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Changing Trade Structure and Industrial Deepening in the Thai Economy

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Abstract

Industrial development is increasing in complexity by economic inter-dependence within an economy. Between 1975 and 2010, Thailand's industrial deepening was evidenced by an increase in average aggregate linkages. Backward linkages for manufacturing sectors is found to be above the agricultural and primary sectors as well as service sectors. Backward linkage improvement in the agricultural and primary sectors is matched by forward linkage improvement in the service sectors. Through the growth of intra-industry trade of the global supply chain, structural change is driven by the strong growth of manufacturing sectors, relative to the agricultural and primary sectors as well as the service sectors. Stationary backward and forward linkages in manufacturing sectors indicate constant reliance on imports and equally on the agricultural, primary and service sectors for input requirements and a strong reliance on export market for growth.

Keywords: Industrial deepening, input-output analysis, backward linkages, forward linkages

1. Introduction

Development economics advocates industrial deepening to raise the development of a country (Javorcik, 2004; Lauridsen, 2008; Shuja' et al., 2008; Yean & Heng, 2011). Economic growth is driven more efficiently by domestic production (UNCTAD, 2013), as value added is generated by employment of labor and capital factors as well as indirect tax collection. The more domestic production a country can achieve, the greater the value added contributing to gross domestic products (GDPs) and economic growth. In contrast, production requiring large imported inputs can create comparatively small value added and contributes little to GDP and economic growth.

An economy can consist of a large number of production sectors, ranging from agricultural and primary production to simple processing industries to more complex industries and to service sectors. This wide range of sectors can engage in the transaction of inputs and outputs. They are interdependent in terms of direct and indirect input requirements and product customers. The output of one sector is the input for other sectors. Likewise, the production of sectors can require inputs of many types and sectors. These connections are called backward linkages as inputs are required from other sectors, and forward linkages as a product is required by other sectors. The output of a petroleum refinery, for example, is used by all

sectors of an economy. Likewise, inputs for the automobile industry are drawn from many sectors. The linkages are complex, as there are indirect connections for both outputs and inputs.

If sectors of an economy are grouped by function as agricultural and primary sectors, manufacturing sectors, and service sectors, it is intuitive that for developed economies, more complex linkages would be found for manufacturing sectors compared with the agricultural and primary sectors and the service sectors. For less-developed economies, this difference may not be conclusive, as manufacturing sectors may be in their initial stage, operating in the downstream assembly of imported parts (Amirahmadi and Wu, 1995). The upstream manufacturing process to supply these parts is dominated by developed economies (Riad et al., 2012). Over time, development can take less-developed countries to more upstream levels depending on the evolution of internal factors, such as learning and educational culture, innovation drive, and public policies. In terms of economic development, manufacturing sectors will be treated as the main drivers, employment generators, and targets for supportive policies (De Mello, 1997; Borensztein et al., 1998; Gorg and Greenaway, 2004; Pack, 2008; Ritchie, 2008).

The typical production of goods and services in a modern economy is an activity that combines domestically produced and imported inputs. The proportion of imported inputs can vary from a small to a large percentage. Industrial deepening is achieved by increasing the proportion of domestic inputs in the production of goods and services, thereby reducing the proportion of imported inputs. It is thought that industrial deepening evolves over time, along with greater opportunity for the substitution of imported inputs by domestically produced inputs as a country diversifies its industrial production (Chenery and Watanabe, 1958; Hirschman, 1958; Hirschman, 1977; Hirschman, 1986; van Dijck, 1987; Verbruggen, 1987; Kunnoot and Chowdhury, 1992; Schnabl, 1994; Islam and Chowdhury, 1997; Claus, 2003; Javorcik, 2004; Jabbour and Mucchielli, 2007; Rohana and Zakariah, 2007; Gangnes and Assche, 2010; Kohpaiboon, 2010).

This process is called import substitution and is often misunderstood as protectionism. Rather, it can be reasoned that import substitution is a natural process that is the evolutionary outcome of expanding and broadening export markets brought about by foreign direct investment. Overtime, production for expanding export markets generates increases in both domestic and imported inputs. The momentum created by expanding export markets opens up the opportunity for producing domestic inputs to achieve economies of scale, thus becoming more favorable relative to imported inputs. With this process of import substitution, production multiplies. This evolutionary process occurs along with trade growth and can be facilitated by policies to produce external effects such as infrastructure development, as well as human and social capital development.

From the perspective of economic development, import substitution is domestic demand-led growth, wherein the extra value added is generated by expanded production. The market for domestic production can be broadened to include final uses; i.e., consumption by households, investment, government, and the foreign markets, as well as intermediate uses for the production of other goods. The intermediate markets provide a vast opportunity for supply from both domestic and imported sources. Domestic supply can exploit the opportunities provided by new scope for value creation, as well as the expansion and extension of export markets. Support by domestic markets depends on competitive prices and non-price attributes, such as the quality and the reliability of suppliers.

Trade has become an increasingly important tool for economic development used by developing countries to exploit the external effects created by the East Asian NICs (newly

industrialized countries) (Birdsall et al., 1993). Toward the end of the twentieth century and the beginning of the new millennium, advances in computer technology, global communication and transportation networks have transformed world trade into a global production network, thus enabling economies around the world to participate in a network of non-commodity production (Riad et al., 2012; UNCTAD, 2013; UNCTAD, 2014; WTO, 2013; WTO, 2014; Bhagwati et al., 2016). The production of goods and services draws inputs from diverse sources across the world. The growth of intra-industry trade drives the growth of global trade at a faster rate than the growth of global GDP (Ghibutiu, 2013).

Global trade has evolved over the past years into increased intra-industry trade (World Bank, 2009; Vogiatzoglou, 2017), whereby the production of intermediate goods is shared by countries participating in the international division of labor. This is evidenced by the rapid growth of the global export-GDP ratio (Dean and Sebastia-Barriel, 2004; Kunnoot, 2017). One possibility is that a participating country has greater opportunity for industrialization and income generation. In this context, the economic development of less-developed countries approximates that of developed countries, and industrial deepening takes on a global scale (Riad et al., 2012; WTO, 2014). Alternatively, the industrialization of a participating country can weaken as the proportion of intermediate goods production by a participating country decreases (Zhang and Xia, 2017). The third possibility is that a participating country maintains this proportion and growth rate along with the change in global trade. Over time, changes have been reported in the positions of countries in the global value chain (Gao, 2017; Muradovd, 2017) and in their impacts on domestic added value and job opportunities (Kong, 2017; Meng et al., 2017; Villanueva and Jiang, 2017).

Thailand is considered an active participant in global trade (Kunnoot, 2017; World Bank, 2018), as evidenced by the growth in the export-GDP ratio and the increased proportion of industrial goods in its trade structure. In this study, evidence of Thailand's industrial deepening is presented in the context of rapid growth in global trade. The evidence was produced from the computed value of backward and forward linkages from Thailand's input-output tables for the years 1975, 1980, 1985, 1990, 1995, 2000, 2005, and 2010. These indicators are used to describe Thailand's industrialization over time in the changing context of global trade and to explore options for public policies.

2. Measuring Industrial Deepening

A method to quantify inter-industry dependence was invented by Wassily Leontief (Leontief, 1936). Known as an input-output table, it enables a system for the computation of the effects of multipliers on the output of sectors across an economy originating from the change in final demand of any one sector. Thailand's input-output table classifies 180 sectors, comprised of 41 agricultural and primary sectors, 93 manufacturing sectors, and 46 services sectors. A schematic layout of Thailand's input-output table is shown in Figure 1.

Leontief's (1936) input-output system equation expresses total demand as consisting of two components: intermediate demand and final demand. Intermediate demand is the use of a commodity for the production of another commodity. Y denotes the column vector of the total demand for goods i=1..180; A denotes the square matrix of coefficients of domestically produced intermediate inputs i=1..180 for the production of goods j=1..180; F denotes the column vector of the final demand for domestic goods i=1..180; and I denotes the identity matrix with elements i=1..180 ×j=1..180. The matrix form is expressed as:

$$Y = AY + F$$

The expression can be transformed into:

$$Y = (I - A)^{-1}F.$$

For economic application, the magnitude of change in output Y is predicted by the magnitude of multipliers $(I-A)^{-1}$ on change in final demand F. The column element of $(I-A)^{-1}$ measures the multiplier of output of every commodity used as intermediate input of production following the change in the final demand of any one commodity. Thus, the column total of $(I-A)^{-1}$ measures the total change of output across an economy following a change in final demand of any one commodity. On the other hand, the row element of $(I-A)^{-1}$ measures the multiplier of the output of a commodity used as intermediate input following successive change in the final demand of the respective commodity. Thus, the row total of $(I-A)^{-1}$ measures the total change in the output of a commodity following successive change in the final demand of the respective commodity.

Leontief's multipliers can be used to identify the strength of impacts produced by an industry (Schultz, 1977). The measurement of the impacts, known as backward and forward linkages of the industry, has been pioneered by Rasmussen (1956) and Hirschman (1958) (Jones, 1976). In this study, backward and forward linkages are expressed in total multiplier values for each sector of Thailand's input-output table. R_{ij} denotes element $(I \quad A)^{-1}$; L_j^B denotes the backward linkage values for sectors j; and L_i^F denotes the forward linkages value for sectors i. The backward linkages are found by:

$$L_j^B = \sum_{i=1}^{N} R_{ij},$$

and the forward linkages are found by:

$$L_i^F = \sum_{j=1}^{N} R_{ij}.$$

Let L^A denote the average linkages found by:

$$L^A = \frac{\sum_{j=1}^{N}\sum_{i=1}^{N} R_{ij}}{N}.$$

The average for linkages is the sum of all elements of $(I-A)^{-1}$ divided by the number of sectors. The change in average linkages is influenced by a change in the R_{ij} value, which results from a change in intermediate input coefficients.

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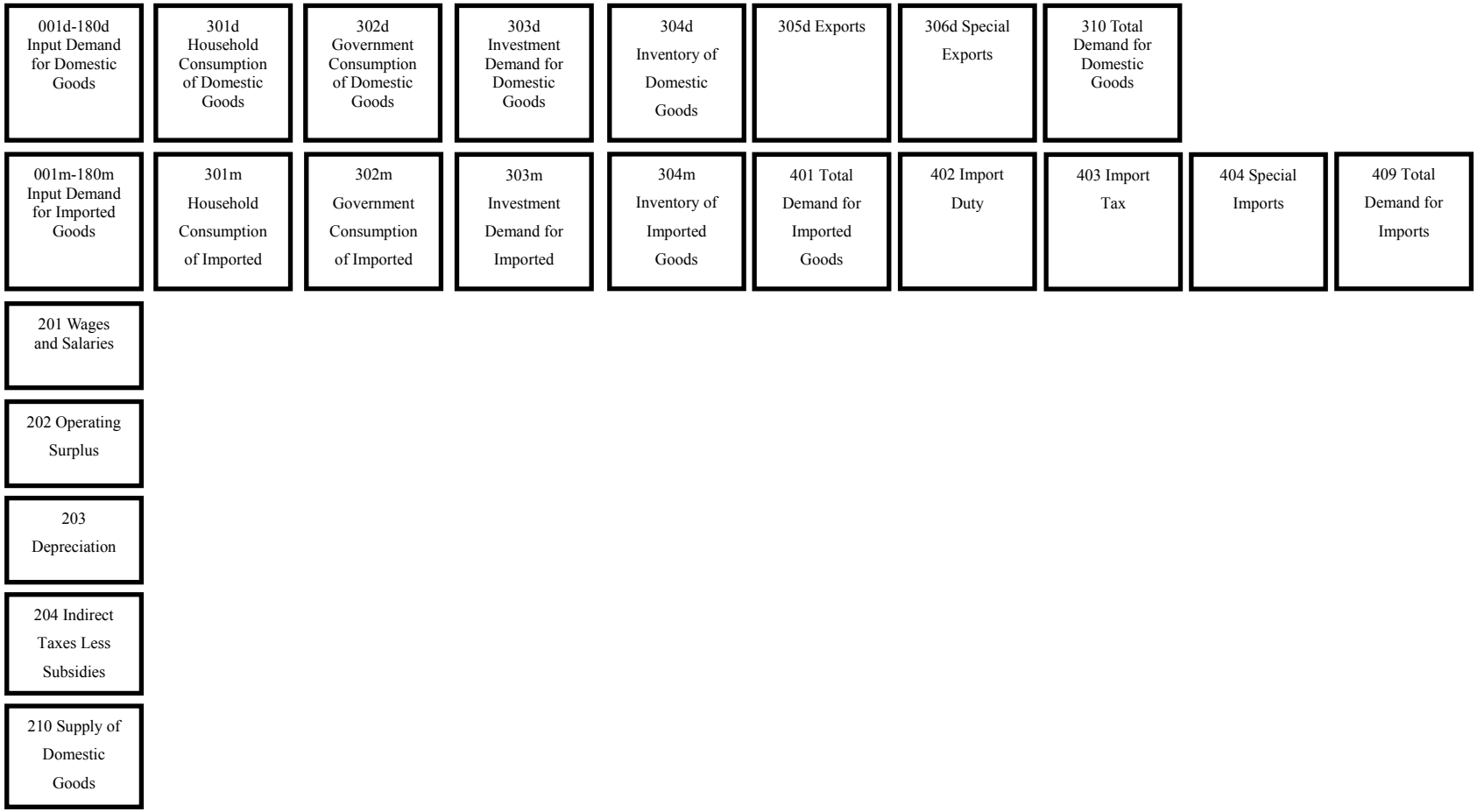

Figure 1. Layout for Thailand's input-output table.

Source: Constructed according to the structure of Thailand's input-output table.

Backward and forward linkages for 180 sectors have been computed from Thailand's input-output tables released by the Office of National Economic and Social Development Board for the years 1975, 1980, 1985, 1990, 1995, 2000, 2005, and 2010.

Larger values of L_j^B, L_i^F, and L^A are interpreted as stronger backward, forward, and average linkages, respectively, whereas an increase in value is interpreted as industrial deepening. Other things being equal, sectors with larger values of forward and backward linkages are likely to better contribute to the growth of GDP. An exception is for linkages consisting mostly of elements having a small share of the value added component of output. On the other hand, sectors consisting of less complex linkages may better contribute to the growth of GDP, as the linkages consist of elements having a large share of the value added component of output.

There are reasons for a country to expect improvement in linkages over time. The high import content of newly established industries producing finished goods creates opportunity for local enterprises to emerge to provide substitution for imported inputs. Import substitution can take advantage of scale as user industries become more diversified. Industrial establishments multiply quickly as industrial interdependence and urbanization take motion. Free trade policies and active participation in foreign trade help accelerate the establishment of the production of finished goods. Foreign direct investment to take advantage of low wages and fewer restrictions on social and environmental regulations results in diversified industries. The growth of foreign direct investments is facilitated by investment promotion measures that provide special privileges in terms of exemptions for income tax and duty for imported machinery. The growth of local banks and financing of small and medium enterprises is facilitated by foreign direct investments. The growth of public investments for infrastructures in diversified areas helps to increase the scale of infrastructural services that provide cost subsidies for production.

3. Industrial Deepening in the Context of Trade Growth

In the context of Thailand, despite an unstable pattern over 35 years from 1975-2010, the average linkages over 180 sectors have shown significant improvement, as shown in Table 1 and Figure 2. If sectors are grouped to comprise 41 agricultural and primary sectors, 93 manufacturing sectors, and 46 services sectors, the differences can be compared as shown in Figure 3. Over 35 years, the average backward linkages for manufacturing sectors are graphed above services sectors and agricultural and primary sectors. As a group, backward linkage development for manufacturing sectors has been relatively slow compared to that of the agricultural and primary sectors as well as services sectors.

The yearly averages for forward linkages are shown in Figure 4. Service sectors are graphed above manufacturing sectors and agricultural and primary sectors. Service sectors have shown significant improvement, whereas manufacturing, agricultural and primary sectors have shown slight improvement.

For the respective sectors, the values for backward linkages and computed improvement between 1975 and 2010 for 41 agricultural and primary sectors, 93 manufacturing sectors, and 46 service sectors are presented in Table 2 through Table 4, respectively. Differences from mean improvement $(x - \mu)$ are shown in the far-right column. For agricultural and primary sectors, outlying improvement includes other root crops, other crops for textile and matting, coffee and tea, and tungsten ore. For manufacturing, outlying improvement includes canning and preserving of meat, spinning, jute mill products, plastic ware, iron and steel, and aircraft. For service sectors, outlying improvement includes pipeline and gas distribution, air

transport, movie theatres, radio, television, and related services.

The stationary pattern of the backward linkages of manufacturing sectors as a group can be explained by the unchanged import content of Thailand's exports over the period of rapid trade growth. Thailand has been an active participant in world trade (Kunnoot, 2017). The ratio between exports and GDP has increased from 16 percent in 1960 to 71 percent in 2008, stabilizing at approximately 69 percent from 2012 to 2016, as shown in Figure 5. As described earlier, the growth of world trade toward the end of the twentieth century and the start of the twenty-first century has been characterized by growth of intra-industry trade of the global supply chain, which has been made possible by advances in computer technology as well as decreased costs of transportation and communication. Thailand's export and import structures have shifted toward manufacturing commodities, as shown in Figure 6 and Figure 7, respectively.

In 2015, the exports of three items of manufacturing commodities total 3,184 billion baht, which is 3.95 times the total export value for 12 items of agricultural and food commodities. These are HS 84 for nuclear reactors, boilers, machinery and mechanical appliances and parts thereof; HS 85 for electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles; and HS 87 for vehicles other than railway or tramway rolling-stock and parts and accessories thereof. A review of revealed comparative advantage (RCA) found that many of Thailand's exported items have gained increased share in world trade (Kunnoot, 2017).

Thailand's major sources of imports have shifted from Japan to emerging market economies (EMES) (Kunnoot, 2017; Nozaki and Shu, 2017). The shift in the structure of Thailand's exports toward significantly larger shares of manufacturing exports has been paralleled by imports of the same sectors. This explains Thailand's role in downstream industries in the global supply chain.

Table 1. Simple average of yearly aggregate linkages and structural level backward and forward linkages

	1975	1980	1985	1990	1995	2000	2005	2010
Average for linkage values for 180 sectors	1.5836	1.5508	1.6099	1.5532	1.5635	1.6367	1.6642	1.7550
Backward linkage values for 41 agricultural and primary sectors	1.2866	1.2755	1.4052	1.3712	1.3964	1.4905	1.5382	1.6104
Backward linkage values for 93 manufacturing sectors	1.7386	1.7066	1.7293	1.6507	1.6579	1.7196	1.7344	1.8271
Backward linkage values for 46 service sectors	1.5348	1.4813	1.5510	1.5182	1.5215	1.5993	1.6346	1.7381
Forward linkage values for 41 agricultural and primary sectors	1.4919	1.4638	1.5694	1.4880	1.4677	1.4798	1.4809	1.5372
Forward linkage values for 93 manufacturing sectors	1.5369	1.5219	1.5390	1.4609	1.4486	1.5586	1.5540	1.6285
Forward linkages values for 46 service sectors	1.7595	1.6869	1.7894	1.7978	1.8810	1.9343	2.0505	2.2047

Source: Computed from Thailand's input-output table.

As the growth of trade is paralleled in proportion by the growth of output and imports, the stationary improvement of linkages can be seen as industrial progress as domestic contents also advance in proportion. Trade growth contribution to GDP depends on the share of value added in the output of the respective sector. It is more likely for slower growth of GDP than trade as the share of value added becomes thin.

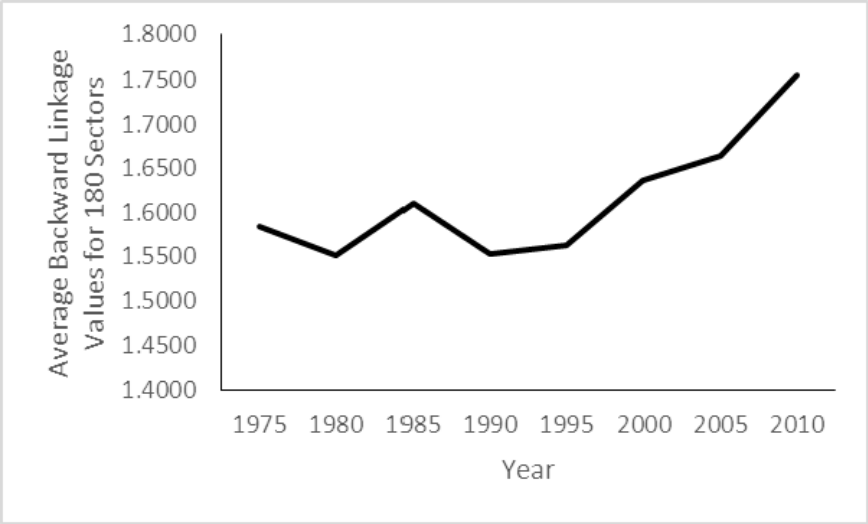

Figure 2. Simple average of yearly aggregate linkages for 180 sectors

Source: Computed from Thailand's input-output table

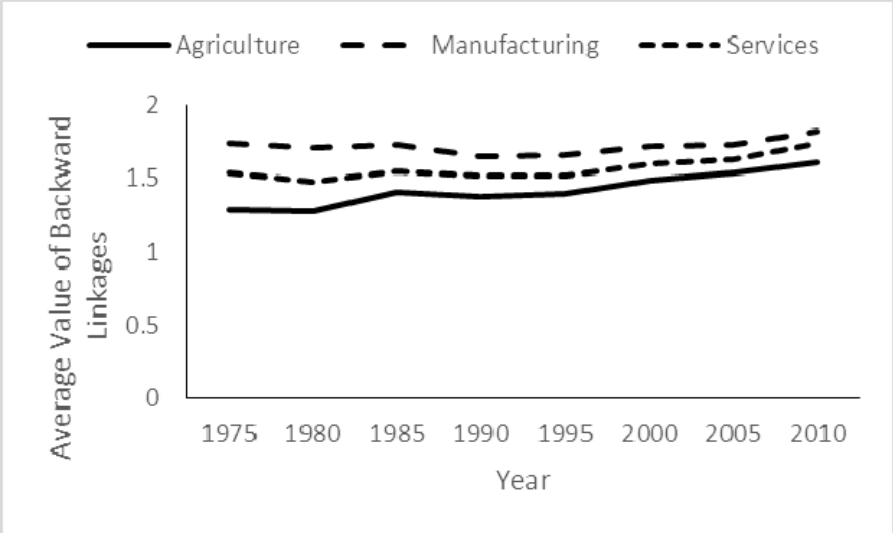

Figure 3. Average backward linkages for 41 agricultural and primary sectors, 93 manufacturing sectors, and 46 services sectors

Source: Computed from Thailand's input-output table

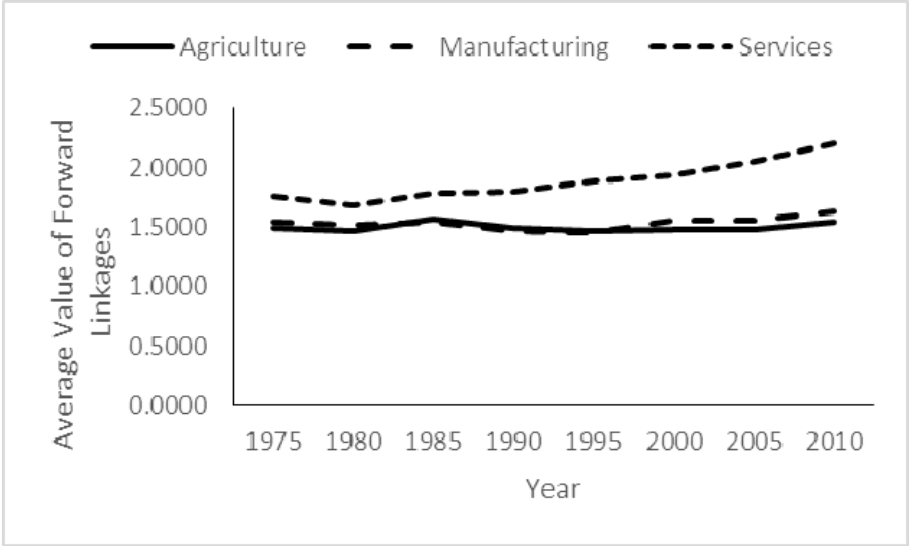

Figure 4. Average forward linkages for 41 agricultural and primary sectors, 93 manufacturing sectors, and 46 services sectors

Source: Computed from Thailand's input-output table

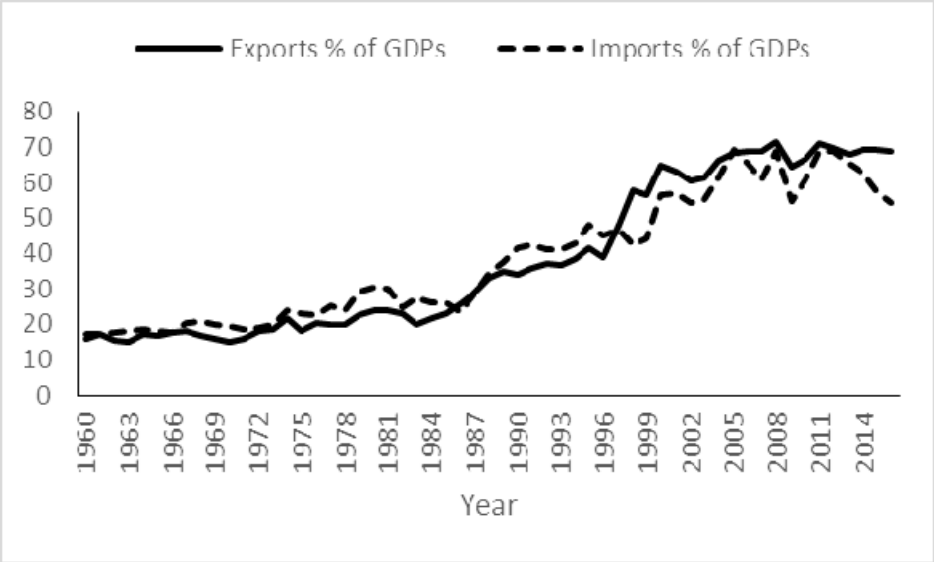

Figure 5. Thailand's exports-GDP ratios and imports-GDP ratios, 1960-2016

Source: Constructed from World Bank data.

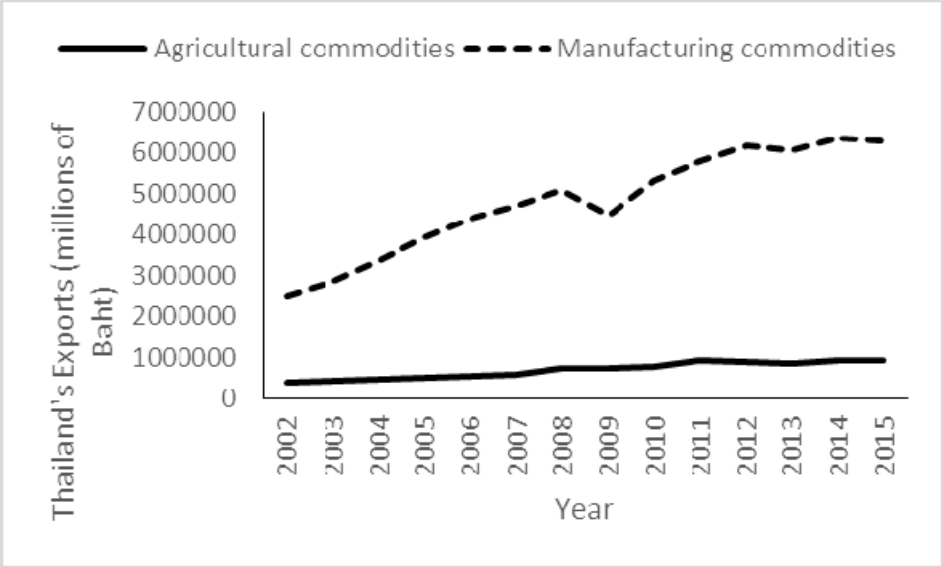

Figure 6. Thailand's exports (millions of Baht)

Source: Constructed from data released by Thailand's Ministry of Commerce

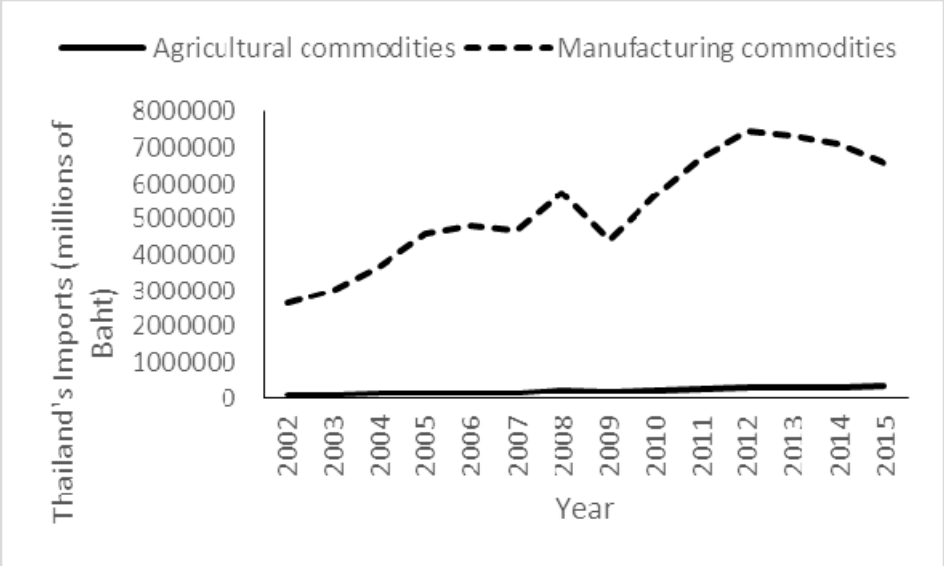

Figure 7. Thailand's imports (millions of Baht)

Source: Constructed from data released by Thailand's Ministry of Commerce

Table 2. Backward linkages of 41 agricultural and primary sectors and differences from mean improvement $(x-\mu)$ between 1975 and 2010

No.	Item	1975	1980	1985	1990	1995	2000	2005	2010	$x-\mu$
001	Paddy	1.1557	1.1842	1.2185	1.2090	1.2198	1.2681	1.2740	1.2853	-0.1942
002	Maize	1.3166	1.3714	1.4676	1.4701	1.4494	1.3678	1.4963	1.4678	-0.1727
003	Other cereals	1.2414	1.2836	1.5659	1.4807	1.3749	1.3791	1.4448	1.5790	0.0139
004	Cassava	1.1630	1.2153	1.3507	1.2805	1.3071	1.5134	1.6326	1.4555	-0.0313
005	Other root crops	1.1557	1.1520	1.2445	1.2377	1.2844	1.4745	1.3676	1.8701	0.3907
006	Beans and nuts	1.1780	1.2032	1.4001	1.3368	1.3124	1.6278	1.4885	1.5204	0.0186
007	Vegetable	1.1731	1.1861	1.2693	1.2295	1.2632	1.4314	1.5451	1.4220	-0.0748
008	Fruits	1.1396	1.1586	1.2387	1.1963	1.2165	1.3778	1.4058	1.4737	0.0103
009	Sugar cane	1.2164	1.1939	1.4043	1.3088	1.3384	1.4266	1.5564	1.5385	-0.0017
010	Coconut	1.1018	1.0825	1.1344	1.1188	1.1281	1.1512	1.1609	1.3211	-0.1045
011	Oil palm	1.0955	1.1102	1.2931	1.3547	1.3005	1.5370	1.5867	1.6995	0.2802
012	Kenaf and jute	1.1141	1.1351	1.3148	1.2728	1.3069	1.3470	1.4651	1.5847	0.1468
013	Other crops for textile and matting	1.1410	1.1394	1.2810	1.2695	1.2642	1.5879	1.6286	1.7903	0.3255
014	Tobacco	1.2281	1.2197	1.3652	1.3471	1.3717	1.4887	1.5866	1.7226	0.1707
015	Coffee and tea	1.0848	1.0673	1.2819	1.3078	1.1941	1.4307	1.7319	1.8988	0.4902
016	Rubber	1.0860	1.0810	1.1168	1.1227	1.1215	1.1193	1.1582	1.2551	-0.1547
017	Other agricultural product	1.2674	1.2536	1.3055	1.2807	1.3215	1.4151	1.4705	1.4577	-0.1334
018	Cattle and buffalo	1.2041	1.2080	1.2824	1.2654	1.3468	1.2972	1.3218	1.3744	-0.1536
019	Swine	2.1213	2.0911	2.3731	2.3249	2.3027	2.2371	2.2905	2.2411	-0.2040
020	Other livestock	1.5640	1.5831	1.7226	1.6905	1.6999	1.4538	1.4667	1.6899	-0.1978
021	Poultry	2.1825	1.9890	2.1871	2.1337	2.0769	2.0651	2.0253	1.9805	-0.5258
022	Poultry products	2.0167	1.8872	2.0135	1.9504	2.0444	2.1424	2.1305	2.1235	-0.2170

023	Silk worm	1.8320	1.4851	1.5330	1.5209	1.5524	1.5296	1.5996	1.2586	-0.8972
024	Agricultural services	1.3172	1.3084	1.3397	1.3075	1.3168	1.4231	1.4629	1.4925	-0.1485
025	Logging	1.1952	1.2207	1.3290	1.2171	1.2550	1.3099	1.3300	1.3878	-0.1312
026	Charcoal and fire-wood	1.1223	1.1321	1.2097	1.1637	1.2008	1.1745	1.2837	1.3495	-0.0967
027	Other forest products	1.0587	1.0665	1.1963	1.1844	1.1996	1.2607	1.3013	1.3893	0.0068
028	Ocean and coastal fishing	1.2860	1.4938	1.5936	1.3410	1.3786	1.5630	1.5785	1.6799	0.0702
029	Inland fishing	1.3355	1.2788	1.5383	1.5346	1.5762	1.7639	1.7868	1.7820	0.1227
030	Coal and lignite	1.2233	1.2229	1.3046	1.2766	1.3106	1.4763	1.4946	1.5684	0.0213
031	Petroleum and natural gas	1.0000	1.0830	1.4253	1.5090	1.5818	1.4715	1.4998	1.5745	0.2507
032	Iron ore	1.5111	1.4846	1.5857	1.5094	1.5013	1.7578	1.6651	1.8357	0.0008
033	Tin ore	1.1736	1.1285	1.1991	1.2100	1.3894	1.5751	1.6165	1.6783	0.1809
034	Tungsten ore	1.0836	1.0674	1.3443	1.4143	1.4462	1.4621	1.6683	2.0993	0.6919
035	Other non-ferrous metals	1.2258	1.1867	1.3103	1.2320	1.3338	1.4119	1.4701	1.5549	0.0053
036	Fluorite	1.3672	1.3646	1.4810	1.4492	1.6818	1.7691	1.7873	1.8517	0.1608
037	Chemical fertilizers	1.1624	1.1367	1.2978	1.2439	1.3219	1.4244	1.4791	1.5405	0.0544
038	Salt	1.1381	1.0985	1.0850	1.0666	1.0650	1.1947	1.2489	1.3745	-0.0874
039	Limestone	1.3067	1.3024	1.3241	1.2484	1.2837	1.3537	1.3776	1.5035	-0.1270
040	Stone quarrying	1.3164	1.2964	1.5280	1.4416	1.4186	1.5128	1.6134	1.6933	0.0531
041	Other mining and quarrying	1.1497	1.1440	1.1587	1.1603	1.1917	1.5375	1.5667	1.6609	0.1874
	Average	1.2866	1.2755	1.4052	1.3712	1.3964	1.4905	1.5382	1.6104	-0.1942

Source: Computed from Thailand's input-output table.

Table 3. Backward linkages of 93 manufacturing sectors and differences from mean improvement $(x-\mu)$ between 1975 and 2010

No.	Item	1975	1980	1985	1990	1995	2000	2005	2010	$x-\mu$
042	Slaughtering	2.5937	2.4034	2.4976	2.4791	2.5013	2.4209	2.5320	2.3531	-0.3291
043	Canning and preserving of meat	2.1989	2.0953	2.3961	2.3534	2.2999	2.4445	2.6144	2.6993	0.4120
044	Dairy products	1.7378	1.9131	1.8851	1.8169	1.7121	1.8910	2.0113	2.1683	0.3420
045	Canning and preservation of fruit and vegetables	1.8275	1.8550	1.8274	1.8469	1.8627	1.8814	1.9765	2.0430	0.1270
046	Canning and preservation of fish and other sea foods	1.6934	1.7490	1.7693	1.6125	2.0088	2.0840	1.8420	1.9672	0.1853
047	Coconut and palm oil	1.4274	1.5352	1.8692	1.9815	1.9021	2.2884	2.4007	2.5411	1.0252
048	Animal oil, animal fat, vegetable oil and by-products	2.0154	2.0886	1.9807	1.9272	1.7448	1.4067	1.2466	1.2694	-0.8345
049	Rice milling	1.9511	1.9835	2.0733	2.0474	2.0771	2.0503	2.0996	2.1091	0.0696
050	Tapioca milling	1.9394	2.0588	2.3177	2.3724	2.3453	2.5563	2.4270	2.2915	0.2637
051	Grinding of maize	1.9312	1.9777	2.1038	1.9335	1.9031	1.9903	2.1275	2.2401	0.2204
052	Flour and other grain milling	1.8249	1.6372	1.9224	1.5875	1.5608	1.9557	1.9083	2.0680	0.1546
053	Bakery products	2.0556	2.0264	1.8642	1.7820	1.8803	1.9825	1.9213	2.1331	-0.0109
054	Noodles and similar products	2.1518	2.1438	2.2035	2.1872	2.2296	2.2746	2.2809	2.3568	0.1165
055	Sugar	1.8525	1.9407	1.6928	1.9065	1.7699	1.8230	1.8612	1.8616	-0.0794
056	Confectionery	1.8207	1.6948	2.0390	1.9632	2.1165	2.1981	2.1075	2.1464	0.2372
057	Ice	1.4108	1.5463	1.6614	1.6156	1.7446	1.6926	1.8035	1.8255	0.3262
058	Monosodium glutamate	1.7160	1.7516	1.9065	2.0349	2.0930	2.1104	2.1500	2.2145	0.4101
059	Coffee and tea	1.8002	1.8322	1.8132	1.8338	1.5947	2.4315	2.2723	2.1197	0.2311
060	Other food products	1.7330	1.7435	1.8364	1.8882	1.9175	1.6760	1.7494	1.8471	0.0256
061	Animal feed	2.1207	2.0381	1.9751	1.7555	1.7352	1.7804	1.6358	1.6127	-0.5965
062	Distilling and spirits blending	1.3971	1.4136	1.4090	1.3926	1.3605	1.8778	1.6203	1.6432	0.1576
063	Breweries	1.4546	1.3018	1.3439	1.2955	1.3453	1.3933	1.4017	1.5144	-0.0287
064	Soft drinks and carbonated water	1.6094	1.4355	1.6265	1.7364	1.7929	1.6646	1.7497	2.0399	0.3420
065	Tobacco processing	1.9165	1.8558	1.9670	1.8869	1.7962	1.8056	1.8391	2.0306	0.0256

066	Tobacco products	1.3501	1.4848	1.2219	1.1819	1.1763	1.2066	1.2185	1.3602	-0.0784
067	Spinning	1.3824	1.5182	1.4697	1.5588	1.6036	1.8626	1.7681	1.9493	0.4784
068	Weaving	1.9036	1.9546	1.9731	1.8028	1.7883	1.9030	1.8469	1.6711	-0.3210
069	Textile bleaching, printing and finishing	1.6609	1.5625	1.6057	1.4856	1.5576	1.7687	1.7487	1.8567	0.1073
070	Made-up textile goods	1.9831	1.9795	2.0122	1.8582	1.8847	1.7855	1.8887	1.8136	-0.2580
071	Knitting	1.7579	1.8337	1.7710	1.8196	1.8172	1.8892	1.7599	2.0097	0.1634
072	Wearing apparel	2.0646	2.1461	1.9337	2.0542	2.0013	2.0766	2.0755	2.0767	-0.0763
073	Carpets and rugs	2.0126	1.9906	2.0081	1.8038	1.8193	2.0717	2.1076	2.2229	0.1218
074	Jute mill products	1.6830	1.5274	1.6257	1.5469	1.5706	1.4113	1.5490	2.1923	0.4208
075	Tanneries and leather finishing	2.4234	2.3048	2.5203	1.7927	1.6617	1.2710	1.4769	1.4215	-1.0904
076	Leather products	2.0151	1.8967	1.7530	1.5925	1.5576	1.5619	1.6788	1.6334	-0.4701
077	Footwear, except of rubber	2.1138	2.0750	2.2414	1.9191	1.7630	1.8560	1.8348	1.8101	-0.3922
078	Saw mills	1.7309	1.5514	1.5611	1.3888	1.3592	1.4257	1.7579	1.8658	0.0465
079	wood and cork products	1.7970	1.7503	1.7946	1.6714	1.8172	1.8622	1.9796	1.9277	0.0422
080	Wooden furniture and fixtures	1.8654	1.7964	1.6807	1.6475	1.5332	1.3969	1.6382	1.6808	-0.2731
081	Pulp, paper and paperboard	1.5867	1.5545	1.4347	1.4137	1.3613	1.3707	1.4965	1.5649	-0.1103
082	Paper and paperboard products	1.6924	1.6389	1.4188	1.5161	1.5804	1.6335	1.5197	1.6090	-0.1719
083	Printing and publishing	1.5245	1.4821	1.3155	1.2793	1.4138	1.5605	1.6476	1.7046	0.0917
084	Basic industrial chemicals	1.6335	1.4508	1.5112	1.4198	1.4272	1.3978	1.4116	1.5898	-0.1321
085	Fertilizer and pesticides	1.6082	1.5190	1.3699	1.3188	1.3290	1.5785	1.4220	1.5706	-0.1261
086	Petrochemical products	1.8729	1.9843	1.7322	1.9557	1.9636	1.6436	1.5401	1.6639	-0.2975
087	Paints	1.6387	1.4772	1.5300	1.6918	1.6877	1.8727	1.9519	1.6092	-0.1180
088	Drugs and medicines	1.5349	1.4230	1.6994	1.5136	1.4861	1.5731	1.5912	1.7642	0.1409
089	Soap and cleaning preparations	1.6434	1.4183	1.5959	1.5951	1.6283	1.6511	1.5991	1.6502	-0.0818
090	Cosmetic	1.7959	1.6402	1.6396	1.5321	1.3954	1.6329	1.5741	1.7709	-0.1135
091	Matches	1.9166	1.7627	1.6897	1.6629	1.5889	1.7299	1.7300	1.9266	-0.0784

092	Other chemical products	1.7398	1.4617	1.4724	1.4542	1.4678	1.5085	1.4964	1.4949	-0.3333
093	Petroleum refineries	1.1223	1.0593	1.2817	1.1114	1.0896	1.1577	1.0540	1.1521	-0.0587
094	Other petroleum products	1.8551	1.7308	1.5333	1.2005	1.2096	1.0689	1.7426	1.2954	-0.6481
095	Rubber sheet and block rubber	1.8318	1.8537	2.0207	2.0581	2.0220	1.8406	1.9465	1.9064	-0.0139
096	Types and tubes	1.5540	1.5637	1.8837	1.7314	1.7701	1.7118	1.7573	1.9111	0.2686
097	Other rubber products	1.7839	1.7285	1.7383	1.7975	1.8677	1.7863	1.7987	1.9211	0.0487
098	Plastic ware	1.2818	1.3815	1.4358	1.5662	1.7234	1.8611	1.8265	1.8543	0.4841
099	Ceramic and earthen ware	1.6843	1.6157	1.6513	1.6266	1.7143	1.6384	1.8500	1.9718	0.1991
100	Glass and glass products	1.7449	1.5361	1.7076	1.5800	1.5832	1.5596	1.7658	1.9497	0.1163
101	Structural clay products	1.7093	1.6219	1.7574	1.7438	1.7001	1.8438	1.9523	2.1344	0.3366
102	Cement	1.8074	1.6413	1.8026	1.6898	1.5832	1.6502	1.6503	1.8347	-0.0612
103	Concrete and cement products	1.9709	1.9596	1.8969	1.9917	1.8713	1.7753	1.8435	2.0944	0.0351
104	Other non-metallic products	1.6304	1.7917	1.9365	1.7886	1.9445	1.9563	2.0147	2.0637	0.3449
105	Iron and steel	1.3175	1.3463	1.5311	1.3510	1.3147	3.0860	3.2298	3.0667	1.6607
106	Secondary steel products	1.6962	1.6784	1.6579	1.6164	1.3038	1.6975	1.6823	1.7188	-0.0659
107	Non-ferrous metal	1.8930	1.8982	1.8281	1.5631	1.4391	1.3748	1.3412	1.5051	-0.4764
108	Cutlery and hand tools	1.7713	1.5636	1.3757	1.2650	1.2969	1.4687	1.3713	1.7235	-0.1363
109	Metal furniture and fixtures	1.8263	1.6120	1.6267	1.6140	1.6438	1.4376	1.4394	1.7860	-0.1287
110	Structure metal products	1.6154	1.5043	1.4862	1.3115	1.3360	1.4020	1.3517	1.5282	-0.1757
111	Other fabricated metal products	1.3631	1.3246	1.4848	1.3876	1.4264	1.4099	1.3749	1.4818	0.0303
112	Engines and turbines	1.4306	1.5762	1.6771	1.6855	1.5262	1.5357	1.7431	1.5446	0.0256
113	Agricultural machinery and equipment	1.6477	1.6591	1.5565	1.5360	1.5932	1.7301	1.5277	1.6078	-0.1283
114	Wood and metal working machines	1.7220	1.6979	1.7813	1.5417	1.7378	1.6420	1.5165	1.7845	-0.0260
115	Special industrial machinery	1.4397	1.5158	1.4294	1.4386	1.4754	1.5272	1.4954	1.5146	-0.0136
116	Office and household machinery and appliances	1.5865	1.5474	1.5228	1.2193	1.4734	1.5275	1.4841	1.9470	0.2721
117	Electrical industrial machinery and appliances	1.6313	1.6533	1.5510	1.4862	1.3391	1.4141	1.2967	1.4191	-0.3007

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118	Radio, television and communication equipment and apparatus	1.6236	1.7119	1.6963	1.2558	1.1694	1.1595	1.1150	1.3519	-0.3602
119	Household electrical appliances	1.8447	1.7891	1.8722	1.6355	1.5317	1.5980	1.5424	1.8170	-0.1162
120	Insulated wire and cable	1.8379	1.7812	1.5114	1.3183	1.3187	1.5031	1.3329	1.4677	-0.4586
121	Electric accumulators and batteries	1.7209	1.6639	1.5957	1.5563	1.7191	1.5851	1.5042	1.6744	-0.1349
122	Other electrical apparatus and supplies	1.7554	1.4505	1.6141	1.5152	1.3971	1.2197	1.7646	1.4461	-0.3978
123	Ship building and repairing	1.6974	1.8917	1.9669	1.8360	1.7332	1.6566	1.7255	1.7939	0.0080
124	Railroad equipment	1.3783	1.4364	1.4242	1.3458	1.8333	1.8707	1.9563	1.7703	0.3035
125	Motor vehicles	1.4752	1.5818	1.4286	1.3381	1.4274	1.3419	1.5415	1.5790	0.0153
126	Motor bicycle and bicycle	1.5471	1.6138	1.7088	1.7098	1.8270	1.8099	1.8466	1.7546	0.1190
127	Repair of motor vehicles	1.7598	1.7265	1.4114	1.3000	1.5153	1.6938	1.5864	1.6054	-0.2429
128	Aircraft	1.4858	1.5045	1.5929	1.2253	1.1969	1.5253	1.2649	2.2202	0.6459
129	Scientific equipment	1.5321	1.6193	1.6619	1.5070	1.5476	1.5249	1.2987	1.4246	-0.1960
130	Photographic and optical goods	1.7988	1.6396	1.7699	1.7023	1.4266	1.4488	1.4572	1.4893	-0.3980
131	Watches and clocks	1.9641	1.9396	1.6918	1.6228	1.6947	1.5050	1.5175	1.7749	-0.2776
132	Jewelry and related articles	1.2317	1.3176	1.3754	1.4154	1.6068	1.5480	1.3573	1.6354	0.3152
133	Recreational and athletic equipment	2.0093	1.8376	1.8617	1.8124	1.9150	1.9114	1.8719	2.0509	-0.0469
134	Other manufactured goods	1.9994	1.9457	1.9209	1.8028	1.8040	1.7339	1.6723	1.8384	-0.2495
	Average	1.7386	1.7066	1.7293	1.6507	1.6579	1.7196	1.7344	1.8271	-0.3291

Source: Computed from Thailand's input-output table.

Table 4. Backward linkages of 46 service sectors and differences from mean improvement $(x-\mu)$ between 1975 and 2010.

No.	Item	1975	1980	1985	1990	1995	2000	2005	2010	$x-\mu$
135	Electricity	1.7252	1.3264	1.7928	1.8562	1.6394	1.6849	1.6184	1.7264	-0.2021
136	Pipe line and gas distribution	1.0000	1.0000	2.0938	2.3716	2.3343	2.2790	2.2573	2.3689	1.1656
137	Water work and supply	1.6078	1.4938	1.3427	1.2980	1.3353	1.3720	1.4921	1.5592	-0.2519
138	Residential building construction	1.8932	1.9062	1.8912	1.6890	1.7117	1.7764	1.8867	1.9406	-0.1559
139	Non-residential building construction	1.8723	1.8367	1.9111	1.7019	1.6689	1.9850	2.0030	2.0789	0.0034
140	Public works for agriculture and forestry	1.7292	1.7132	1.9393	1.8963	1.8483	1.6751	1.6957	1.9732	0.0406
141	Non-agriculture public works	1.7747	1.8998	1.9208	1.9532	1.8421	1.9550	2.0212	2.1977	0.2197
142	Construction of electric plants	1.9008	1.9012	1.8131	1.7195	1.7072	1.8585	1.6679	1.9150	-0.1890
143	Construction of communication facilities	1.5523	1.6335	1.7536	1.6077	1.5379	1.5602	1.4496	1.7662	0.0106
144	Other construction	1.7935	1.7700	1.6540	1.6087	1.5491	1.6188	1.6819	1.7937	-0.2031
145	Wholesale trade	1.2576	1.2179	1.2842	1.3009	1.3443	1.3107	1.3303	1.3738	-0.0871
146	Retail trade	1.2822	1.2338	1.2813	1.2900	1.3029	1.2645	1.2867	1.2761	-0.2093
147	Restaurants and drinking places	1.7557	1.6637	1.9174	1.9493	1.9328	1.9290	1.9578	2.0482	0.0892
148	Hotels and places of loading	1.6958	1.5844	1.7332	1.6858	1.7423	1.7871	1.9263	2.0230	0.1239
149	Railways	1.6844	1.9749	1.5897	1.6744	1.6268	1.5354	1.5880	1.7282	-0.1595
150	Road passenger transport	1.7064	1.6199	1.6025	1.5745	1.6391	1.9487	1.9228	1.9224	0.0128
151	Road freight transport	1.6648	1.6778	1.5672	1.5300	1.6468	2.0885	1.9771	1.9995	0.1314
152	Land transport support service	1.5351	1.5130	1.4579	1.2841	1.2613	1.2596	1.2806	1.3571	-0.3814
153	Ocean transport	1.7337	1.7551	1.1707	1.2952	1.4216	1.7927	1.6751	1.7036	-0.2334
154	Coastal and inland water transport	1.3105	1.4435	1.4937	1.3337	1.3554	1.4670	1.5494	1.6539	0.1401
155	Water transport services	1.4257	1.6303	1.2550	1.1368	1.1954	1.3716	1.4203	1.4389	-0.1900
156	Air transport	1.6385	1.4243	1.4580	1.6617	1.7212	1.9308	1.8477	2.2507	0.4090
157	Other services	1.5175	1.4192	1.6286	1.5905	1.6294	1.7181	1.7001	1.9289	0.2082
158	Storage and warehousing	1.5504	1.4121	1.4818	1.4254	1.4753	1.5641	1.6626	1.7305	-0.0231

159	Post and telecommunication	1.4775	1.4330	1.2916	1.1872	1.2265	1.4527	1.6402	1.6720	-0.0088
160	Banking services	1.3013	1.2124	1.2086	1.3048	1.3189	1.3614	1.5037	1.5485	0.0439
161	Life insurance services	1.4100	1.3199	1.2595	1.1577	1.1622	1.3271	1.3183	1.3649	-0.2484
162	Other insurance services	1.3496	1.2561	1.3008	1.2643	1.2744	1.3514	1.3235	1.3415	-0.2114
163	Real estate	1.1635	1.2111	1.1959	1.1910	1.2351	1.1573	1.2277	1.3322	-0.0346
164	Business services	1.5596	1.5809	1.9280	1.7305	1.8462	2.0294	2.1605	2.0317	0.2688
165	Public administration	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-0.2033
166	Sanitary and similar services	1.2041	1.1499	1.3196	1.2734	1.2695	1.4340	1.4542	1.5158	0.1084
167	Education	1.1433	1.2402	1.1787	1.2200	1.1965	1.2471	1.3295	1.4265	0.0799
168	Research	1.3302	1.2214	1.4329	1.3899	1.4022	1.4663	1.4572	1.4901	-0.0434
169	Hospital	1.4620	1.3932	1.4458	1.4495	1.4303	1.4908	1.5292	1.7217	0.0564
170	Business and labor associations	1.4342	1.4377	1.5152	1.5014	1.4938	1.5494	1.4944	1.7076	0.0700
171	Other community service	1.2838	1.3802	1.3402	1.3282	1.3229	1.3380	1.3476	1.5087	0.0216
172	Movie theatres	1.6575	1.5481	1.9018	1.8277	1.5847	1.5944	1.8951	2.1273	0.2665
173	Movie theatres	1.8003	1.4609	2.0432	2.3204	2.1554	2.1156	2.3021	2.5267	0.5231
174	Radio, television and related services	1.3673	1.2332	1.5238	1.5787	1.6461	1.8293	1.9924	2.0487	0.4782
175	Libraries and museums	1.6489	1.3741	1.4392	1.4382	1.3388	1.3990	1.4457	1.4723	-0.3800
176	Amusement and recreation	1.4817	1.4283	1.4414	1.2253	1.3080	1.3303	1.3800	1.4358	-0.2491
177	Repair not classified elsewhere	2.0434	1.4965	1.7347	1.5987	1.7444	1.9349	1.7035	1.9047	-0.3419
178	Personal service	1.2922	1.2242	1.2328	1.2011	1.1908	1.3932	1.4962	1.7291	0.2336
179	Other service not classified elsewhere	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-0.2033
180	Unclassified	2.5816	2.4868	2.5793	2.2167	2.3736	2.0321	2.2921	2.2900	-0.4948
	Average	1.5348	1.4813	1.5510	1.5182	1.5215	1.5993	1.6346	1.7381	-0.2021

Source: Computed from Thailand's input-output table

4. Conclusion

At the aggregate level, a change in Thailand's industrial deepening from 1975 to 2010 is evidenced by increases in yearly average aggregate linkages. At the structural level from 1975-2010, average backward linkages for 93 manufacturing sectors are measured above the 41 agricultural and primary sectors and 46 service sectors. Average forward linkages for the 46 service sectors are measured above the 93 manufacturing sectors and 41 agricultural and primary sectors.

Increases in yearly average aggregate linkages are contributed to by strong improvements in the agricultural and primary sectors as well as service sectors relative to manufacturing sectors. In comparison, the growth of manufacturing sectors is stronger relative to agricultural and primary sectors. While yearly average backward and forward linkages for manufacturing sectors are viewed as rather stable from 1975 to 2010, increases in backward linkages for agricultural and primary sectors are viewed as matching the increases in forward linkages of service sectors. This means that increases in the input requirements of agricultural and primary sectors is supported by service sectors rather than by manufacturing sectors.

Stable backward linkages for manufacturing sectors means that the strong growth of manufacturing exports maintains a ratio of input requirements from imports, agricultural and primary sectors, and service sectors. On the other hand, stable forward linkages for manufacturing sectors means that the strong growth of manufacturing sectors is supported by exports rather than by domestic demand. The strong growth of manufacturing sectors is seen as coupled with industrial deepening. Stable linkages in the context of growth of output driven by growth of trade is a context for two moving objects. Progress is measured by the distance covered by the moving objects. For manufacturing sectors, the growth of output is paralleled by the growth of domestic input requirements, keeping stable backward linkages. The growth of the Thai economy is strongly contributed to by growth in manufacturing exports relative to agricultural and primary exports.

Future improvement of linkages can be expected to approach the limit sooner, as manufacturing production enjoys intra-industry trade of the global supply chain. For Thailand, the future growth of the rest of its economy, largely service sectors, which account for 55 percent of Thailand's GDP, would likely be driven by structural change dominated by the growth in manufacturing sectors through trade.

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