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Analysis of Structural Change for the Kyrgyz Republic Economy: Evidence from Decomposition of Output Changes and Multiplier Product Matrix

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ABSTRACT

Input-output analyses, which investigate intersectoral interdependencies and structural changes, are critical to sectoral planning by providing policymakers with significant information. This study draws on the input-output tables calculated by the Asian Development Bank for Asian and Pacific countries, specifically for the Kyrgyz Republic. The decomposition of output changes and the multiplier product matrix are employed to identify any structural changes in the country's economy. The empirical findings indicate that a major structural change has occurred in the Kyrgyz economy, led by the financial intermediation sector.

Keywords: Input-Output Analysis, Structural Change, Kyrgyz Republic, Decomposition of Output Changes, Multiplier Product Matrix

JEL Classification Codes: C67, D57

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INTRODUCTION

Given the ineffectiveness of market mechanisms to solve development issues, underdeveloped economies have resorted to economic planning to address these problems (Öney, 1980: 7). Economic planning can be defined simply as the methods and techniques used to enable an economy to develop more rapidly within a specific region and time period. Here, economic planning should not be confused with government interventions aimed at macroeconomic stability. An economic plan aims to influence the future through forecasts and actions that need to be taken from now on. In contrast, government interventions only aim to eliminate existing economic imbalances (Özyurt, 2012: 25-26).

The first step to setting macroeconomic objectives in economic planning is to conduct a comprehensive sector analysis for the relevant economy. In this regard, it is imperative to determine the quantities of goods or services to be produced; in other words, sectoral production levels and investment distributions should be identified. The aforementioned analysis identifies the components of total demand at the sectoral level, specifically the demand for final goods, intermediate goods, and imported goods. At this point, to ensure consistency between the data obtained from sectoral analyses and macroeconomic objectives, the fundamental models utilized in the inter-industry analysis are expressed as input-output models (Öney, 1980: 97-98).

The intersectoral interdependencies, expressed as linkages between sectors, and the shares of each sector in net value added can change over time. The input-output approach examines structured change in terms of intersectoral interdependence (Özdil, 1993: 110). Thus, the present study examines whether there has been any structural change within the inter-industry linkages in the Kyrgyz Republic economy. The country data are taken from the input-output tables calculated by the Asian Development Bank (ADB) for Asian and the Pacific economics for 2000 and 2018.

In the early 1990s, enterprises in Kyrgyz Republic's Moscow-based planned economy lost their privileged access to markets or production inputs. This damaged intersectoral connections in the economy, resulting in a severe decline in the manufacturing sector. In response, the primary strategy was to shift back to the agricultural sector, which consequently experienced less contraction than the services and industrial sectors, so its share of the economy and employment capacity increased. As the Kyrgyz Republic progressed with its open economy

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strategy, informal trade networks, including cross-border trade, rapidly emerged. As a result, the services sector contracted less than the industrial sector. In the mid-1990s, the industrial sector began to recover, led by foreign-owned mining companies, while small-scale manufacturers producing household goods gradually revived and expanded to include the ready-made garment sector, which encouraged exports. Furthermore, companies in newly established free economic zones contributed to production by benefiting from government fiscal incentives. Meanwhile, the construction industry grew rapidly, primarily as a result of housing projects financed through labor remittances (Yamano et al., 2019: 11-12).

Figure 1, which presents the percentage shares of sectoral value-added contributions in the Kyrgyz economy from 2000 to the present, indicates that significant changes have occurred in the Kyrgyz Republic's economic structure over the past twenty years. However, this transformation has not significantly contributed to increased productivity. The agricultural sector's shares of value added and employment have decreased by 22 and 33 percentage points, respectively. In contrast, the services sector, which offers many opportunities, currently accounts for 55% of the Kyrgyz Republic's total employment. Surprisingly, while manufacturing employment has more than doubled since 2000, the sector's share of GDP has fallen slightly, indicating a decline in manufacturing productivity. Finally, retail and wholesale trade was the only one of the sectors with an increasing share of employment to increase productivity (Izvorski et al., 2020: 5).

The remainder of this paper comprises the following sections. The next section reviews empirical studies using input-output analysis. Following the literature review, the dataset section describes the general characteristics of the input-output tables calculated by the ADB for the Kyrgyz Republic economy between 2000 and 2018. The methodology section explains how input-output tables can be used to analyse structural change. After presenting the empirical findings, the study concludes by discussing the results to provide policy recommendations.

LITERATURE REVIEW

The first empirical study on the input-output model in the literature was conducted by Leontief (1936), drawing on an input-output table calculated for the United States (US) economy using 1919 data. As part of economic planning since the 1950s, input-output models have been used frequently to determine sectoral investment priorities. Initially closed and static, input-output models have evolved into dynamic structures (Aydoğuş, 2010: 6). Very few empirical studies (Temurshoev, 2004; Seil and Ichihashi, 2012) related to input-output analysis have focused on the Kyrgyz economy. These international papers are highlighted in this literature review.

In addition to studies examining the intersectoral interdependencies of sectors, international empirical analyses have examined the economic roles of specific sectors, such as construction (Pietroforte and Gregori, 2003; Wu and Zhang, 2005; İlhan and Yaman, 2011; Ali et al., 2019). Pietroforte and Gregori (2003) analyzed the effects of the construction sector on advanced

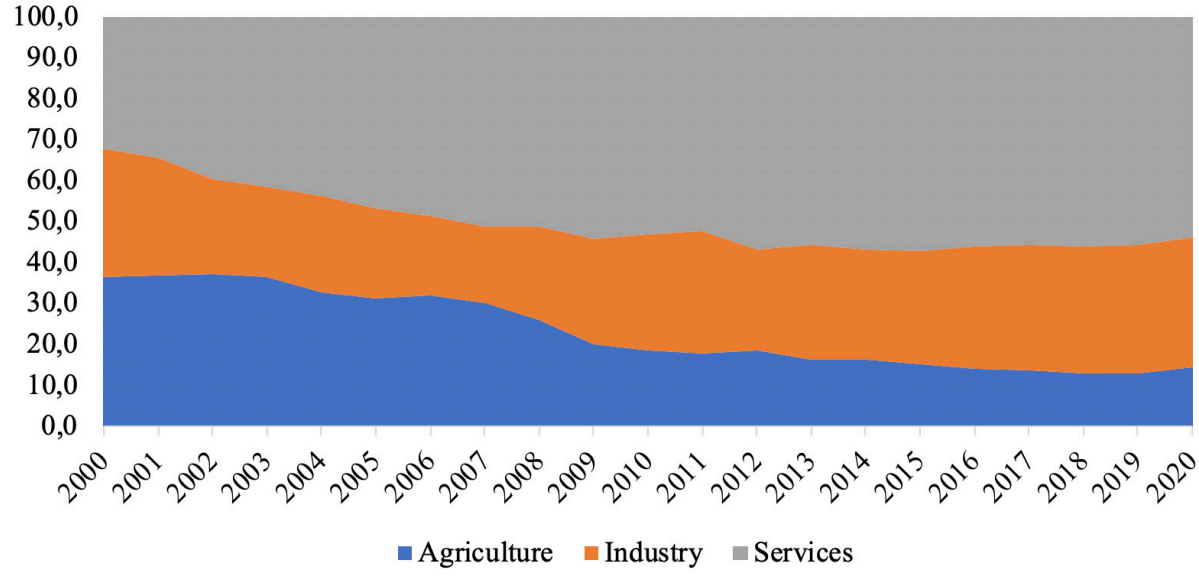

Figure 1: Sectoral Value Added in the Kyrgyz Republic Economy
Kaynak: ADB (2022), Key Indicators for Asia and the Pacific.

economies for 1969-1990, finding that it had a smaller propulsive effect in France and Australia but a larger effect in Denmark and Germany. Additionally, in terms of the output multiplier, the construction sector had a low push effect and a high pull effect on the Japanese economy, whereas the opposite was true for the United States. Wu and Zhang (2005) used 17-sector input-output tables calculated for 1992, 1995, 1997, and 2000, to examine the construction sector's importance for the Chinese economy. They found that the sector's pull effect on other sectors exceeded its push effects on the overall economy, while the sector's pull and push effects of increased throughout the sample period. Using input-output tables aggregated into nine sectors for 1998 and 2002, İlhan and Yaman (2011) analyzed the construction sector's economic effects for selected EU countries and Turkey. The results showed that Turkey's construction sector followed the same trend as that in the Czech Republic, Portugal, Slovakia, and Hungary, namely a low push effect and a high stimulating impact due to its high backward linkage effects and low forward linkage effects. Using 15-sector input-output tables for 2006, Ali et al. (2019) investigated the construction sector in Bangladesh, Sri Lanka, and Nepal. The study implemented the hypothetical extraction method as well as investigating traditional linking effects. In all three countries, the construction sector exhibited strong backward linkage and weak forward linkage effects indicating that it has a significant pull effect but a weak push effect.

Surugiu (2009) examined the tourism sector and focused on the Romanian economy. In this study, the input-output tables for 2000 and 2005 were aggregated into 12 sectors to calculate output, input, employment, and value-added multipliers. The output and employment multiplier values in the hotels and restaurants sector increased over the period, whereas the income and value-added multiplier values decreased. In 2005, Romania's hotels and restaurants sector ranked among the top in terms of employment multipliers. However, the sector's forward linkage effect decreased over the period to make it one of the least economically impactful sectors.

Another group of studies has investigated the information and communication technology sector (Xing et al., 2011; Toh and Thangavelu, 2013). Focusing on Singapore, Xing et al. (2011) applied the cross-entropy method to the input-output table for 2002 to analyze the information and communication technology sector, classified into five manufacturing and two services sub-sectors. The findings indicated high convergence between Singapore's manufacturing and service subsectors. Furthermore, the sector exhibited supply-side convergence but very few structural changes in demand-side convergence. Focusing on China, Toh and Thangavelu (2013) aggregated input-output tables for 1990, 1995, and 2000 into 39 sectors. They found that the information and communication technology sector had crucial linkages for expanding high-value manufacturing and electronic exports.

The mining and quarrying sector and sub-sectors were examined for European Union (EU) countries by San Cristóbal and Biezma (2006). For Germany, the key extraction sectors were peat, coal, and lignite; for Sweden, it was metal ore mining; for Austria, Denmark, and Spain it was other mining and quarrying. The linkage effects indicated that the mining and quarrying industries in EU countries is stimulated more than other sectors by production increases. That is, the mining and quarrying sub-sectors have higher forward linkage effects and lower backward linkage effects.

Focusing on the relationship between Malaysia's energy and agriculture sectors, Bekhet and Abdullah (2010) aggregated input-output data for 1991 and 2000 into 15 sectors. Regarding direct and total backward linkage effects, energy use increased significantly in agriculture over the sample period, although the linkage effect remained weak. Among Malaysia's energy-related sectors, agriculture had the greatest petroleum and coal inputs. In another study examining the energy sector, Loizou et al. (2015) drew on a 62-sector input-output table for 2010 based on data from the Greek economy. The multipliers for output, household income, and employment indicated that energy sub-sectors were not the highest regarding multipliers and elasticities. Nevertheless, the analysis showed that energy sectors with strong linkage effects were crucial to increasing total output, employment, and household income.

Fewer studies in the input-output analysis literature have addressed structural change. In addition to sectoral output changes, multiplier analyses, and linkage effects, this strand of research has investigated the decomposition of output changes and multiplier product matrix analysis (Sonis et al., 1996a, 1996b, 1997, 2000; Guo and Planting, 2000; Guo and Hewings, 2001; Munjal, 2007; Magtibay-Ramos et al., 2011; Hor, 2021; Huang et al., 2023).

Sonis et al. (1996a) examined the sources of output changes in the US economy between 1948 and 1977, using input-output tables aggregated into three primary

sectors. The findings showed that output changes in agriculture and mining were highly dependent on changes in other sectors. Conversely, production changes in trade, transportation, and services were primarily due to changes within these sectors. In another study on the US economy, Guo and Planting (2000) calculated the multiplier product matrix for 1972-1996. Taking 1972 as the base year, the findings indicated that dependency between domestic industries decreased as imports increased while the weight of manufacturing in the US economy decreased during the study period.

Using regional input-output data, Sonis et al. (1996b, 1997) examined input-output tables for Japan and China, using the multiplier product matrix calculated at the regional level to determine whether regional linkage effects were similar in the two cases. Sonis et al. (1996b) concluded that Japan's Chubu and Kanto regions were similar in terms of sectorial linkage effects, but different in structure to Hokkaido. On the other hand, Sonis et al. (1997) concluded that port cities were similar whereas Beijing was different from other regions.

Sonis et al. (2000) used input-output tables for 1987 and 1990 to analyze the Chinese economy. The findings indicated that, by 1990, the forward linkage effects of industries identified as key sectors in 1987 had strengthened. That is, the Chinese economy's economic landscape changed between 1987 and 1990. In another study of the Chinese economy, using input-output tables for 1987, 1992, and 1997, Guo and Hewings (2001) showed that labor-intensive sectors, such as textiles, were replaced by technology-intensive sectors during the study period.

From their analysis of the Indian economy from 1989 to 1999, Munjal (2007) found that intermediate goods and infrastructure sectors played an important role throughout the study period while the weight in the economy of both capital goods and durable consumer goods increased. In another study of the Indian economy, Huang et al. (2023) examined the period from 2000 to 2019. They found that sectors related to manufacturing industries had a stronger linkage effect than sectors related to services.

Using the multiplier product matrix to analyze structural changes, Magtibay-Ramos et al. (2011) classified input-output tables calculated between 1979 and 2000 into 11 sectors. Manufacturing was further divided into five sub-categories for 1979, 1990, and 2000. The findings indicated that manufacturing consistently played a key role, with the highest linkages being for resource and scale-intensive manufacturing industries. Private services and transportation, communication, and storage increased in economic weight.

Focusing on Cambodia, Hor (2021) applied a social accounting matrix using multiplier product matrix and field of influence approaches to analyze input-output tables for 2005, 2010, and 2015, particularly the links between tourism sectors and structural changes. The findings indicated relatively low inter-industry connections while the textile, other manufacturing, transportation, and communications sectors played crucial roles throughout the study period. Although tourism became a key sector in 2010 and 2015, it still lacked sufficient forward and backward linkages. Finally, the field of influence analysis generated a high coefficient for tourism, thereby identifying it as a promising sector.

Turning to the Kyrgyz Republic specifically, there have been several input-output analyses of its economy, notably Temurshoev (2004) and Seil and Ichihashi (2012). Temurshoev (2004) created 34-sector input-output tables for 1998 to analyze the country's production structure. Besides the traditional methods of Rasmussen (1957) and Chenery and Watanabe (1958), this study also implemented the hypothetical extraction methods proposed by Dietzenbacher and Van der Linden (1997) to determine key sectors. The three methods identified four key sectors: fishing and pisciculture; water generation, purification and distribution; wholesale trade and finance.

Using traditional methods, Seil and Ichihashi (2012) drew on input-output tables for 2009 to identify linkage effects. The study also addressed the sectoral effects of indirect tax reduction through two different scenario simulations. The findings identified the following key sectors in the Kyrgyz economy: agriculture, hunting and forestry; financial activities; construction; hotels and restaurants; manufacture of food products, beverages, and tobacco; metallurgical industry; other non-metallic mineral products; and textiles and textile products, leather, leather products, and footwear. The scenario analysis suggested that the overall economy would benefit from halving value-added tax and allocating the additional tax revenue to consumption.

This literature review suggests that input-output analysis studies predominantly focus on multipliers and key sector analyses, with only a small number analyzing scenario simulations and structural changes. To the best of our knowledge, no study has analyzed the Kyrgyz economy using two different input-output tables over about twenty years. The present study is also

novel in using the decomposition of output changes and multiplier product matrix analysis to determine whether there has been structural change in the Kyrgyz Republic economy. Thus, the present study fills a gap in the literature on the Kyrgyz Republic by investigating potential structural changes in the economy through input-output analysis.

DATASET AND METHODOLOGY

Dataset

The ADB (2020) has calculated input-output tables for countries in South and Central Asia, Southeast Asia, the Pacific, and East Asia regions, primarily based on data from 2000 to 2018. Unlike the earlier tables (ADB, 2018), which included 35 sectors, the latest tables (ADB, 2020) aggregate the sectors into 15 sectors and five elements of final demand. Using the input-output tables for the Kyrgyz Republic for 2000 and 2018, the present study investigates potential structural changes between these two years.

Table 1A in the appendix presents a simplified example of the ADB input-output tables. The Intermediate Uses section shows that sector *j* is produced by industry *i* and consumes x_{ij} of goods and services. The imported inputs used by industry *j* are denoted by denoted by xm_j. Total inputs (x_j) are calculated by adding the value added (v_j) to the intermediate consumption. The Final Uses section of Table 1A has five components: Households consumption (f_{i1}); nonprofit organizations and institutions serving households (f_{i2}); government expenditures (f_{i3}); gross fixed capital formation (f_{i3}) inventory changes (e_i) and exports (f_{i1}). Imported goods and services consumed as final products are indicated by f_{mj}. The sectors in the columns to the left of the table represent selling sectors whereas the sectors across the top represent buying sectors (ADB, 2018: 1-2).

Based on the sectors used in the World Input-Output Database, ADB (2018) prepared input-output tables for 35 sectors for 2010-2017. The calculated input-output tables of ADB (2020) for the Kyrgyz Republic and other Asian countries are aggregated into the following 15 sectors: Agriculture, hunting, forestry, and fishing, construction, education, health, and social work, financial intermediation, heavy manufacturing, hotels and restaurants, light manufacturing, mining and quarrying, other personal services, public administration and defense, real estate, renting, and business activities, telecommunications, trade services, transport services and utilities[1].

[1] The data for input-output tables are available at https://data.adb.org/taxonomy/term/476

Methodology

Decomposition of Output Changes

The decomposition analysis of output changes in the input-output models makes it possible to predict how structural changes in one sector or group of sectors affect the rest of the economy in terms of changes in total output (Haddad et al., 2007: 290). Using input-output tables, Sonis et al. (1996a) developed a comprehensive approach to structural change analysis that decomposes sectoral output changes into three components. In the following two stages, the three components are categorized into self-generated changes and non-self-generated changes. Decomposition of output changes involves analyzing sectoral output changes over two different time periods to determine the impact on production of changes in input coefficients and final demand components. Accordingly, the total output vectors for the time periods t_0 and t_1 are represented by X_0 and X_t, respectively. The corresponding Leontief inverse matrices for the two time periods are represented by R_0 and R_t, respectively, while the final demand vectors are represented by Y_0 and Y_t, respectively. In this way, the following difference equations can be obtained:

$$\Delta X = X_t - X_0 \qquad \Delta R = R_t - R_0 \qquad \Delta Y = Y_t - Y_0 \tag{1}$$

The total output vector equation obtained from the Leontief inverse matrix and final demand vectors $(X = (I - A)^{-1}Y)$ can be formulated in terms of the previous expressions as $X = RY$. Hence, the difference equations can be identified as follows:

$$\Delta X = X_t - X_0 = R_t Y_t - R_0 Y_0 \tag{2}$$

Based on the Feldman et al. (1987) approach to determine the degree of final demand changes and the impact of changes in input coefficients on the level of output, Sonis et al. (1996a) decompose the difference equations into three basic components:

$$\begin{aligned} \Delta X &= (R_0 - \Delta R)(Y_0 + \Delta Y) - R_0 Y_0 \\ \Delta X &= R_0 \Delta Y + \Delta R Y_0 + \Delta R \Delta Y \\ \Delta X &= \Delta X^Y + \Delta X^R + \Delta X^{RY} \end{aligned} \tag{3}$$

The first component (ΔX^Y) in the previous equations represents the output changes due to changes in final demand. The second component (ΔX^R) represents the output changes due to the technological progress. The third component (ΔX^{RY}) represents the output changes due to the interdependent interactions between final demand and technological advancement (Sonis et al., 1996a: 17; Nazara et al., 2003: 21).

Decomposition analysis is then used to determine whether changes in output in each sector originate from sector-specific changes (self-generated) or changes in other sectors (non-self-generated). In other words, changes in a sector's output level can originate from factors within the sector itself, such as final demand or technological changes, and/or developments in other sectors. Self-generated and non-self-generated changes in the output level for sector i are defined by $s\Delta X$ and $ns\Delta X$, respectively. Consequently, the three basic components of output changes (final demand, technological progress, and interaction) are defined by the following equations, depending on whether the changes are self-generated or non-self-generated (Sonis et al., 1996a: 23-24; Nazara et al., 2003: 21):

$$\begin{aligned} s\Delta X_i^Y &= r_{ii}\Delta Y_i \quad ; \quad ns\Delta X_i^Y = \Delta X_i^Y - s\Delta X_i^Y \\ s\Delta X_i^B &= \Delta r_{ii} Y_i \quad ; \quad ns\Delta X_i^R = \Delta X_i^R - s\Delta X_i^R \\ s\Delta X_i^{BY} &= r_{ii}\Delta Y_i \quad ; \quad ns\Delta X_i^{RY} = \Delta X_i^{RY} - s\Delta X_i^{RY} \end{aligned} \tag{4}$$

Furthermore, including the entire input-output system, changes in the output of any industry may also originate from itself and other sectors as follows (Sonis et al., 1996a: 24):

$$\begin{aligned} s\Delta X_i &= s\Delta X_i^Y + s\Delta X_i^R + s\Delta X_i^{RY} \\ ns\Delta X_i &= ns\Delta X_i^Y + ns\Delta X_i^R + ns\Delta X_i^{RY} \end{aligned} \tag{5}$$

Multiplier Product Matrix

Input-output analysis may also be used to identify structural changes in the economy by using the multiplier product matrix, which is obtained by multiplying the column and row multipliers of the Leontief inverse matrix. This approach can also be applied to any matrix that represents the economy. The analysis of key sectors through forward and backward linkages is based on this approach. An additional advantage of this method is that it can be used to present an economy's macroeconomic outlook, thereby enabling comparison of different economies over time or structural changes within the same economy (Sonis et al., 1996b: 2).

The multiplier product matrix, utilizing information on both forward and backward linkage effects, reveals the relationships of any industry with all other sectors through a single indicator. This approach allows for the quantitative measurement of inter-industry relationships, organizing industries in a hierarchy based on the magnitude of linkage effects. The analysis makes it possible to develop a graphical representation of the economic landscape for each period to reveal how the economic structure has changed over time through forward and backward linkages (Guo and Planting, 2000: 8; Sonis and Hewings, 1999: 63, Sonis et al., 1997). The purpose of this method is to rank the rows and columns of the multiplier product matrix based on the base year, denoted by t_0, which remains constant throughout the analysis. In this way, the economic landscape of a single economy for different time periods can be compared (Munjal, 2007: 84).

Assuming that $A = [a_{ij}]$ and $R = (I - A)^{-1} = [r_{ij}]$ indicate the input coefficient matrix and the Leontief inverse matrix, respectively, the column and row factors of the Leontief inverse matrix are defined as $R_{.j}$ and $R_{i.}$ as follows (Guo and Hewings, 2001: 2):

$$\begin{aligned} R_{.j} &= \textstyle\sum_{i=1}^{n} r_{ij} \\ R_{i.} &= \textstyle\sum_{j=1}^{n} r_{ij} \end{aligned} \tag{6}$$

As shown in the following equation, GL indicates the global intensity of the Leontief inverse matrix (Sonis and Hewings, 1999: 61):

$$GL = \textstyle\sum_{i=1}^{n}\sum_{j=1}^{n} r_{ij} \tag{7}$$

By defining the forward and backward linkages, the multiplier product matrix can be expressed as follows (Sonis et al., 1996b: 3; Sonis et al., 1997: 152):

$$MPM = [mpm_{ij}] = \frac{1}{GL}[R_{i.}R_{.j}] = \frac{1}{GL}\begin{bmatrix} R_{1.} \\ R_{2.} \\ \vdots \\ R_{n.} \end{bmatrix}(R_{.1} \quad R_{.2} \quad \cdots \quad R_{.n}) \tag{8}$$

Here, it should be emphasized that the column and row multipliers obtained from (MPM) are identical to the multipliers derived from the Leontief inverse matrix (Sonis and Hewings, 1999: 61-62):

$$\begin{aligned} \textstyle\sum_{j=1}^{n} mpm_{ij} &= \frac{1}{GL}\textstyle\sum_{j=1}^{n} R_{i.}R_{.j} = R_{i.} \\ \textstyle\sum_{j=1}^{n} mpm_{ij} &= \frac{1}{GL}\textstyle\sum_{j=1}^{n} R_{i.}R_{.j} = R_{.j} \end{aligned} \tag{9}$$

The structure of the , which can be defined as a visualization technique derived from the Leontief inverse matrix, is generally closely related to the characteristics of the backward and forward linkage effects. The rows and columns of this matrix are rearranged from largest to smallest based on the magnitudes of forward (rows) and backward (columns) linkage effects to organize the sequence of forward and backward linkages (Nazara et al., 2003: 22).

EMPIRICAL FINDINGS

Decomposition of Output Changes

The input-output tables for 2000 and 2018 were analyzed together to identify potential structural changes in the Kyrgyz economy. Based on Sonis et al. (1996a), Table 1 presents the results of the decomposition of output changes at the sectoral level.

Generally, changes in final demand originating from the sector itself had a greater impact on output increases. The increase in final demand in public administration, defense, education, health, and social work almost entirely originated from output changes within these sectors. Between 99.83% and 99.30% of these increases can be attributed to self-generated changes. In contrast, the increase in final demand in the utilities sector was largely driven by other sectors, with 80.50% of the increase in the services sector attributable to changes in other sectors. For financial intermediation and agriculture, hunting, forestry, and fishing the increase was relatively balanced, with 54.36% of the final demand increase in agriculture, hunting, forestry, and fishing sector coming from self-generated changes and 45.64% from non-self-generated changes. Similarly, 47.74% of the demand increase in financial intermediation was self-generated while 45.64% was non-self-generated.

For almost all sectors, the primary cause of output changes due to technological progress was progress in other sectors. More specifically, changes in other sectors accounted for 99.94%, 99.51%, and 99.22% of the increase in output due to technological progress in hotels and restaurants, mining and quarrying, and trade services, respectively. In contrast, self-generated changes were the primary driving component of output increases due to technological progress in financial intermediation. Technological progress was associated with decreases in output in five sectors: agriculture, hunting, forestry, and fishing, light manufacturing, heavy manufacturing, utilities, and construction.

The above comprehensive analysis of changes in output caused by the synergistic interaction between final demand and technological progress shows that the interactions decreased output in agriculture, hunting, forestry, and fishing, mining and quarrying, light manufacturing, heavy manufacturing, and utilities. For the other sectors, the interactions between final demand and technological progress increased output. The declines in output changes in agriculture, hunting, forestry and fishing, mining and quarrying, light manufacturing, and utilities sectors were primarily due to changes in other industries. On the other hand, among the sectors in which output increased in response to the interaction of final demand and technological progress, most of the increase in hotels and restaurants and trade services can be attributed to non-self-generated events. Finally, unlike other sectors that experienced an increase in output, 78% of the increase in the financial intermediation sector was self-generated.

Multiplier Product Matrix

The second approach used in this study to investigate potential structural changes in the Kyrgyz economy from 2000 to 2018 was multiplier product matrix analysis. Figures 2 and 3 provide three-dimensional representations of the multiplier product matrices ($MPMs$) for 2000 and 2018, respectively. The z axis represents linkage effects values; the x axis represents backward linkage effects; the y axis represents forward linkage effects. The sectors are sorted from largest to smallest based on the backward and forward linkage values calculated from the input-output table for 2000. The sectors exhibiting the highest and lowest forward linkage effects were agriculture, hunting, forestry, and fishing (1) and public administration and defense (13), respectively. The sectors exhibiting the highest and lowest backward linkage effects were light manufacturing (3) and telecommunications (10), respectively.

Following Sonis et al. (1996b; 1997), the ranking of sectors based on the backward and forward linkage values calculated from the input-output tables for 2000 was considered to observe structural changes over time. Using the 2000 rankings as a reference, the backward and forward linkage rankings were also applied to 2018 to determine whether the intersectoral interdependencies of the sectors changed between 2000 and 2018. If there has been no structural change in the economy, then the forward and backward linkage effects should not differ, and the $MPMs$ should be similar for both years. In Figures 2 and 3, the larger the value of the $MPMs$, the higher the column for that sector. If the column heights are similar then this suggests that intersectoral relations have remained unchanged over time (Magtibay-Ramos et al., 2011: 44).

Figures 2 and 3 demonstrates that the forward and backward linkage effects in the Kyrgyz economy changed noticeably between 2000 and 2018. That is, the economy undoubtedly experienced significant structural changes over this time period. More specifically, from 2000 to 2018, column heights for agriculture, hunting, forestry, and fishing (1), utilities (5), and light manufacturing (3)

Table 1: Kyrgyz Republic Input-Output Table, 2000 and 2018, Decomposition of Output Changes

Sectors	ΔX^{Y}			ΔX^{R}			ΔX^{RY}			ΔX
	ΔX_i^Y	$s\Delta X_i^Y$	$ns\Delta X_i^Y$	ΔX_i^R	$s\Delta X_i^R$	$ns\Delta X_i^R$	ΔX_i^{RY}	$s\Delta X_i^{RY}$	$ns\Delta X_i^{RY}$	
Agriculture, hunting, forestry, and fishing	4211.686	2289.584	1922.102	-491.665	-49.505	-442.160	-1850.760	-170.134	-1680.626	1869.260
Mining and quarrying	221.644	194.253	27.391	-6.965	-0.034	-6.931	-19.799	-1.584	-18.215	194.880
Light manufacturing	1129.921	427.720	702.201	-113.112	-25.102	-88.010	-509.310	-34.103	-475.207	507.500
Heavy manufacturing	1211.765	705.713	506.052	-11.465	65.950	-77.415	-195.810	126.197	-322.007	1004.490
Utilities	516.049	100.623	415.427	-100.083	-40.855	-59.227	-261.867	-19.912	-241.955	154.100
Construction	1696.463	1503.954	192.509	-14.857	25.978	-40.834	227.363	299.497	-72.134	1908.970
Trade services	1831.390	1134.702	696.688	11.896	0.092	11.804	121.054	1.652	119.402	1964.340
Hotels and restaurants	260.470	213.338	47.132	6.980	0.004	6.976	36.251	0.050	36.201	303.700
Transport services	523.295	400.575	122.720	25.523	1.475	24.048	101.042	13.396	87.645	649.860
Telecommunications	279.585	262.856	16.729	33.793	1.414	32.379	151.402	11.029	140.373	464.780
Financial intermediation	118.523	56.584	61.939	70.999	60.659	10.339	194.308	152.114	42.194	383.830
Real estate, renting, and business activities	245.095	230.847	14.248	46.440	5.224	41.216	234.544	17.891	216.653	526.080
Public administration and defense	555.379	554.476	0.903	2.435	0.368	2.067	7.826	2.233	5.593	565.640
Education, health, and social work	610.236	605.966	4.271	4.182	1.266	2.916	17.572	7.650	9.922	631.990
Other personal services	126.496	122.846	3.650	11.370	1.897	9.473	59.694	8.275	51.419	197.560

Note: Self-generated and non-self-generated output changes are indicated by and , respectively.

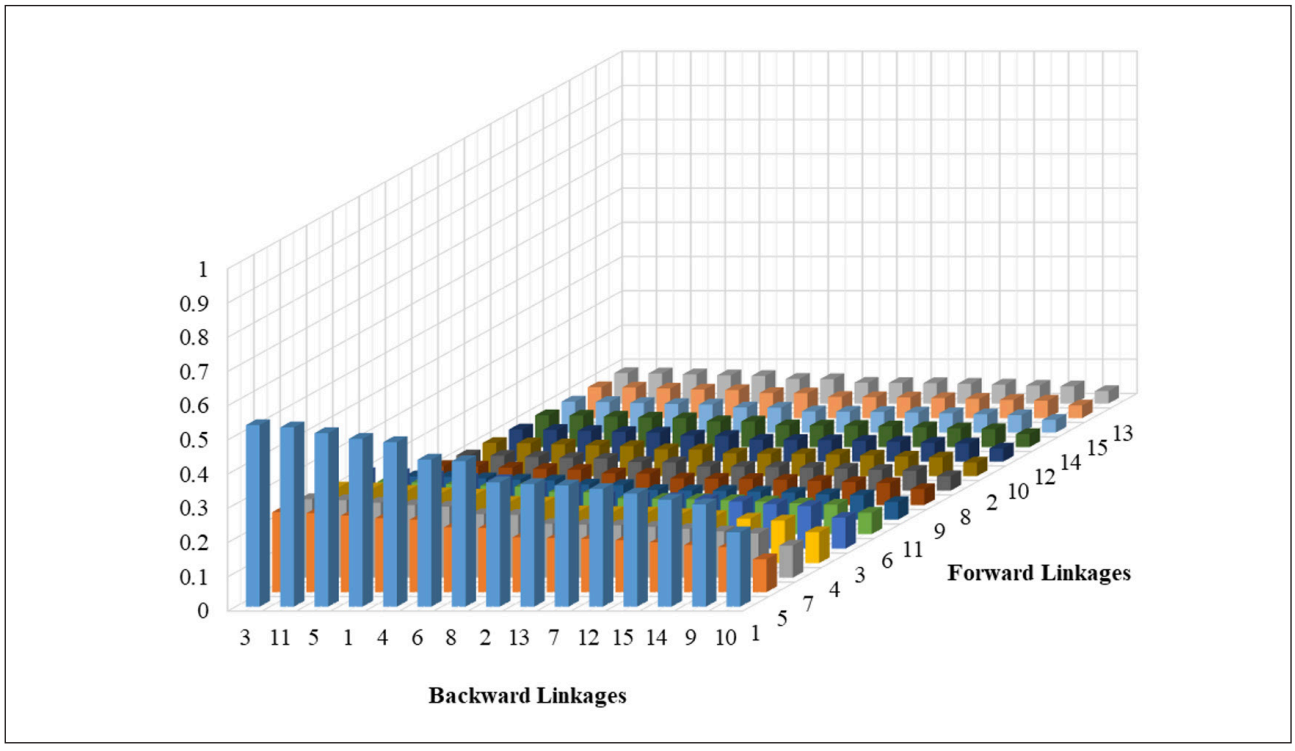

Figure 2: Multiplier Product Matrix of Kyrgyz Republic Economics (2000)

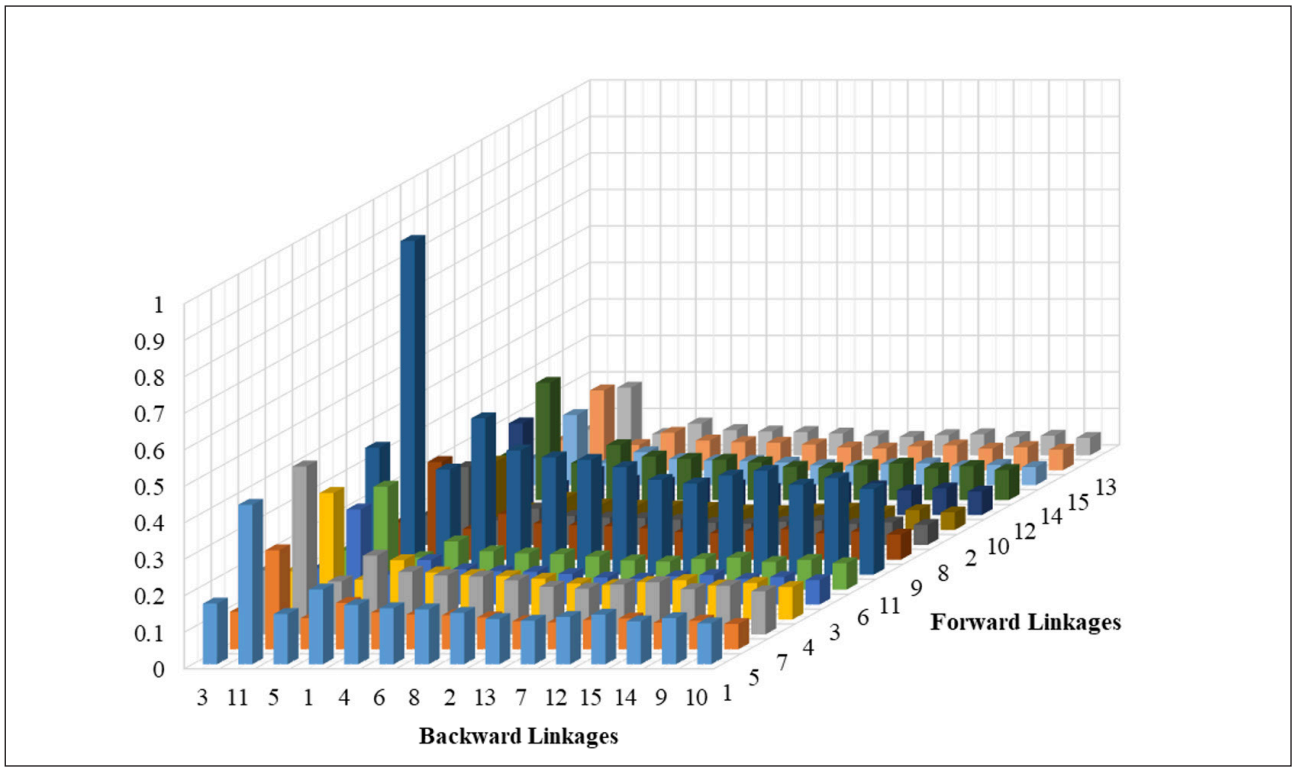

Figure 3: Multiplier Product Matrix of Kyrgyz Republic Economics (2018)

decreased significantly whereas the column heights for financial intermediation (11) and real estate, renting, and business activities (12) increased substantially. Sectors with decreasing column heights in the MPM had a reduced impact on the overall economy whereas sectors with increasing column height became more dominant.

The intersection between agriculture, hunting, forestry, and fishing (1) and light manufacturing (3) has the highest forward and backward linkage effect of 0.531 in 2000, considering the economic impact of the sectors. In contrast, the intersection of public administration and defense (13) and telecommunications (10) had

the lowest forward and backward linkage effect with a value of 0.037. For 2018, financial intermediation (11) had the highest forward and backward linkage effect, at 0.914 while the intersection of public administration and defense (13) with telecommunications (10) had the lowest forward and backward linkage effect of 0.48, similar to the value for 2000.

CONCLUSION

Input-output analysis enables measurement of the multiplier coefficients of each sector and linkage effects, and identification of the key economic sectors. This provides crucial information for policymakers in prioritizing investments across sectors. Besides capturing interindustry relationships, input-output models can also reveal structural changes in an economy (Sonis et al., 1996a: 15). Accordingly, the present study adopted the input-output approach to investigate structural changes in the Kyrgyz Republic's economy from 2000 to 2018.

Drawing on the input-output tables calculated by the ADB for countries in the Asia-Pacific region, the study investigated 15 sectors and 5 elements of final demand in the Kyrgyz Republic economy for 2000 and 2018. Using the framework of Sonis et al. (1996a, 1996b, 1997, 2000), decomposition of output changes and the MPM were applied to determine whether there were any structural changes during the sample period.

The decomposition of the output changes indicated that the changes in final demand generally originated from each sector's internal dynamics. On the other hand, output changes resulting from technological improvements generally resulted from developments in other sectors. Furthermore, these technological improvements did not increase output in all sectors. In particular, technological improvements in five sectors, namely agriculture, hunting, forestry, and fishing, mining and quarrying, light and heavy manufacturing, utilities, and construction, resulted in decreased output.

The results of the MPM, which is a visualization technique based on the Leontief inverse matrix, indicated that the Kyrgyz economy experienced substantial structural changes between 2000 and 2018. Specifically, three sectors, namely agriculture, hunting, forestry, and fishing, utilities, and light manufacturing, decreased in significance whereas three sectors became more economically important, namely financial intermediation and real estate, renting, and business activities.

In conclusion, the empirical results indicate a significant structural change in the sectoral linkages of the Kyrgyz Republic economy from 2000 to 2018. Future studies should conduct similar analyses to compare the output-input tables obtained from a variety of databases.

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APPENDIX

Table 1A: Structure of Input-Output Tables Calculated by ADB

		Intermediate Uses							Final Uses						Gross Output
		1. Sector	2. Sector	⋯	$i.$ Sector	⋯	$n-1.$ Sector	$n.$ Sector	HH	NPISH	GOV	GFCF	CIIs	Export	
Local	1. Sector	x_{11}	x_{12}	⋯	x_{1i}	⋯	x_{1n-1}	x_{1n}	f_{11}	f_{11}	f_{11}	f_{11}	f_{11}	e_1	X_1
	2. Sector	x_{21}	x_{22}	⋯	x_{2i}	⋯	x_{2n-1}	x_{2n}	f_{21}	f_{21}	f_{21}	f_{21}	f_{21}	e_2	X_2
	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯
	$i.$ Sector	x_{i1}	x_{i2}	⋯	x_{ii}	⋯	x_{in-1}	x_{in}	f_{i1}	f_{i1}	f_{i1}	f_{i1}	f_{i1}	e_i	X_i
	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯	⋯
	$n-1.$ Sector	x_{n-11}	x_{n-12}	⋯	x_{n-1i}	⋯	x_{n-1n-1}	x_{n-1n}	f_{n-11}	f_{n-11}	f_{n-11}	f_{n-11}	f_{n-11}	e_{n-1}	X_{n-1}
	$n.$ Sector	x_{n1}	x_{n2}	⋯	x_{ni}	⋯	x_{nn-1}	x_{nn}	f_{n1}	f_{n2}	f_{n3}	f_{n4}	f_{n5}	e_n	X_n
Imports		xm_1	xm_2	⋯	xm_i	⋯	xm_{n-1}	xm_n	fm_1	fm_2	fm_3	fm_4	fm_5		
Value-Added		v_1	v_2	⋯	v_i	⋯	v_{n-1}	v_n							
Total Inputs		X_1	X_2	⋯	X_i	⋯	X_{n-1}	X_n							

Source: ADB (2018), Miller and Blair (2009).
Notes: HH: Households Consumption,
NPISH: Nonprofit Organizations and Institutions Serving Households,
GFCF: Gross Fixed Capital Formation,
CIIs: Changes in Inventories.