market compared to traditional products based on horizontal specialization. In contrast, an industry with high per-unit value added may not guarantee ‘employment generation’ simply because it relatively requires more of capital in production process.

With a phenomenon of global production sharing, a dependence of imported intermediate inputs, and rising capital-output ratio, we hypothesise that high per-unit value added industry does not necessarily generate an impressive export growth, employment generation, and income. Policy guidance based on domestic value added is thus not pertinent to the country’s comparative advantage in the era of economic globalisation.

3. Export-oriented industrialisation and global production sharing in Thailand

3.1 Policy context

In 1961, Thailand inaugurated the first National Economic and Social Development Plan. Despite there being no specific guidelines on foreign trade, private sector-led industrialisation was encouraged through various measures aimed at protecting domestic production, for example, taxation for foreign trade and tax exemption for domestic production (Akrasenee, 1980). In addition to the national plan, the establishment of the Board of Investment (BOI) in 1966 marked a revolution in industrial policy in Thailand. Its policies were conducive to the encouragement of private investment using tax and nontax incentives. These measures were valid under the Investment Promotion Act (1954). The most crucial feature was tax concessions on imported machinery, equipment, and other intermediate inputs used in promoted industries. Yet, those who enjoyed these concessions until the early 1970s were import-competing firms (Akrasenee, 1980).[2] Export promotion was thus ignored while some primary exports were taxed (e.g., rice and rubber). The rapid growth of the manufacturing sector during the 1960s and early 1970s was arguably due to import substitution policies (Tambunlertchai, 1993; Warr, 2008).

A policy shift towards manufactured exports occurred in the early 1970s through strategies set out in the Third Development Plan (1972-1976) together with the Investment Promotion Act (1972) and Export Promotion Act (1972). There were several measures used to promote manufactured exports, for example, full exemption from tariffs and business taxes on imported inputs, exemption from business taxes as well as discounts on loans (Akrasenee, 1980). This strategy was continued to the next development plans as the

[2] From 1961 to 1671, there were several measures aimed to help domestic industries, for instance, industrial controls through regulations, import and export controls, and credit assistance (Akrasanee, 1980).

industrial policy was used to promote export-oriented industries and to allocate factories to be installed in provincial areas in the meantime.

During the 1980s, there was strong growth in textile and clothing exports in Thailand, which significantly contributed to employment. This success was attributed to several factors such as credible macroeconomic and exchange rate management, depreciation of the Baht, credit assistance, and open foreign investment regimes (Hill and Suphachalasai, 1992). From 1988 to 1990, Thailand experienced rapid growth as its economy expanded by 2-digit growth. This boom was due to the depreciation of Thai currency and the international relocation of light manufacturing from the Newly Industrialized Countries (NICs) to several ASEAN countries (Warr, 1993). Moreover, the appreciation of the Japanese Yen after the Plaza Accord was considered as another driving force behind this growth (Jitsuchon and Sussangkarn, 2009).

In 1991, the Thai government further reformed industrial policies by liberalising investment and factory installation. The government also liberalised automobile industries by allowing the importation of complete vehicles and reducing tariffs on imported parts. Since then, the automobile industry has become a core industry in Thailand. This growth in manufacturing sector continued until the 1997 Asian Financial Crisis. After the crisis, the BOI allowed complete foreign ownership in supported industries in all areas aimed at attracting foreign investors whose financial status was stronger than that of domestic firms. Currently, no doubt Thailand is adopting an export-led growth strategy through foreign direct investments using generous tax incentives and Special Economic and Development Zones (Board of Investment, 2017; Kuroiwa, 2017; Warr, 1993).

Under the current government, there is a strong emphasis on high-value-added products.[3] An apparent emphasis is spelt out in the 20-year national strategy (2017-2036) as its apex goal is to transform the Thai economy to a value-based and innovation-driven economy. A subsequent plan, for instance, a 5-year economic and social development plan and the investment plan, must be in line with this strategy. Additionally, industries using advanced technology to produce high value-added products are highly supported through many benefits provided by the BOI. Therefore, it is evident from the policy point of view that Thailand is now in the process of shifting from an economy relying on labor-intensive industries to one relying on high value-added industry.

3.2 Thailand's engagement in global production sharing

Global production sharing (GPS) has been a major force in the economic dynamism of the Southeast Asian economies over the last half century (Athukorala and Kohpaiboon, 2014). Thailand's engagement in GPS can be traced from the late 1970s when Thailand, together with other Southeast Asian countries (e.g., Malaysia and the Philippines), was an important area to assemble semiconductor devices (Flamm, 1985, p. 71). Today parts and components and final assembly exports within the global production network ('network trade')[4] account for a sizable share of Thailand's manufacturing exports.

[3] In 2014, Deputy Prime Minister Somkid Jatusripitak said that 'Our economy has relied on industries providing low value-added, cheap goods. Thailand is determined to develop the next generation industry' (Suruga, 2017). In the same year, a senior Board of Investment (BOI) Ajarin Pattanapanchai also said that 'If the country has targeted a shift from middle income to higher income, we have to focus more on value-added industries and build up the competitiveness of our industries' (Janssen, 2014).

[4] Basically, there are two tasks within production networks: parts and components and final assembly. Data on network trade are used to measure GPN trade, following the publication of Yeats (2001). Detailed explanation about data compilation are shown in the methodology part of this paper.

Table 1 displays Thailand's patterns of network trade between 2009 and 2018. Manufacturing exports (in current prices) increased from US$116 billion in 2009 to about US$165 billion in 2018. Global production sharing played a vital role in this expansion as GPN products accounted for around 70% of total manufacturing exports.[5] Also, there was a shift in network trade composition. The share of parts and components in network products declined from 64% in 2009 to 56% in 2018 while the share of final assembly increased from 36% to 44% over the same period.

The commodity composition of manufacturing exports over the last decade is shown in Table 2. The data point to the concentration in electronics and electrical goods (SITC 75, 76 and 77) compared to the total network exports. However, due to the damage caused by flood in 2011, electrics industry, in particular, semiconductor, was heavily affected as its share in total manufacturing exports fell by more than 2%.[6] In 2018, automobiles and other transport equipment (SITC 78 and 79) accounted for a larger share compared to electronics.[7]

[5] Share of network products in total manufacturing exports fell in 2011 due to production disruption caused by flood. Exports of parts and components decreased by US$3,000 million.

[6] Chip maker ON semiconductor decided to cease production at its Sanyo Semiconductor division as it could not restore the facility. About 1,600 workers were laid off (Reuters, 2011).

[7] Automotive industry had a fast recovery from the 2011 flood, partly due to an initiative of the government of Prime Minister Yingluck Shinnawatra (2011-2014) to offer tax rebates for the first-time car buyers. It stimulated domestic demand by more than a million units (Warr and Kohpaiboon, 2018).

Table 1: Thailand's GPN-based export performance and their share in total manufacturing exports between 2009 and 2018

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Δ2009-2018 (%)	Δ2014-2018 (%)
Panel A: Export value of GPN products (million USD)												
Parts and components	53,113	69,429	72,272	69,281	69,877	74,530	72,964	74,898	80,005	63,880	20.27	-14.29
Final assembly	29,484	38,962	41,880	45,029	47,794	48,397	48,300	48,837	55,765	51,161	73.52	5.71
Total GPN	82,597	108,391	114,152	114,310	117,672	122,927	121,264	123,735	135,770	115,041	39.28	-6.42
Manufactured products	115,530	155,377	173,303	171,641	179,704	186,060	179,447	181,541	195,331	165,443	43.20	-11.08
Total products	155,931	205,881	239,749	235,160	236,454	241,117	229,704	233,339	252,434	206,964	32.73	-14.16
Panel B: Share of GPN products in total GPN exports (%)												
Parts and components	64.30	64.05	63.31	60.61	59.38	60.63	60.17	60.53	58.93	55.53	-13.65	-8.41
Final assembly	35.70	35.95	36.69	39.39	40.62	39.37	39.83	39.47	41.07	44.47	24.58	12.96
Panel C: Share of GPN products in total manufacturing exports (%)												
Parts and components	45.97	44.68	41.70	40.36	38.88	40.06	40.66	41.26	40.96	38.61	-16.01	-3.61
Final assembly	25.52	25.08	24.17	26.23	26.60	26.01	26.92	26.90	28.55	30.92	21.17	18.88
Total GPN	71.49	69.76	65.87	66.60	65.48	66.07	67.58	68.16	69.51	69.53	-2.74	5.25
Panel D: Share of GPN products in total exports (%)												
Parts and components	34.06	33.72	30.15	29.46	29.55	30.91	31.76	32.10	31.69	30.87	-9.38	-0.15
Final assembly	18.91	18.92	17.47	19.15	20.21	20.07	21.03	20.93	22.09	24.72	30.73	23.15
Total GPN	52.97	52.65	47.61	48.61	49.77	50.98	52.79	53.03	53.78	55.58	4.94	9.03

Notes: GPN is global production networks product, manufacturing sectors are SITC 5-8 excluding SITC 68 (non-ferrous metals)
Source: Compiled from UN Comtrade Database (SITC Rev. 4)

Table 2: Commodity composition of Thailand's network exports in total manufacturing exports between 2009 and 2018 (%)

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Δ2009-2018 (%)	Δ2014-2018 (%)
Automatic data processing machines (75)	18.95	16.45	14.08	15.92	14.06	14.19	14.05	13.40	12.57	12.57	-33.67	-11.40
Telecommunication and sound recording equipment (76)	10.00	9.51	9.31	9.10	8.46	8.19	8.94	8.97	9.45	9.05	-9.49	10.43
Electrical machinery excluding semiconductors (77 - 776)	7.23	7.13	7.14	6.82	6.92	7.20	7.24	7.43	7.46	7.40	2.26	2.73
Semiconductor (776)	9.67	9.92	8.35	6.22	6.34	6.90	7.22	7.93	8.77	7.53	-22.11	9.20
Road vehicles (78)	8.79	11.17	10.23	13.03	14.02	13.25	13.84	14.09	15.37	16.50	87.71	24.48
Other transport equipment (79)	0.09	0.22	0.37	0.19	0.14	0.15	0.12	0.09	0.12	0.30	237.44	96.83
Professional and scientific equipment (87)	1.38	1.39	1.43	1.57	1.64	1.93	2.33	2.76	2.50	1.86	34.84	-3.38
Photographic apparatus and optical goods, watches and clocks (88)	1.72	1.53	1.43	1.31	1.39	1.47	1.47	1.46	1.51	1.71	-0.41	16.08
Others	13.67	12.45	13.53	12.45	12.51	12.79	12.36	12.04	11.74	12.62	-7.69	-1.31
Total GPN products	71.49	69.76	65.87	66.60	65.48	66.07	67.58	68.16	69.51	69.53		

Notes: Manufacturing sectors are SITC 5-8 excluding SITC 68 (non-ferrous metals)
Source: Compiled from UN Comtrade Database (SITC Rev. 4)

4. Methodology

To examine the relationship between value added ratio and its developmental gains, I use the standard input-output framework (Leontief, 1936). Since policy targeting high value added was an industry-level policy, data from I-O table are suitable for empirical evaluation. This section first describes the methodology of calculating value added ratio and three key export performances indicators: net-export earnings and export-induced income. This is followed by the specification of the regression model used to investigate the relationship between value added ratio and export performances.

4.1 Input-output model

The non-competitive Input-Output system is employed in this paper. The input-output structure of the economy can be written as

$$X = Zi + F \tag{1}$$

where i is a column vector of 1's of n dimension. From the I-O coefficient matrix, it yields

$$X = AX + F$$

$$X - AX = F$$

$$(I - A)X = F$$

$$X = (I - A)^{-1}F = Lf \tag{2}$$

where $(I - A)^{-1}$ = L = $[l_{ij}]$ is known as the Leontief inverse matrix. This shows the dependence of gross output on the values of final demand (the relationship can be written as $\partial x_i / \partial f_j = l_{ij}$).

To be specific with a non-competitive type I-O table, it can be written as

$$X = (I - A^d)^{-1}F \tag{3}$$

where A^d is referred to as a matrix of the domestic I-O coefficient.

Final demand, F, can be decomposed to

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

where Y^d is a vector of domestic final demand and E is export on domestically produced goods. $(I - A^d)^{-1}$ is an output multiplier. It shows the total value of production in all sectors throughout the economy that is required to satisfy an increase in a unit of output of sector j (final demand).

The sum of the j^{th} column of $(I - A^d)^{-1}$ gives a value of total backward linkages when domestic final demand or foreign final demand for the j^{th} commodity increases by one unit. Backward linkage[8] for sector j is

$$BWL_j = \sum_{i=1}^{n} l_{ij} \tag{5}$$

4.2 Import intensity

Industry uses both domestically produced input and imported input in its production process. A diagonal matrix of imported input coefficients is

$$R = [r_i], r_i = \frac{R_i}{X_i} \tag{6}$$

where R_i is import used by sector i and r_i is thus imported input coefficient. It can be written in a matrix form:

$$R = \begin{bmatrix} r_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & r_{nn} \end{bmatrix}$$

To quantify the total imports as a part of the production, it gives

8 Backward linkage shows the full impacts of an exogenous increase in final demand on all sectors. It can be interpreted through a chain of interactions. If the final demand in a given sector increases, it raises the demand for intermediate input from that sector itself and from other sectors. This leads to n^{th} rounds of effects.

$$M = R(I - A^d)^{-1} = \begin{bmatrix} r_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & r_{nn} \end{bmatrix} \begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{bmatrix} = \begin{bmatrix} m_{11} & \cdots & m_{1n} \\ \vdots & \ddots & \vdots \\ m_{n1} & \cdots & m_{nn} \end{bmatrix}$$

where M is the import inverse matrix. This is a total import requirement matrix of domestic production. An element of matrix M, m_{ij}, is the total amount of imports i that sector j needs to produce one unit of commodity j in the economy. As sector j uses imported intermediates from several sectors, the total import required to produce a unit of commodity j is therefore

$$m_{Tj} = \sum_{i=1}^{n} m_{ij} \quad (7)$$

This shows a corresponding demand for imports when a final demand in sector j increases.

4.3 Net-export earnings and value added ratio

Let e_j be a value of total exports from sector j. It is assumed that there is no difference in using imports in producing a unit of output whether the product is sold within the economy or exported to the foreign market.

Thus, each unit of export of commodity j, e_j, is embodied with imports used by sector j, m_{Tj}. It yields

$$m_{Tj}^{e} = m_{Tj} e_j \quad (8)$$

where m_{Tj}^{e} is the total value of imports embodied in the export of commodity j.

Let e_j^n be net-export earnings of sector j. This is estimated by:

$$e_j^n = e_j - m_{Tj} e_j = (1 - m_{Tj}) e_j \quad (9)$$

Lastly, dividing (9) by gross exports yields per-unit domestic value added of export (value added ratio) as the following:

$$DVA = e_j^n / e_j \quad (10)$$

This is the domestic content of exports as a percentage of gross exports. It is important to distinguish between value added as a share of gross exports (value added ratio) and total value added in exports (net-export earnings). Value added ratio can be low due to high value of export while net-export earnings (addition to GDP).

4.4 Export-induced income

As an output expansion might not reflect an income received by the worker, an effect on household income (monetary earnings) is further analysed.

Let h' be a row vector of wage and salary in payment sectors. Defining a diagonal matrix of household income coefficient as a proportion of household income to total output in each industry as:

$$H = [h_i], h_i = \frac{H_i}{X_i} \tag{11}$$

where H_i is wage and salary received by worker in sector i and h_i is then a household income coefficient. In matrix form, it can be written as:

$$H = \begin{bmatrix} h_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & h_{nn} \end{bmatrix}$$

To quantify total household income as a part of production (outlays), this can be spelt out as:

$$C = H(I - A^d)^{-1} = \begin{bmatrix} h_{11} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & h_{nn} \end{bmatrix} \begin{bmatrix} l_{11} & \cdots & l_{1n} \\ \vdots & \ddots & \vdots \\ l_{n1} & \cdots & l_{nn} \end{bmatrix} = \begin{bmatrix} c_{11} & \cdots & c_{1n} \\ \vdots & \ddots & \vdots \\ c_{n1} & \cdots & c_{nn} \end{bmatrix}$$

where C is the wage and salary requirement matrix of domestic production. An element of matrix C, c_{ij}, is the total amount of wage and salary in sector i that sector j needs to pay labor services to produce a unit of commodity j in the economy. Total required payment to household from all sectors to produce a unit of commodity j is

$$C_{Tj} = \sum_{i=1}^{n} c_{ij} \tag{12}$$

This shows a corresponding increase in received wage and salary when a final demand in sector j increases.

How export can lead to an increase in household income can be illustrated by reproducing an expression of net export earnings. Let us assume that workers are paid indifferently in producing a commodity whether the product is sold domestically or exported. The total value of household income embodied in exports, e_j, can be estimated as:

$$c_{Tj}^{e} = c_{Tj} e_j \tag{13}$$

where c_{Tj}^{e} is the total value of household income embodied in the export of commodity j.

Thus, the total export-induced household income of the economy, C_T, is therefore

$$C_T = \sum_{j=1}^{n} c_{Tj}^{e} \tag{14}$$

4.5 Regression Model

The regression model takes the following form:

$$\left.\begin{matrix} NEEX_{it} \\ EXIN_{it} \end{matrix}\right\} = \alpha + \beta_1 DVA_{it} + \beta_2 GPN_{it} + \beta_3 PROD_{it} + \beta_4 GPN_i * DVA_{it} + \beta_5 GPN_i * PROD_{it} + \mu_i + v_t + \varepsilon_{it} \tag{15}$$

where the subscripts i refer to industry and t is time (year). The explanatory variables are listed below, with the postulated sign of the regression coefficient for the explanatory variables in parenthesis.

$NEEX$	Net-export earnings
$EXIN$	Export-induced income
DVA	Domestic value added ratio of gross export $(+/-)$

GPN	Global Production Network (+)
$PROD$	Productivity (+/−)
α	A constant term
μ	A set of country dummy variables to control for time-invariant heterogeneity at the industrial level
v	A set of time dummy variables to capture unobservable time effects
ε	A stochastic error term, representing the omitted influences on export performance

Net-export earnings and export-induced income are measured at constant (2010) producer's price. All three dependent variables are in natural logarithms.

The main variable of interest is domestic value added ratio (DVA). It is postulated among policy makers, who use value added share as a policy criterion, to have a positive effect on export performances. However, as discussed, in the era of global production sharing, industry with employment potential does not necessarily to have high domestic value added. The expected sign of the coefficient of this variable is ambiguous.

Global production network orientation (GPN) is included in the model to test whether the hypothesised relationships vary among GPN products. Trade based on GPN are trade in parts and components, and assembled end products within the production networks. The data are compiled at the 5-digit level of the Standard International Trade Classification (SITC) based on SITC Revision 3. List of parts and components are derived by mapping parts and components in the intermediate products subcategory of the UN Broad Economic Classification (BEC) with SITC.[9] For exports of final goods assembled

[9] The complete data set and the list of parts and components are available on request.

within production network, it is approximately estimated as the difference between parts and components, which are directly calculated based on the list, and total export of these product categories. Product categories involved in final assembly are based on Athukorala (2019) which are office machines and automatic data processing machines (SITC 75), telecommunication and sound recording equipment (SITC 76), electrical machinery (SITC 77), road vehicles (SITC 78), other transport equipment (SITC 79), travel goods (SITC 83), clothing and clothing accessories (SITC 84), professional and scientific equipment (SITC 87), photographic apparatus (SITC 88), and toys and sport goods (SITC 894).[10] GPN orientation is the share of export of parts and components and final assembly to total manufacturing export (expressed as percentage). After that, I match[11] these shares at 5-digit level of SITC into 2-digit level of Thailand's I-O table.[12] GPN orientation measures the degree of importance of GPN products within the total manufacturing exports of country. Therefore, the expected sign of the coefficient is positive.

Productivity ($PROD$) is defined by the real value added per worker (labor productivity). It captures both total factor productivity (efficiency) and capital deepening which is measured by a change in capital per worker. Unfortunately, these two effects cannot be separated due to the limitation of data at industry level. Once efficiency in production improves, it can pull resources from other industries to be used in production

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[10] However, this estimate may not cover all final assembly because these product categories contain unknown share of horizontal trade – trade in goods which are produced from start to finish in one country.

[11] I use a concordance table published by Eurostat to match commodities at 5-digit level of SITC Rev 3 to 2-digit ISIC Rev 3. I further match these commodities to TSIC (version 2009), and then to 2-digit level of Thailand's I-O table using concordance tables provided by NSO and NESDB.

[12] However, an ideal estimation of GPN orientation is the share of export of GPN-related industry (5-digit level of the SITC) to total export of that industry (2-digit level used in I-O table). Unfortunately, export value from Thailand's I-O table is not comparable with value from UN Comtrade database even after correcting for trade and transport margin and converting into the same currency.

process. At the same time, it can push or release labor to other activities. The expected sign of the coefficient can be both positive and negative.

I perform the Hausman test to examine whether unobserved explanatory variables are distributed independently of the explanatory variables. The results favor the fixed effect estimator over the random effects estimator. Furthermore, I use heteroscedasticity-consistent robust standard error estimates to handle the concern about heteroscedasticity. Industry fixed effects are included to capture a large proportion of the cross-industry differences in export performances and allows us to focus on the determinants of within-industry variations. Year dummies are included to capture the influence of aggregate (time-series) trends.

I report the regression result separately for total manufacturing and manufacturing excluding processed foods. The reason is that processed foods sectors are basically based on domestic resources and therefore not subject to global production network.

Data

The main data used are the input-output tables (non-competitive type) of Thailand for 1990, 1995, 2000, 2005 and 2010 from the National Economic and Social Development Board (NESDB).[13] The data used in the analysis of global production networks are compiled from the UN Comtrade database, based on Revision 3 of the Standard International Trade Classification (SITC, Rev. 3).

[13] Thailand's I-O tables are originally published in Thai Baht. In regression analysis, I deflated key variables using GDP deflator, published by the World Bank (2019), to net out changes in exchange rate. See the definition of sector in table A1 in the appendex.

Table 3: Descriptive statistics

	1990	1995	2000	2005	2010
Panel A. Industry characteristics					
Value added ratio	0.5815 (0.1737)	0.5671 (0.1742)	0.5627 (0.1787)	0.5353 (0.1741)	0.5486 (0.1658)
Productivity	0.0892 (0.3338)	0.1186 (0.3953)	0.0385 (0.1002)	0.0568 (0.1722)	0.0604 (0.1178)
GPN orientation (%)	1.0544 (3.5184)	1.1089 (3.4185)	1.2224 (4.0242)	1.1664 (3.3813)	1.1225 (3.0448)
Panel B. Three key export performances					
Net-export earnings (million US$)	253.0532 (498.5919)	533.0894 (938.4853)	552.7799 (1029.2266)	753.1164 (1246.2732)	1206.5195 (2138.2393)
Export-led income (million US$)	79.0524 (172.7907)	144.5442 (255.5387)	148.4832 (249.4018)	223.1190 (332.3136)	324.5609 (524.4615)
Number of sectors	55	55	55	55	55

Notes: Simple mean and standard deviation (in parenthesis) are reported for each indicator; summary statistics are based on manufacturing sectors excluding processed foods; key export performances are converted to US$ using the exchange rate for each year.

Summary statistics of the key indicators derived from the I-O tables over time are presented in Table 3. Panel A of Table 3 describes industry's basic characteristics: value added ratio, productivity, and GPN orientation. Panel B presents summary statistics of two key export performances: net-export earnings and export-led income.

Panel A shows that, on average, domestic value added ratio slightly decreased over time from 0.5815 in 1990 to 0.5486 in 2010. It implies an increasing role of imported intermediate in the production process across manufacturing sectors. There was a slight increase in value added ratio from 2005 to 2010.[14] Moreover, productivity increased from 1990 to 1995, and then declined significantly after the 1997 Asian Financial Crisis. Nevertheless, productivity increased after 2000. Panel B suggests that all key export performances indicators rose sharply from 1990 to 2010. On average, net-export earnings

[14] Note that this falling is common in other countries using OECD's TiVA database.

(addition to GDP) doubled from 253.05 million US$ in 1990 to 552.78 million US$ in 2005 and further increased to 1,206.52 million US$ in 2010. Export-led income (wage and salary) also grew from 79.05 million US$ to 324.56 million US$ in 2010.

5. Results

Regression results are presented in Tables 5 and 6. There is a positive and significant association between value added ratio and net-export earnings for total manufacturing (Table 5, Column 1). A 1 percentage point increase in value added ratio is associated with an increase in net-export earnings by 1.53%. The estimated coefficients are slightly larger using a sample on manufacturing excluding processed foods; however, the coefficients are marginally significant for manufacturing excluding processed foods.

As shown in columns 2 and 6, there is a positive and significant association between GPN orientation and net-export earnings on both samples. A 1 percentage point increase in GPN orientation leads to an increase in net-export earnings by 16.3%. As the coefficient on this factor is statistically significant at the 1% level, there is strong support that engagement in international production network boosts net-export earnings (addition to GDP) significantly.

Table 5: Value added ratio and net-export earnings

Dependent variable: Net-export earnings (log)								
	Total Manufacturing				**Manufacturing excluding processed foods**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
DVA	0.0152**	0.0166**	0.0155**	0.0158**	0.016*	0.0158**	0.0157*	0.0162*
	(0.0074)	(0.0073)	(0.0075)	(0.0075)	(0.0.0085)	(0.0085)	(0.0088)	(0.0088)
PROD	0.253***	0.245***	0.244***	0.248***	0.260***	0.252***	0.251***	0.256***
	(0.0852	(0.0834)	(0.0838)	(0.0846)	(0.0872)	(0.0853)	(0.0859)	(0.0869)
GPN		0.163***	0.105	0.190**		0.160***	0.0873	0.192**
		(0.0390)	(0.0781)	(0.0746)		(0.0400)	(0.0767)	(0.0777)
GPN x DVA			0.120	0.135			0.151	0.169
			(0.115)	(0.126)			(0.115)	(0.123)
GPN x PROD				-0.009				-0.0117
				(0.009)				(0.00797)
1995	0.975***	0.972***	0.974***	0.978***	1.154***	1.149***	1.153***	1.159***
	(0.119)	(0.118)	(0.118)	(0.119)	(0.142)	(0.140)	(0.141)	(0.142)
2000	1.125***	1.105***	1.114***	1.118***	1.334***	1.308***	1.326***	1.330***
	(0.143)	(0.141)	(0.142)	(0.142)	(0.161)	(0.159)	(0.161)	(0.161)
2005	1.482***	1.476***	1.483***	1.487***	1.694***	1.685***	1.699***	1.705***
	(0.162)	(0.155)	(0.156)	(0.157)	(0.184)	(0.173)	(0.175)	(0.175)
2010	1.761***	1.761***	1.763***	1.769***	1.909***	1.909***	1.913***	1.923***
	(0.178)	(0.168)	(0.168)	(0.169)	(0.217)	(0.201)	(0.202)	(0.203)
Observations	370	370	370	370	275	275	275	275
Adj. R-sq	0.526	0.557	0.557	0.557	0.563	0.597	0.598	0.597
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses, time (year) dummy with the year 1990 as the base dummy, table reports within R-square, ***, **, * indicate significance level at 1, 5, and 10%, respectively.

The coefficients on productivity are also statistically significant at the 1% level.[15] Nevertheless, none of the coefficients on the interaction with GPN orientation variables is significant even at the 10% level. This suggests that the estimated impacts of (a) value added ratio and (b) productivity on net-export earnings does not vary between total manufacturing GPN products and total manufacturing.

Table 6 provides the regression output on export-led income. The results show that value added ratio has no significant impact on export-related income. Overall, these results provide support for the hypothesis that value added as a share of gross manufacturing exports is not pertinent to export-led income. Additionally, as reported in column 2 of Table 6, the sign of GPN orientation coefficient is positive and statistically significant at the 1% level. A 1 percentage point increase in GPN orientation is associated with a 16.2% increase in net-export income. This indicates that an increase in global production networks can significantly boost wage and salary generated from export. Note further that productivity also plays a positive role in export-led income. The results are consistent between total manufacturing and manufacturing excluding processed foods.

[15] From a theoretical perspective (e.g., Melitz, 2003), there can be some endogeneity problems because it is only the efficient, productive firms with higher productivity that can enter the export market, especially in this case via global production network. However, to drop such productivity variable (PROD) from model specification leads to a larger coefficient on value added ratio but smaller adjusted R-square.

Table 6: Value added ratio and export-led income

Dependent variable: Export-led income (log)								
	Total manufacturing				Manufacturing excluding processed foods			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DVA	0.0109	0.0122	0.0112	0.0116	0.0131	0.0147*	0.0133	0.0140
	(0.0078)	(0.0077)	(0.0079)	(0.0079)	(0.0088)	(0.0087)	(0.0091)	(0.0091)
PROD	0.243***	0.234***	0.234***	0.240***	0.255***	0.247***	0.246***	0.254***
	(0.0862)	(0.0844)	(0.0848)	(0.0853)	(0.0877)	(0.0858)	(0.0863)	(0.0870)
GPN		0.162***	0.108*	0.236***		0.160***	0.101	0.2555***
		(0.0353)	(0.0639)	(0.0631)		(0.0369)	(0.0652)	(0.0645)
GPN x DVA			0.112	0.135			0.124	0.151
			(0.0913)	(0.101)			(0.0963)	(0.102)
GPN x PROD				-0.0144*				-0.0173**
				(0.0084)				(0.0078)
1995	0.918***	0.914***	0.916***	0.922***	1.081***	1.076***	1.079***	1.088***
	(0.120)	(0.119)	(0.119)	(0.120)	(0.144)	(0.142)	(0.143)	(0.144)
2000	1.138***	1.118***	1.127***	1.132***	1.283***	1.257***	1.272***	1.278***
	(0.141)	(0.139)	(0.140)	(0.141)	(0.162)	(0.159)	(0.162)	(0.162)
2005	1.582***	1.576***	1.582***	1.582***	1.758***	1.749***	1.761***	1.769***
	(0.163)	(0.155)	(0.156)	(0.156)	(0.184)	(0.172)	(0.175)	(0.174)
2010	1.807***	1.808***	1.809***	1.809***	1.909***	1.909***	1.913***	1.927***
	(0.178)	(0.168)	(0.168)	(0.169)	(0.215)	(0.200)	(0.201)	(0.201)
Observations	370	370	370	370	275	275	275	275
Adj. R-sq	0.537	0.566	0.566	0.566	0.563	0.596	0.596	0.597
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Robust standard errors are reported in parentheses, time (year) dummy with the year 1990 as the base dummy, table reports within R-square, ***, **, * indicate significance level at 1, 5, and 10%, respectively.

The coefficient estimates on the interaction between GPN orientation and value added ratio are positive but not significant. This means that the relationship between export-led income and value added ratio does not vary in GPN products, suggesting that value added ratio does not have a significant impact even among GPN products. Interestingly, as reported in columns 4 and 8, the coefficients on an interaction between GPN orientation and productivity are negative and statistically significant. This suggests that there is a trade-off between an improvement in production efficiency and export-led income. This can happen through an increase in the use of capital (capital deepening) and total factor productivity. As GPN products (parts and components and final assembly) are more labor-intensive, increased efficiency in production may reduce the demand for labor which, in turn, reduces their income.

An endogeneity problem (reverse causality, measurement error, and omitted variable bias) is worth discussing here. Reverse causality may not be a formidable issue in this case because all three outcome variables are total impacts induced from export, not the current export. Recalled from the methodology section, it is how an increase in export can, directly and indirectly, generate income, and net-export earnings. It is not possible that total effects from export of a given sector could exist *prior to* changes in current level of policy variable such as value added ratio or global production network orientation. In addition, the results are not sensitive to an alternative specification with the lag of value added ratio. However, using lagged variable may not fully address the endogeneity problem, especially the reverse causality (Bellamare et al., 2017). Another threat could be a measurement error which can largely originate from matching Thailand's labor force survey and input-output tables with trade statistics because all are published using different classifications. The key results still hold up even though several ways of matching among industries are employed. Regarding omitted variables, admittedly, it is challenging to include all relevant industry characteristics and geographic information due to unavailability of data. It is also not possible to take into account the role of MNEs in export performance. However, during 1990 to 2017, there is no radical change in the key investment incentives *at industry level* granted by the Board of Investment. These incentives are based on the location of factory, not merit-based incentives (targeted industries) adopted after 2017. Unfortunately, standard I-O tables do not provide such geographical information. I thus rely on industry fixed effects to capture these time-invarying factors.

In a broad summary, the results from regression analysis suggest that greater value added ratio fails to increase key export performances significantly. However, there is strong evidence that participation in global production networks plays a pivotal role in export performances.

I supplement the results on net-export earnings and export-induced income with the empirical analysis on the ratio of wage to total value added and the ratio of wage to profit. Wage covers compensation paid to employees both in cash and in kind. Employees include long-term workers, temporary workers, executives and hired laborers in the agricultural sector excluding family workers. Profit is an operating surplus defined as total value added including business income tax, minus wages and salaries, depreciation and indirect taxes, less subsidies.

Table 7 shows that the association between value added ratio and labor share in value added is negative and statistically significant at the 1% level. A 1 percentage point increase in value added ratio is associated with a 17 percentage point drop in this measure. The results are consistent between total manufacturing and manufacturing excluding processed foods. The findings do not support the widely held view in policy circles that high value-added industries have the potential to uplift citizen's living standard.

However, the association between GPN orientation and labor share in value added are positive but not significant even at the 10% level. Engagement in international production network alone cannot pull up labor's share in national income. But, as shown in Table 6, this factor can play a crucial role in citizen's living standard as it significantly increases export-related income. Furthermore, the sign of productivity is negative, but the estimated impact is not statistically significant. It is also found that the effect of GPN orientation on poverty vary by the level of productivity.

According to Table 8, there is a negative and significant association between value added ratio and the ratio of wage to profit. It implies that an emphasis on high value-added industry can worsen inequality because it tends to reduce the share of wage to profit. The channel for this reason is that, as explained earlier, industries that have high value-added industry are usually capital-intensive (e.g., cement and concrete products) and thus have low employment generation. Again, the association between GPN orientation and inequality is positive but not significant. It implies that a deeper economic integration through global production network does not lead to a relatively fast rate of growth of profit compared to wage. Lastly, none of the coefficients on the interactions is statistically significant.

Table 7: Results on the ratio of wage in total value added

Dependent variable: Ratio of wage to total value added	Total manufacturing				Manufacturing excluding processed foods			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DVA	-0.174***	-0.173***	-0.172***	-0.164***	-0.134**	-0.133**	-0.126**	-0.116**
	(0.0538)	(0.0535)	(0.0558)	(0.0555)	(0.0533)	(0.0549)	(0.0570)	(0.0570)
PROD	-0.0008	-0.0009	-0.0009	0.0001	0.0007	0.0007	0.0007	0.0019
	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0022)
GPN		0.0014	0.0020	0.0229*		0.0016	0.0041	0.0275**
		(0.0042)	(0.0062)	(0.0135)		(0.0040)	(0.0059)	(0.0133)
GPN x DVA			-0.0011	0.0027			-0.0053	-0.0012
			(0.0135)	(0.0113)			(0.0133)	(0.0110)
GPN x PROD				-0.0024**				-0.0026**
				(0.0011)				(0.0011)
1995	-0.0181***	-0.0181***	-0.0181***	-0.0171***	-0.0230***	-0.0231***	-0.0232***	-0.0217***
	(0.0042)	(0.0041)	(0.0042)	(0.0041)	(0.0047)	(0.0047)	(0.0047)	(0.0046)
2000	-0.0105	-0.0106	-0.0107	-0.0099	-0.0240**	-0.0242**	-0.0249**	-0.0240**
	(0.0093)	(0.0093)	(0.0093)	(0.0093)	(0.0105)	(0.0105)	(0.0105)	(0.0105)
2005	0.0001	0.0000	-0.0000	0.0010	-0.0059	-0.0060	-0.0065	-0.0051
	(0.0095)	(0.0095)	(0.0094)	(0.0093)	(0.0115)	(0.0115)	(0.0114)	(0.0112)
2010	-0.0151	-0.0151	-0.0152	-0.0136	-0.0217*	-0.0217*	-0.0219*	-0.0197
	(0.0100)	(0.0101)	(0.0101)	(0.0099)	(0.0121)	(0.0121)	(0.0121)	(0.0118)
Observations	370	370	370	370	275	275	275	275
Adj. R-sq	0.07	0.068	0.066	0.079	0.06	0.058	0.056	0.078
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Ratio of labor share (wages) in total value added is used as a proxy for poverty; robust standard errors are reported in parentheses; time (year) dummy with the year 1990 as the base dummy; table reports within R-square, ***, **, * indicate significance level at 1, 5, and 10%, respectively.

Table 8: Results on the ratio of wage to profit

Dependent variable: Ratio of wage to profit								
	Total manufacturing				**Manufacturing excluding processed foods**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
DVA	-0.819***	-0.807***	-0.749***	-0.726***	-0.731***	-0.716***	-0.637***	-0.605***
	(0.209)	(0.203)	(0.199)	(0.197)	(0.224)	(0.216)	(0.206)	(0.202)
PROD	-0.0043	-0.0050	-0.0048	-0.0016	-0.0035	-0.0043	-0.0039	-0.0003
	(0.0063)	(0.0065)	(0.0064)	(0.0061)	(0.0064)	(0.0067)	(0.0065)	(0.0062)
GPN		0.0145	0.0448*	0.113		0.0147	0.0478*	0.120
		(0.0124)	(0.0262)	(0.0749)		(0.0129)	(0.0263)	(0.0740)
GPN x DVA			-0.0631	-0.0508			-0.0687	-0.0559
			(0.0548)	(0.0449)			(0.0555)	(0.0459)
GPN x PROD				-0.0076				-0.0081
				(0.0062)				(0.0062)
1995	-0.0511***	-0.0514***	-0.0524***	-0.0492***	-0.0536***	-0.0540***	-0.0556***	-0.0511***
	(0.0163)	(0.0162)	(0.0163)	(0.0161)	(0.0166)	(0.0164)	(0.0164)	(0.0165)
2000	-0.0456	-0.0474	-0.0526	-0.0499	-0.0498	-0.0522	-0.0604	-0.0577
	(0.0404)	(0.0394)	(0.0389)	(0.0393)	(0.0468)	(0.0452)	(0.0443)	(0.0448)
2005	-0.0408	-0.0414	-0.0451	-0.0416	-0.0344	-0.0352	-0.0416	-0.0375
	(0.0407)	(0.0405)	(0.0404)	(0.0403)	(0.0461)	(0.0458)	(0.0456)	(0.0454)
2010	-0.0680*	-0.0679*	-0.0688*	-0.0637	-0.0596	-0.0597	-0.0619	-0.0552
	(0.0387)	(0.0390)	(0.0395)	(0.0394)	(0.0430)	(0.0435)	(0.0440)	(0.0435)
Observations	370	370	370	370	275	275	275	275
Adj. R-sq	0.07	0.074	0.082	0.09	0.051	0.057	0.068	0.08
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Ratio of wages to profit is used as a proxy for inequality; robust standard errors are reported in parentheses; time (year) dummy with the year 1990 as the base dummy; table reports within R-square; ***, **, * indicate significance level at 1, 5, and 10%, respectively.

6. Conclusion

This paper has examined the relationship between value added ratio and two key export performance indicators (net-export earnings and export-induced income) using input-output tables for Thailand.

The results cast doubt on the validity of the contemporary approach to policy guidance based on the domestic content of exports that is currently adopted across countries. It is found that there is no statistically significant relationship between value added ratio and net-export earnings and export-induced income. Moreover, there is strong evidence that value added ratio is negatively associated with wage share in value added) and wage to profit ratio. In the meantime, the results suggests that participation in the global production networks help increase the wage share in total value added. The policy implication of the results is that, in a context where global production sharing (GPS) is the key driver of economic integration, national industry policy needs be guided by market potential (the volume factor) rather than value added ratio.

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References

Acharya, S. N. and B. Hazari (1971), Linkages and imports: A comparative study of India and Pakistan. *Journal of Development Studies*, 8(1), 107-115.

Akrasanee, N. (1980), Trade strategy for employment growth in Thailand. In: *Trade and Employment in Developing Countries Volumn 1: Individual Studies* (eds Krueger A. O., Lary, H. B., Monson, T. and Akrasanee, N.), pp. 393-434. Chicago: University of Chicago Press.

Antràs, P. (2016), *Global Production: Firms, Contracts, and Trade Structure*. Princeton NJ: Princeton University Press.

Antràs, P., T. C. Fort, and F. Tintelnot (2017), The margins of global sourcing: Theory and evidence from US Firms. *American Economic Review*, 107(9), 2514-2564.

Arndt, S. W. and H. Kierzkowski (2001), Introduction. In: *Fragmentation: New Production Patterns in the World Economy* (eds Arndt S. W. and Kierzkowski, H.), pp. 1-16. New York: Oxford University Press.

Athukorala, P. (2014), Global production sharing and trade patterns in East Asia. In: *The Oxford Handbook of the Economics of the Pacific Rim* (eds Kaur, I., and Singh, N.), pp. 333-361. New York: Oxford University Press.

Athukorala, P. (2019), Joining global production networks: Experience and prospects of India. *Asian Economic Policy Review*, 14, pp. 1-21.

Athukorala, P. and A. Kohpaiboon (2014), Global production sharing, trade patterns, and industrialization in Southeast Asia. In: *Routledge Handbook of Southeast Asian Economics* (ed Coxhead, I.), pp. 131-161. New York: Routledge Taylor and Francis Group.

Athukorala, P. and A. Patunru (2019), Domestic value added, exports, and employment: An input-output analysis of Indonesian manufacturing. ERIA Discussion Paper Series No. 292.

Baldwin, R. E. (2016), *The Great Convergence. Information Technology and the New Globalisation.* Cambridge: Harvard University Press.

Barrientos, S., G. Gereffi, and A. Rossi (2011), Economic and social upgrading in global production networks: A new paradigm for a changing world. *International Labor Review*, 150, 319-340.

Bellemare, M. F., T. Masaki, and T. B. Pepinsky (2017), Lagged explanatory variables and the estimation of causal effect. *Journal of Politics*, 79(3), 949-963.

Bharadwaj, K. R. (1966), A note on structural interdependence and the concept of a key sector. *Kyklos,* 19, 315-319.

Board of Investment (2017), *A Guide to Investment in* the *Special Economic Development Zones*. Retrieved from https://www.boi.go.th/upload/content/BOI-book%202015_20150818_95385.pdf

Caves, R. E., J. Frankel, and R. W. Jones (2007), *World Trade and Payment* (10th edition). Boston: Pearson, Chapter 8.

Chor, D. (2019), Modelling global value chains: Approaches and insights from economics. In: *Handbook of Global Value Chains* (eds Ponte, S., Gereffi, G., and Raj-Reichert, G.), Cheltenham: Edward Elgar Publishing.

Dicken, P. (1986), *Global Shift: Industrial Change in a Turbulent World.* London: Harper & Row.

Dollar, D., B. Khan, and J. Pei (2019), Should high domestic value added in exports be an objective of policy? In: *Global Value Chain Development Report 2019: Technological Innovation, Supply Chain Trade, and Workers in a Globalized World (English)*, pp. 141-153. Washington, D. C.: World Bank Group.

Ernst, D. and P. Guerrieri (1998), International production networks and changing trade patterns in East Asia: The case of the Electronics Industry. *Oxford Development Studies,* 26(2), 191-212.

Feenstra, R. C. (2009), *Offshoring in the Global Economy: Microeconomic Structure and Macroeconomic Implications*. Cambridge, MA: MIT Press.

Flamm, K (1985), Internationalization in the semiconductor industry. In: *The Global Factory: Foreign Assembly in International Trade* (eds Grundwald, J. and Flamm, K.), pp. 38-136. Washington, D. C.: Brookings Institution.

Fort, T. C. (2017), Technology and production fragmentation: Domestic versus foreign sourcing. *Review of Economic Studies*, 84(2), 650-687.

Goldin, I. (2018), *Development: A Very Short Introduction.* Oxford: Oxford University Press.

Hazari, B. R. (1970), Empirical identification of key sectors in the Indian economy. *Review of Economics and Statistics*, 52(3), 301-305.

Head, K. and J. Ries (2002), Offshore production and skill upgrading by Japanese manufacturing firms. *Journal of International Economics*, 58, 81-105.

Helpman, E. (2011), *Understanding Global Trade*. Cambridge, MA: Harvard University Press.

Hill, H. and S. Suphachalasai (1992), The myth of export pessimism (even) under the MFA: Evidence from Indonesia and Thailand. *Weltwirtschaftliches Archive*, 128, 310-329.

Hirschman, A. O. (1958), *The Strategy of Economic Development.* New Haven, CT: Yale University Press.

Janssen, P. (2014), Junta sends clear message: More foreign investment a must. Retrieved from https://asia.nikkei.com/Economy/Junta-sends-clear-message-More-foreign-investment-a-must

Jitsuchon, S. and C. Sussangkarn (2009), *Thailand's Growth Rebalancing.* ADBI Working Paper Series No. 154. Tokyo: Asian Development Bank Institution. Retrieved from https://www.adb.org/sites/default/files/publication/156009/adbi-wp154.pdf

Jones, L. P. (1976), The measurement of Hirschmanian linkages. *Quarterly Journal of* Economics, 90(2), 323-333.

Jones, R. W. (2000). *Globalization and the Theory of Input Trade*. Cambridge, MA: MIT Press.

Jones, R. W. and H. Kierzkowski (2001), A framework for fragmentation. In: *Fragmentation: New Production Patterns in the World Economy* (eds Arndt S. W. and Kierzkowski, H.), pp. 1-16. New York: Oxford University Press.

Kimura, F., Y. Takahashi, and K. Hayakawa (2007), Fragmentation and parts and components trade: Comparison between East Asia and Europe. *North American Journal of Economics and Finance,*18(2007), 23-40.

Krugman, P. (1995), Growing world trade: Causes and consequences. *Brooking Papers on Economic Activity 1: Macroeconomics, 25th Anniversary Issue,* 327-377.

Krugman, P., M. Obstfeld, and M. Melitz (2018), *International Economics: Theory and Policy*. Upper Saddle River, NJ: Pearson Education.

Kuroiwa, I. and K. Techakanont (2017), *Formation of Automotive Manufacturing Clusters in Thailand*. ERIA Discussion Paper Series No.32. Jakarta: Economic Research Institute for ASEAN and East Asia. Retrieved from http://www.eria.org/ERIA-DP-2016-32.pdf

Little, I. M. D. (1981), The experience and causes of rapid labor-intensive development in Korea, Taiwan Province, Hong Kong, and Singapore and the possibilities of emulation. In: *Export-led industrialisation & development* (ed Lee E.), pp. 23-45. Geneva: International Labor Organization.

Leontief, W. (1936), Quantitative input and output relations in the economic systems of the United States. *Review of Economics and Statistics,* 18(3), 105-125.

Maulia, E. (2018), Indonesia's Widodo urges miners to move into processing. Retrieved from https://asia.nikkei.com/Economy/Indonesia-s-Widodo-urges-miners-to-move-into-processing

Melitz, M. J. (2003), The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, 71(6), 1695-1725.

McGilvray, J. (1977), Linkages, key sectors and development strategy. In: *Structure, System and Economic Policy* (ed Leontief, W.), pp. 49-56. Cambridge: Cambridge University Press.

Miller, R. E. and P. D. Blair (2009), *Input-Output Analysis Foundations and Extensions.* New York: Cambridge University Press.

National Economic and Social Development Board. (2018), *Thailand Input-Output Tables*. Retrieved from http://www.nesdb.go.th

OECD (2019), *Trade in Value Added (TiVA).* Retrieved from https://www.oecd.org/sti/ind/measuring-trade-in-value-added.htm

Patunru, A. (2018), Rising economic nationalism in Indonesia. *Journal of Southeast Asian Economies*, 35(3), 335-354.

Porter, M. E. (1998), *On Competition*. Cambridge, MA: Harvard University Press.

Rasmussen, P. N. (1956), *Studies in Intersectoral Relations.* Amsterdam: North-Holland Publishing Company.

Reuters (2011), *ON Semiconductor ceases some Thai operations after flood*. Retrieved from https://www.reuters.com/article/onsemiconductor-thailand-flood/on-semiconductor-ceases-some-thai-operations-after-flood-idUSL3E7N92K520111209

Siriprachai, S. (1998), Export-oriented industrialisation strategy with land-abundance: some of Thailand's shortcomings. *Thammasat Economic Journal*, 16(2), 83-138.

Suruga, T. (2017), Thai ministers seek tech, investments from Japan. Retrieved from https://asia.nikkei.com/Politics/International-relations/Thai-ministers-seek-tech-investments-from-Japan

Tambunlertchai, S. (1987), *Development of the Manufacturing Sector in Thailand*. Paper presented at the International Conference on Thai Studies, Australian National University, Canberra.

Tambunlertchai, S. (1993), Manufacturing. In: *The Thai Economy in Transition* (ed Warr, P. G.), pp.118-150. Cambridge: Cambridge University Press.

Warr, P. G. (1993), The Thai economy. In: *The Thai Economy in Transition* (ed Warr, P.), pp.118-150. Cambridge: Cambridge University Press.

Warr. P. G. (1994), Myths about dragons: The case of Thailand. *Agenda: A Journal of Policy Analysis and Reform*, 1(2), 215-227.

Warr, P. G. (2008), Trade policy and the structure of incentives in Thai agriculture. *ASEAN Economic Bulletin*, 25(3), 249-270.

Warr, P. G. and A. Kohpaiboon (2018), Explaining Thailand's automotive manufacturing success. *Journal of Southeast Asian Economies*, vol. 35(3), 425-448.

World Bank. (1987), *World Development Report 1987.* New York: Oxford University Press.

World Bank (2019), World Development Indicator. Retrieved from https://databank.worldbank.org

Yeats, A. (2001), Just how big is global production sharing? In: *Fragmentation: New Production Patterns in the World Economy* (eds Arndt, S. and Kierzkowski, H.), pp. 108-143. New York: Oxford University Press.

Yotopoulos, P. A. and J. B. Nugent (1973), A balanced-growth version of the linkage hypothesis: A test. *Quarterly Journal of Economics,* 87(2), 157-71.

Appendix

Table A1: Definition of manufacturing sector

Sector	Definition	Sector	Definition
15	Slaughtering, canning and preservation of meat	52	Drugs and medicines
16	Dairy products	53	Soap, cleaning preparations, and cosmetics
17	Canning and preservation of fruit and vegetables	54	Other chemical products
18	Canning and preservation of fish and other seafoods	55	Petroleum refineries and other petroleum products
19	Oil from coconut, palm, animal, and vegetables	56	Types and tubes
20	Rice milling, grinding of maize, flour and other grain milling	57	Plastic ware
21	Tapioca milling	58	Ceramic, earthen ware, and structural clay products
22	Bakery products	59	Glass and glass products
23	Noodles and similar products	60	Cement
24	Sugar	61	Concrete, cement products, and other non-metallic products
25	Confectionery	62	Iron, steel, and secondary steel products
26	Other food products	63	Non-ferrous metal
27	animal feed	64	Cutlery and hand tools
28	Distilling and spirits blending	65	Metal furniture and fixtures
29	Breweries	66	Structure metal products
30	Soft drinks and carbonated water	67	Engines and turbines
31	Tobacco processing and tobacco products	68	Agricultural machinery and equipment
32	Spinning and weaving	69	Wood and metal working machines
34	Made-up textile goods	70	Special industrial machinery
35	Knitting	71	Office and household machinery and electrical appliances
36	Wearing apparel	72	Electrical industrial machinery and appliances
37	Carpets and rugs	73	Radio, television and communication equipment and apparatus
38	Jute mill products	74	Insulated wire and cable
39	Tanneries and leather finishing	75	Electric accumulators and batteries
40	Leather products	76	Other electrical apparatus and supplies
41	Rubber products	77	Ship building and repairing
42	Saw mills	78	Railroad equipment
43	Wood and cork products	79	Motor vehicles
44	Wooden furniture and fixtures	80	Motorcycles and bicycles
45	Pulp, paper and paperboard	82	Aircraft
46	Paper and paperboard products	83	Scientific equipment
47	Printing and publishing	84	Photographic and optical goods
48	Basic industrial chemicals	85	Watches and clocks
49	Fertilizer and pesticides	86	Jewelry
50	Petrochemical products	87	Recreational and athletic equipment
51	Paints	88	Other manufactured goods