論 説

Economic Structure of Uzbekistan and Other Central Asian Countries: Input-Output Approach

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ABSTRACT

Over its years of independence, Uzbekistan's economy has undergone transformation, from a central planning system to a market-oriented one. The purpose of this study is to discuss the characteristics of Uzbekistan's economic structure, relative to those of other Central Asian countries (Kazakhstan, Kyrgyzstan, and Tajikistan), using an input-output approach. Since 2000, Uzbekistan has experienced relatively high and stable economic growth (an annual average of approximately 7%). Although agriculture's share of the total output has been decreasing, its share is still dominant (18%).

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Analysis of the economic structure relies on the input output data of 4 countries, taken from the EORA global database of multi-region input-output tables (MRIOT). The supply side shows that the share of imports of the total output in Uzbekistan is around 3-4%, the lowest among the Central Asian countries. The demand side shows that the intermediate demand's share of the total demand is low, only 35%. In terms of the final demand (65%), domestic demand is dominant, at 50-55%.

The backward and forward linkages show that the agricultural sector still plays a leading role in Uzbekistan's industrial output, followed by the textile industry. In terms of Kazakhstan's industrial output, the mining industry represents the most influential sector.

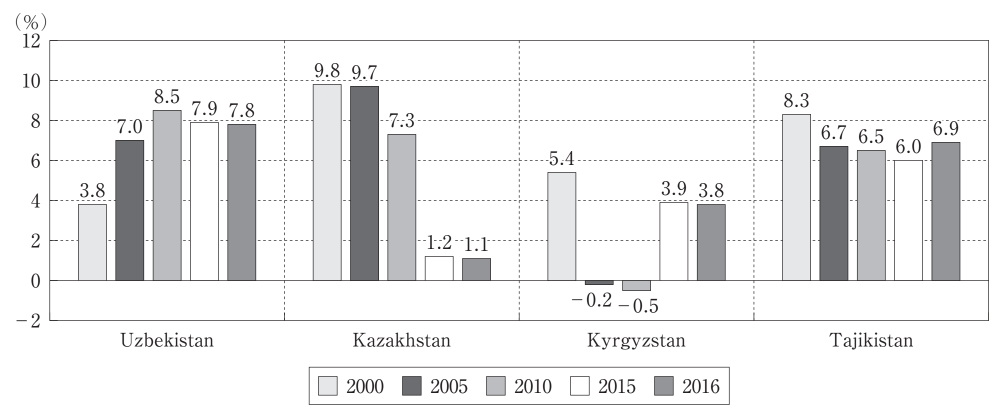
Since September 2017, the Uzbek government has undertaken several drastic reforms, from the closed system to a more open system. Under the new scheme, the Uzbek economic structure may reflect a different picture from that characterizing the period before reforms.

Keywords: industrial distribution, input-output analysis, backward linkages, forward linkages

1. Introduction

According to the World Bank's classification, Uzbekistan still belongs to the category of lower- and middle-income countries. Within the years of independence, Uzbekistan's economy has undergone a transformation, from a central planning economy to a market-oriented one. In fact, the country's economy has also been transforming from dominated economy by its agricultural sector in the post-independence period of the 1990s to the manufacturing-dominated one. Indeed, the country has transitioned into the next economic

Figure 1. Average GDP growth rates in 2000-2016, %

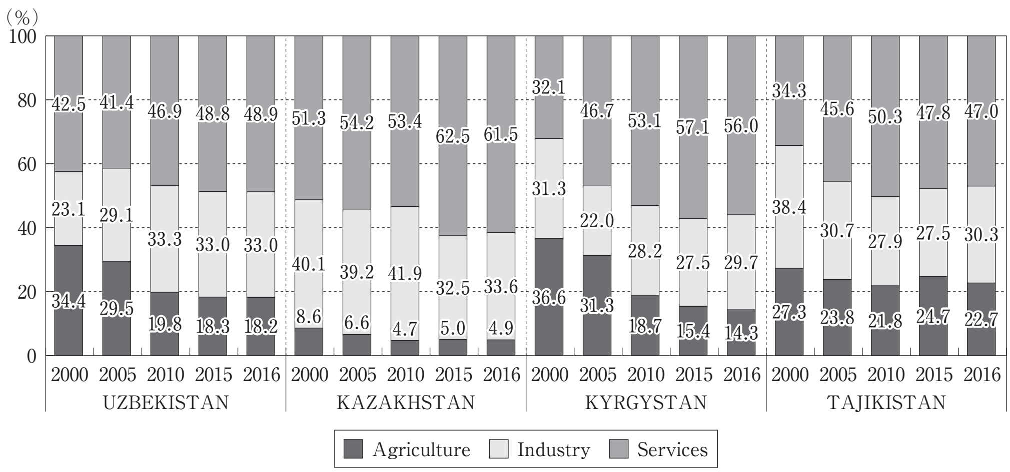


Source: Interstate statistical committee of CIS countries http://cisstat.com/eng/frame_macro.htm, Asian Development bank, https://www.adb.org/data/statistics stage since September 2017. Many new manufacturing firms have emerged in economic life of Uzbekistan.

The GDP growth rate in Uzbekistan has been relatively high and stable, relative to other Central Asian countries over the past fifteen years. As Figure 1 shows, the average annual growth rate of GDP in 2000-2016 was approximately 7%, while the average annual growth rates of the GDP in Kazakhstan, Kyrgyzstan and Tajikistan were 5.8%, 2.5%, and 6.8%, respectively.

As Figure 2 shows, over that 16-year period, Uzbek government policies and regulations resulted in a diversified economic structure. Although the agricultural share in the country's GDP has been declining gradually, from 34.4% in 2000 to 18.2% in 2016, its share remains high. On the other hand, shares of the industrial sector and service sector increased from 23.1% and 42.5% in 2000 to 33% and 48.9% in 2016, respectively. In general, Uzbek's economic structure is similar to those of Kyrgyzstan and Tajikistan.

Figure 2. Economic structure of 4 Central Asian Countries by industry, %



Source: Asian Development Bank (ADB), www.adb.org/statistics

To understand the characteristics of a country's economic structure, the analysis of interindustry relationships is indispensable (Tounsi, Ezzahid, Alaoui and Nihou, 2017).

The purpose of this study is to examine the characteristics of Uzbekistan's economic structure, relative to other Central Asian economies, using the input output (I-O) approach. An analysis of these interrelations makes it possible to compare the structures of production across different countries (Gorska R., 2015). Previous studies did not seek to undertake an analysis because data constraints have hindered the kind of discussion of Uzbekistan's economic structure involved in an I-O analysis. The study aims to use the available data to capture the Uzbek industrial structure.

The paper consists of 5 sections: following the introduction, the next section covers recent studies on I-O analysis; Section 3 outlines research methodology; Section 4 investigates the characteristics of the industrial structure of Uzbekistan; and the last section consists of concluding remarks.

2. Literature review: Recent studies on Input-Output analysis

2.1 Development of the methodology

Although input-output (I-O) analysis is nearly 80 years old, research interest in this area slowed in the 1970s and subsequently reemerged in the 1980s (Soofi, 1992). Recently however, there appears to have been a notable increase in the use of input-output tables in empirical analyses, addressing a wide range of policy issues (Wixted, Yamano and Webb, 2006). The availability of improved national I-O tables and modern information technology (IT) opportunities allows for the pursuit of more high-quality and complex research in this field of study.

In particular, Yamano and Ahmad (2006) showed the conversion of the closely related supply-use tables into symmetric input-output tables. They further account for the development of the organization for economic cooperation and development (OECD) database over the last decade, from the collection side, as well as from the compilation side.

In their study, Wixted, Yamano and Webb (2006) showed how arranged I-O tables can serve a large number of researchers. Mainly, they discussed the construction of I-O tables, which can provide key insights into the rapidly-changing industrial structure of the world economy.

Gorska R. (2015) investigated the Polish production structure, using backward and forward linkages based on input-output analysis, and compared this structure with selected European countries for year 2010. Results showed the main differences among countries are in key industries, the strength of linkages between industries and in effect of economic landscape of the country.

The pattern of Japanese growth during the period between 1914 and 1954 has been discussed in considerable detail by Chenery, Shishido and Watanabe (1962). Generally, they introduced a comprehensive method for analyzing structural change in a developing economy. The results showed that changes in domestic demand and an increase in exports are responsible for less than a quarter of the increase in industrial share of total output, while more than three quarters are related to changes in supply-side covering substitution of domestic production for imports and primary products.

Structural decomposition analysis (SDA) also has become a major analytical tool in I-O analysis over the past two decades. Increasingly, researchers applied SDA in their works that explored changes to some variables in its main determinants. Bekhet (2009) showed, in his study, the major principle of other approaches to develop SDA, estimating similarities and exploring different decomposition changes in I-O tables of the Malaysian economy over time (1983-2000). Based on the results, the Malaysian economy has not experienced noticeable changes over time in the national structure of its intermediate commodities production patterns. However, it showed a notable increase in similarity regarding the patterns of growth processes, with more evident differences between sectors than between tables.

A critical appraisal of I-O structural decomposition analysis, provided by Rose A. and Casler S. (1996), revealed limitations and unresolved issues in their study. However, their study's implications lie with the theory of the firm and consumer.

In a study of national input-output networks of nine selected countries, with different levels of development and notable role in world trade, undertaken by Soyyigit and Ciprici (2017) identifies the existence of a connection between countries' development levels and sectoral dependency over the time period between 2000 and 2014. Results revealed the existence of hubs in networks, indicating that, as development levels grow, the agricultural sector faces decline in their export earnings.

An analysis of the change in raw material consumption, in terms of technology, was completed by Weinzettel and Kovanda (2011) for the Czech Republic between 2000 and 2007 by applying the SDA research method. Their analysis showed an insignificant effect of final demand on change in raw materials flows.

To identify the pattern of growth, in terms of "deviations from proportional growth," DPG analysis has been used by Fujikawa and Kuang-hui (1992). Basically, their study includes the original definition of DPG and "normalized DPGs" for the economies of Japan, Taiwan and Korea. Study reveals that, among these three economies opposites Korean and Taiwanese economies led by export with Japanese growth where role of investment and intermediate demand was considerable.

2.2 Development of database

In the early 1950s the availability of input output tables (IOT) was confined to a few countries. Although the number of countries exploring I-O tables increased in the 1960s and the 1970s, through support from developed countries and international institutions, there were still many countries that lacked I-O tables altogether.

In the database-preparing stage we tried to collect data from the World I-O Database, OECD/WTO trade in value added database, Asian Development Bank multi-regional IOT, as well as from national statistics committees. Unfortunately, data required was not available for all observed countries.

However, only the EORA MRIOT database provides a time-series of high-resolution I-O tables, with matching environmental and social satellite accounts for 190 countries, including the Central Asian countries. The Eora MRIOT dataset consists of complete time-series for 1990-2015, with all raw data drawn from the UN's System of National Accounts and COMTRADE databases, Eurostat, IDE/JETRO, and numerous national agencies, drawing a distinction between basic prices and purchasers′ prices through 5 mark-ups and providing reliability statistics for all results.

3. Methodology and data

3.1 Analytical framework

3.1.1 Input-output methodology

I-O analysis implies that it is based on the interdependencies between economic sectors or industries. This method is used to evaluate the impacts of economic shocks and analyze riffle effects throughout the economy.

In general, interindustry relations measures are derived from I-O tables. I-O tables include the statistical information system and record the quantitative transactions among the economic sectors of the considered region, the sales to the final demand sector and the value added of each sector. In an open economy, the final demand sector includes private consumer goods, public consumer goods, and export and imports. Table 1 shows a typical I-O table, which summarize the distribution of goods and services among the sectors in an economy.

Table 1. Basic transaction I-O table.

Industry i/industry j	Intermediate demand (X_j), sectors (j=1, 2, 3, ……, n)	Final demand (F_i)	Total output (Xi)
		Domestic Export	
industry (i=1, 2, 3, ……, n)	$x_{11}\cdots\cdots x_{1j}$ $x_{21}\cdots\cdots x_{2j}$ . . . . x_{i1} x_{ij}	F_1 F_2 F_3 . . . F_n	X_1 X_2 X_3 . . . X_n
Imports (Mj)	$M_1\cdots\cdots M_N$		
Value added (Vj)	$V_1\cdots\cdots V_N$		
Total inputs (Xj)	$X_1X_2X_3\cdots X_n$		

Therefore, $X_j=\sum_{i=1}^{n}x_{ij}+V_j$ (1)

Where $\sum x_{ij}$ is the amount of input industry j supplies to all industry i in the economy for their own production and V_j is the value added.

Input coefficients are derived by dividing each column of x_{ij} by total input of industry j (X_j) as equation (2):

$$a_{ij}=\frac{x_{ij}}{X_j} \tag{2}$$

Identically to the intermediate inputs, we can define the value added ratio (v_j) by dividing the value added produced by industry j by domestic production:

$$v_j=\frac{V_j}{X_j} \tag{3}$$

Where V_j consists of compensation of employee and corporate surplus.

We must mention that, to avoid inconsistency, all figures in I-O tables are represented in monetary value at the prices of the relevant period of time.

Table 1 shows the balance of every row pursuant to the following equation:

$$X_i=\sum x_{ij}+F_i \tag{4}$$

Further using equation (2), we find a_{ij} and substituting it into the equation (4), we derive the following formula:

$$X_i=\sum a_{ij}X_j+F_i \tag{5}$$

Equation (5), shows that total output is decomposed to intermediate input $(a_{ij}X_j)$ and final demand (F_i) This relationship may therefore be indicated by the term "input coefficients."

In terms of the input coefficient, this coefficient relates industrial (sectoral) output to the primary input. In addition, it helps to identify the amount of an industry's output that comes through the interindustry system, as input for other industries, instead of becoming a part of final demand (Kah, Xian and Yuan, 2015).

From the basic I-O Table 3, input coefficients can be derived by dividing each row of x_{ij} by the total output X_i of the industry i related to that row.

$$a_{ij}=\frac{x_{ij}}{X_i} \tag{6}$$

A crucial moment in input-output analysis is the exploration of the direct and indirect effects of certain final demands on other industrial sectors. Input coefficients play an important role within the observed industrial sector and therefore in the analysis of those effects.

In this regard, we may assume that the economy consists of several industries, and the final demand is given. Solving the equations will yield the domestic production level of all industries.

$$\begin{cases} a_{11}X_1+a_{12}X_2+a_{1j}X_j+F_1=X_1 \\ a_{21}X_1+a_{22}X_2+a_{2j}X_j+F_2=X_2 \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ a_{ni1}X_1+a_{ni2}X_2+a_{nij}X_{nj}+F_{ni}=X_{ni} \end{cases} \quad (7)$$

Equation (7) shows the demand-side model of the I-O table in vertical view. If we suppose that final demand (F_i) is an exogenous variable, then we can get:

$$\begin{bmatrix} (1-a_{11}) & -a_{12}\cdots\cdots-a_{1j} \\ -a_{21} & (1-a_{22})\cdots\cdots-a_{1j} \\ \cdots\cdots\cdots\cdots & \cdots\cdots\cdots\cdots \\ -a_{ni1} & -a_{ni2}\cdots\cdots(1-a_{nnij}) \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \cdots \\ X_{ni} \end{bmatrix} = \begin{bmatrix} F_1 \\ F_2 \\ \cdots \\ F_{ni} \end{bmatrix}$$

In matrix form, $(I-A)*X=F$

$$X=(I-A)^{-1}*F=B*F \quad (8)$$

where B is an inverse matrix as $B=\begin{bmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{n1} & \cdots & b_{nn} \end{bmatrix}$

From inverse matrix tables, we can identify how much production will be stimulated in which industry by increased demand for one unit in a distinct industry.

3.1.2 Backward and forward linkage

Rasmussen (1956) developed methodology to calculate interindustry linkages, using inverse matrix tables, which covers both the direct and indirect effects of industrial output increase. Rasmussen's backward linkages are known as an index of the power of dispersion (IPD) and forward linkages are referred to as the index of sensitivity of dispersion (ISD). The index of the power of dispersion is defined by following equation:

$$IPD=\frac{\textit{sum of each column in inverse matrix table}}{\textit{mean value of whole vertical sum in inverse matrix table}} = \frac{\sum_j b_{ij}}{\overline{B}} \quad (9)$$

$$\textit{where } \overline{B}=\frac{1}{n}\sum_j b_{ij}=\frac{1}{n}\sum_i\sum_j b_{ij}$$

The main purpose of calculating the backward linkages is to identify key industries in the economy. This index facilitates determination of how much the output from the whole industries set increases to cope with an increase in final demand by one unit of products in industry j. The higher an industry's backward-linkage value, the greater is that industry's dependence on the inputs of other industries. Therefore, increase of production in this industry may represent a significant incentive to the whole economy (Cristobal and Biezma, 2006). Index of sensitivity of dispersion is defined in equation (10)

$$ISD = \frac{\textit{sum of each row in inverse matrix table}}{\textit{mean value of whole horizontal sum in inverse matrix table}} = \frac{\sum_i b_{ij}}{\bar{B}} \quad (10)$$

Index of sensitivity of dispersion is used to measure forward linkage, which can be understood as the increase of output in industry i that is required to deal with a unit increase in the final demand of each industry in the whole system for the product. The higher value of the index of sensitivity dispersion reveals that a particular industry contributes steadily to all industries. In other words, as the value of forward linkage increases, so does the stimulation impact a given industry can receive from an increase in the production of other industries (Cristobal and Biezma, 2006).

In general, both indices are used to analyze the relation of input and output. They do this by analyzing demand changes for the final output of a given industry j to other industries in the economy.

3.1.3 Structural change analysis

Any changes that appear in final demand definitely affect the total output. This impact can be analyzed through the inverse matrix tables, where a total multiplier indicates the degree of increase in aggregate output needed to deal with the increase on the demand side for output generated by the increase in final demand.

Moreover, the total change in output, by sectors, was defined by means of the interindustry model, as a function of the following factors, (a) the change in domestic demand, (b) the change in export expansion, (c) the change in technology and organization (Chenery, Shishido, Watanabe, 1962), and (d) the change in imports. First, we explored the economic structure of Central Asian countries over the ten-year interval between 2005 and 2015, using the conceptual framework of the interindustry model. Then, this model was employed to analyze observed changes in output, relative to domestic demand, export, imports, and the effects of technological change, as well as countries' total output change over 10 years. The technology effect shows any changes occurred in technology caused by both innovation and technological progress.

Initially, as we mentioned earlier interindustry tables taken from EORA multi-regional input-output database were presented as outputs, imports and components of final demand for more than hundred industries on the same basis, then we aggregated the data to a uniform 28-sector classification. Besides, we used the PPP index of each country for the relevant year and convert nominal values of given data into real values.

To explore the relationship between the final demand and domestic production, we used the following equation:

$$X=[I-(I-\widehat{M})A]^{-1}*[(I-\widehat{M})Y+E] \tag{11}$$

Here, X, the total domestic output is equal to the multiplication of the inverse matrix $[I-(I-\widehat{M})A]^{-1}$ to the value of final demand induced by exports (E), imports value changes in proportion to the domestic demand $[(I-\widehat{M})Y+E]$.

In this study inverse matrix coefficients are based on $[I-(I-\widehat{M})A]^{-1}$ type, therefore, import coefficients are calculated as ratios to domestic demand, or:

$$m_i=\frac{M_i}{\sum_j^n a_{ij}X_j+Y_i}\widehat{M}=\begin{bmatrix} m_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & m_n \end{bmatrix}$$

So, $M=\widehat{M}(AX+Y)$ (12)

In turn, final demand (F) can be divided into two components: domestic final demand (Y) and export (E). Domestic final demand includes various components of final demand, such as private consumption, gross domestic fixed capital formation and others, and can be expressed as follows:

$$F=Y+E \tag{13}$$

Induced production value-X_k derived from corresponding domestic final demands, can be represented by following equation defining domestic final demand.

$$X_k=[I-(I-\widehat{M})A]^{-1}*[(I-\widehat{M})*F],\ \mathrm{k}=1, 2, 3, \cdots, \mathrm{n} \tag{14}$$

Next, production value, induced by exports can be presented as follows:

$$X_E=[I-(I-\widehat{M})A]^{-1}*E \tag{15}$$

Components of Leontief matrix inverse $[I-(I-\widehat{M})A]^{-1}$ are expressed as B. Subsequently, we find the difference between real values in period 2 and difference in domestic demand, technology expansion, exports and imports between two observed periods.

Subsequently, a modified Leontief model was used to explore relationship between total outputs and domestic demand, imports and exports:

$$X_{it}-\sum_j a_{ijt}X_{jt}=Y_{it}+T_{it}+E_{it}-M_{it} \tag{16}$$ [1)]

Where $i=1, 2, \cdots n$; $t=2005, 2015$, X_{it}-the output of industry i in period t, a_{ijt}-input coefficient for industry i used in industry j in period t, $\sum_j a_{ijt} X_{jt}$- the intermediate use of industry i in all sectors of production, Y_{it}- domestic final demand for industry i in period t, T_{it}-the technology change of industry i in period t and E_{it} *and* M_{it}-are export and import of industry i in period t.

Solution for equation (16) can be represented as $X_{it}=\sum_j b_{ijt}(Y_{it}+T_{it}+E_{it}-M_{it})$ (17)

here, the coefficients b_{ijt} are components of the modified Leontief matrix inverse $[I-(I-\widehat{M})A]^{-1}=\{b_{ij}\}$. Then, to define corresponding growth in two periods (2005 as period 1, 2015 as period 2), we find the total average ratio of expansion of production, obtained by the division of the total gross production in period 2 by that of period 1:

$$\lambda=\frac{\sum_i X_{i2}}{\sum_i X_{i1}} \tag{18}$$

Therefore, if each of four independent elements of equation (17) is multiplied by λ, we will get solution for each production level:

$$X_{it}=\sum_j b_{ij1}\ (\lambda Y_{j1}+\lambda T_{j1}+\lambda E_{j1}-\lambda M_{j1}) \tag{19}$$

Subsequently, we find the difference between actual values in period 2 and difference in total outputs, domestic demand, technology expansion, exports and imports between two observed periods, called deviations from proportional expansion as:

$$\delta X_{i12}=X_{i2}-\lambda X_{i1},$$
$$\delta Y_{i12}=Y_{i2}-\lambda Y_{i1},$$
$$\delta T_{i12}=T_{i2}-\lambda T_{i1}$$
$$\delta E_{i12}=E_{i2}-\lambda E_{i1},$$
$$\delta M_{i12}=M_{i2}-\lambda M_{i1}.$$

Based on these deviations, we can determine deviations in production levels

$$\delta X_{i12}=\sum_j b_{ij2}(\delta Y_{j12}+\delta E_{j12}+\delta T_{j12}-\delta M_{j12}) \tag{20}$$

Where, T_{j12}-the change in intermediate use of industry j caused by the change in technology between period 1 and period 2 (2005 and 2015 respectively). In this regard, the deviation of production in each sector from proportional growth between the two periods was represented as a summary of four components:

i) The change in domestic final demand: $\sum_j b_{ij2}\delta Y_{j12}$;

ii) The change in export expansion: $\sum_j b_{ij2}\delta E_{j12}$;

iii) The change in imports: -$\sum_j b_{ij2}\delta M_{j12}$;

iv) The change in technological aspect: $-\sum_j b_{ij2}\delta T_{j12}$.

3.2 Data for the analysis

For the analysis of the economic structure the input output data of 4 Central Asian countries are taken from the EORA global database of multi-regional input-output table (MRIOT) for the years 2005 and 2015. Initially, the dataset was presented as outputs, imports and components of final demand for more than a hundred industries. To unify these tables with international sectors classification standards, we consolidated it and transformed to 28 industries of classification. However due to the availability of the data, industry classification for Tajikistan was confirmed to the 20 industries.

IOT of EORA were presented in basic USD prices for the particular year. We converted basic USD prices using countries' exchange rate and PPP index for the relevant period of time into real prices.

Moreover, we used key economic indicators, provided by the Asian Development Bank and the Interstate Statistics Committee, of all four observed countries.

4. Analysis of the economic structure of Uzbekistan

4.1 Supply and demand structure

As Table 2 shows slight decline of industrial share in the total output can be traced over the observed period of time in all Central Asian countries except Uzbekistan. In particular, in 2015, the total supply of domestic production and imports in Uzbekistan reached 93.7 billion USD, where the share of domestic production was 96.6% (90.5 billion USD) and imports 3.4% (3.2 billion USD). Compared to 2005, the total supply of domestic production increased nearly 4 times, imports increased by 174%, domestic production experienced a tremendous 296% boost, came up to increase by 290%.

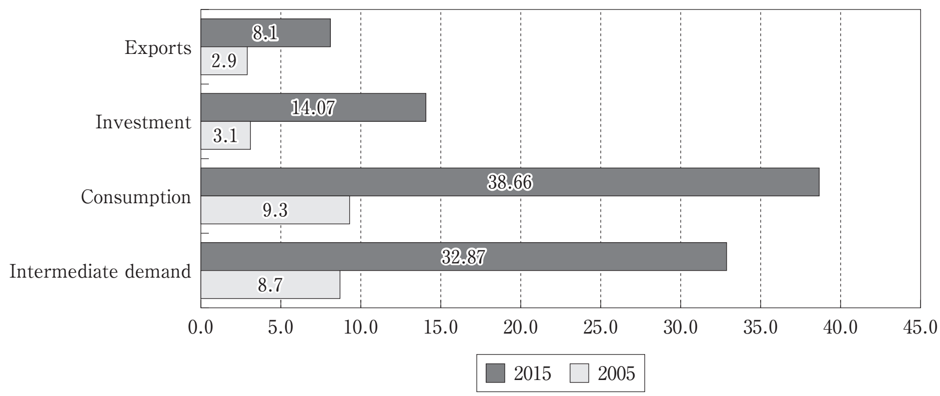
Table 2. Composition and Growth of total supply, billion USD

UZB	2005	2015	KAZ	2005	2015
Total Supply (billion USD)	24.0	93.7	Total Supply (billion USD)	123.1	373.2
Domestic composition (%)	95.2	96.6	Domestic composition (%)	90.6	92.8
Composition of import (%)	4.8	3.4	Composition of import (%)	9.4	7.2
KGZ			TJK		
Total Supply (billion USD)	9.9	44.2	Total Supply (billion USD)	4.8	16.8
Domestic composition (%)	90.3	94.4	Domestic composition (%)	93.1	91.0
Composition of import (%)	9.7	5.6	Composition of import (%)	6.9	9.0

Source: EORA data set, author's calculations

We can trace such boosts, and they also occurred in domestic production and imports share in all other observed countries, which resulted in the dramatic growth of their total supply, but when we compare composition of total supply cross all countries, Tajikistan's volume of domestic production and imports share are the lowest and amounts for 15.3 billion USD and 1.5 billion USD, respectively. The largest domestic producer in the region is Kazakhstan, the figure of which is more than 4 times greater than that of Uzbekistan, while Kyrgyzstan's domestic production is less than half of that in Uzbekistan.

Figure 3. Composition of Total Demand in Uzbekistan (bln. USD)



Source: EORA dataset, author's calculations

Table 3. Composition of Total Demand (%)

UZB	2005	2015	KAZ	2005	2015
Total Demand	100.0	100.0	Total Demand	100.0	100.0
Intermediate demand	36.5	35.1	Intermediate demand	47.6	40.9
Domestic Final demand	51.5	56.3	Domestic Final demand	39.4	46.2
Consumption	38.5	41.3	Consumption	27.9	32.4
Investment	13.0	15.0	Investment	11.5	13.7
Exports	12.0	8.7	Exports	13.0	12.9
Final Demand	63.5	64.9	Final Demand	52.4	59.1
KGZ			TJK		
Total Demand	100.0	100.0	Total Demand	100.0	100.0
Intermediate demand	68.2	42.4	Intermediate demand	52.1	53.9
Domestic Final demand	23.9	15.0	Domestic Final demand	35.5	37.0
Consumption	19.5	11.9	Consumption	32.4	33.8
Investment	4.3	3.1	Investment	3.1	3.2
Exports	7.8	42.6	Exports	12.4	9.0
Final Demand	31.7	57.6	Final Demand	47.9	46.1

Source: EORA data set, author's calculations

Uzbekistan's total demand for 2015 was 93.7 billion USD, with the following decomposition: Intermediate demand accounts for 32.9 billion USD (35.1%) and domestic final demand, including consumption, investment and exports, accounts for 60.8 billion USD (64.9%) (Figure 3). Intermediate demand increased by 3.7 times, relative to the 2005 figure, the levels by which consumption and investment increased were almost equal, by 4 times, the country's exports earning increased by 2.8 times, from 2.9 billion USD to 8.1 billion USD. Generally, the total demand of Uzbekistan economy has grown by 3.9 points.

Considering total demand components of other Central Asian countries, Kazakhstan is the leading player, in terms of its export earnings, investment attraction and consumption volumes, while the last-place position belongs to Tajikistan, with its lowest coefficients in total demand composition.

4.2 Backward and forward linkages

In the framework of input-output analysis, production by one industry has two types of economic effect to other industries. The first effect shows the connection between the industry and its suppliers and is known as backward linkage. It shows the direction of causality in demand-side models. The second effect concerns the connection between the industry and its clients (buyers) and is referred to as forward linkage, indicating the direction of causality in supply-side model (Gorska R. 2015).

Table 4 represents measurements of backward linkage for industrial sectors in Central Asia for 2005 and 2015. We applied equation (9) to calculate this index and, as it indicates, the higher the value of an industry's backward linkage, the more this industry depends on other industries' input products for its own output. Therefore, those industries with backward linkage values greater than one demonstrate an above-average dependence on other industries' input materials. In other words, it reveals a strong backward linkage effect.

Based on the results, surprisingly, we find almost constant relatively stable number of industries have an above-average dependency on other industries′ inputs across all countries over the 2 periods of time. In particular, mining and quarrying, beverages and food, the textile industry, and petroleum and coal products industries serve as strong demanding forces from other domestic industries in national economies.

Iron and steel, machinery production and metals products in Uzbekistan show a slight increase of the backward linkage effect over time, which may be explained by their expansion on final goods production.

Table 5 shows measurements of forward linkage for industrial sectors in Central Asia for 2005 and 2015. We applied equation (10) to calculate this index and, as it shows, the higher industries' forward linkage value, the stronger this industry's influence on other industries' production, through its supplied inputs. Therefore, those industries with values

Table 4. Index of power of dispersion — Backward linkage

	2005				2015			
	UZB	KAZ	TJK	KGZ	UZB	KAZ	TJK	KGZ
Agriculture, forestry and fishing	0.833	0.7904	0.7382	0.9517	0.8178	0.7579	0.5643	0.9694
Mining and quarrying	1.022	1.8872	0.9104	1.2297	1.0338	1.6564	0.9527	1.383
Beverages and foods	1.409	1.3752	1.0241	1.1790	1.4646	1.3550	1.0247	1.1728
Textile products	1.420	1.4195	1.1325	1.0951	1.4326	1.3872	1.1341	1.1040
Pulp, paper and wooden products	1.237	0.9573	1.0209	1.0939	1.2994	0.9616	1.0379	1.0808
Printing, plate making and book binding	0.966	0.6308		0.8446	0.5678	0.8730	0.8554	
Chemical products	1.235	0.9513		0.9073	1.3300	0.9983	0.9049	
Petroleum and coal products	1.154	1.0186	1.1007	1.0668	1.2269	1.0700	1.1362	1.0917
Plastic and rubber products	1.277	0.9329		0.8440	1.3811	0.9600		0.8537
Ceramic, stone and clay products	0.998	0.9452		1.365	1.0068	0.9601		1.3496
Iron and steel	1.002	1.5884		0.8184	1.0781	1.5005		0.7891
Non-ferrous metals	1.168	1.5510		1.623	1.1750	1.4227		1.699
Metal products	1.078	0.9833	1.1813	0.7687	1.0978	1.0092	1.2604	0.7709
Production machinery	1.047	0.9145	1.1038	1.469	1.0655	0.8922	1.1388	1.421
Information and communication electronics equipment	0.942	1.1155			0.9452	1.1239		
Transportation equipment	0.859	0.7862	1.3061	1.01259	0.9145	0.8193	1.3655	0.9856
Miscellaneous manufacturing products	1.151	1.0783	1.0165	0.8394	1.1561	1.0468	1.0353	0.8230
Construction	0.996	0.8793	0.9685	1.3475	0.9955	0.9202	0.7573	1.2969
Electricity, gas and heat supply	0.947	1.1725	1.3048	0.8799	0.9921	1.1538	1.2948	1.0787
Commerce	0.858	0.7571	0.8004	0.3302	0.8263	0.7930	0.6977	0.3073
Finance and insurance	0.675	0.5272	0.8442	1.0108	0.6730	0.5823	1.0206	0.9687
Real estate	0.746	0.8577		0.7274	0.7323	0.8583		0.7087
Transport and postal services	0.758	0.9456	0.9339	1.1799	0.7505	0.8649	0.8076	1.14654
Information and communication	0.737	0.7423	0.8960	0.8267	0.7373	0.7698	0.7053	0.7765
Public administration	0.901	0.6761	0.9741	0.7463	0.8532	0.7099	1.0844	0.7321
education and research	0.818	0.8037	0.9948	0.9101	0.7765	0.8122	1.1251	0.8665
Medical, health care and welfare	0.908	0.8812	0.9036	0.8091	0.8422	0.8938	0.8401	0.7870
Activities not elsewhere classified	0.858	0.8319	0.8453	1.1239	0.8281	0.8477	1.0172	1.0771

Source: EORA data set, author's calculations

Table 5. Index of sensitivity of dispersion — Forward linkage

	2005				2015			
	UZB	KAZ	TJK	KGZ	UZB	KAZ	TJK	KGZ
Agriculture, forestry and fishing	2.0795	2.3448	0.6015	1.671	2.1220	2.2582	0.6502	1.554
Mining and quarrying	1.5745	3.6557	0.7274	4.335	1.5784	3.0610	0.6880	4.056
Beverages and foods	1.3682	1.4778	0.6286	0.932	1.2443	1.4168	0.6593	0.947
Textile products	2.0527	1.3362	0.4742	0.853	2.0053	1.3099	0.5075	0.868
Pulp, paper and wooden products	0.7875	0.7198	1.0256	0.582	0.7754	0.7315	1.0917	0.591
Printing, plate making and book binding	0.6316	0.4987	—	0.702	0.6451	0.5624		0.727
Chemical products	1.2182	0.6691	—	0.383	1.2128	0.7235		0.397
Petroleum and coal products	0.8653	1.0302	1.7679	0.805	0.8838	1.1111	1.9995	0.833
Plastic and rubber products	0.7304	0.6800	—	0.565	0.7270	0.7098		0.582
Ceramic, stone and clay products	0.8437	0.7167	—	0.765	0.8194	0.7729		0.766
Iron and steel	0.8234	0.7154	—	0.554	0.8194	0.7753		0.671
Non-ferrous metals	1.1580	1.0089	—	2.013	1.1920	1.0217		1.872
Metal products	0.6865	0.5242	0.9261	0.531	0.6915	0.5829	1.2740	0.555
Production machinery	0.8702	0.7541	1.6955	0.710	0.8504	0.7357	1.8649	0.718
Information and communication electronics equipment	0.6989	0.5511	—		0.7034	0.6053		
Transportation equipment	0.6818	0.7527	0.9068	1.167	0.6799	0.7803	0.9770	1.170
Miscellaneous manufacturing products	1.1042	1.0296	0.5557	0.541	1.0539	0.9749	0.5206	0.564
Construction	0.8069	0.7339	0.9245	0.793	0.7763	0.7521	0.9509	0.775
Electricity, gas and heat supply	1.2204	1.1393	0.6416	1.262	1.1568	1.1931	0.5989	1.095
Commerce	0.6718	0.5229	1.0750	1.062	0.6854	0.5887	1.0126	1.313
Finance and insurance	0.6957	0.5646	4.0140	0.782	0.7276	0.6429	3.3030	0.765
Real estate	0.6584	0.5209		1.915	0.6680	0.5878		1.957
Transport and postal services	1.5991	2.6557	1.0166	0.601	1.6978	2.3640	1.0527	0.617
Information and communication	0.7326	0.6232	0.9456	0.763	0.7393	0.6942	0.9959	0.779
Public administration	0.6333	0.5062	0.4789	0.746	0.6447	0.5748	0.4394	0.796
education and research	1.0198	0.8229	0.6255	0.575	1.0629	0.8907	0.5416	0.599
Medical, health care and welfare	0.6792	0.5395	0.5085	0.587	0.6957	0.6028	0.4613	0.621
Activities not elsewhere classified	1.1082	0.9059	0.4605	0.8026	1.1418	0.9758	0.4112	0.815

Source: EORA data set, author's calculations

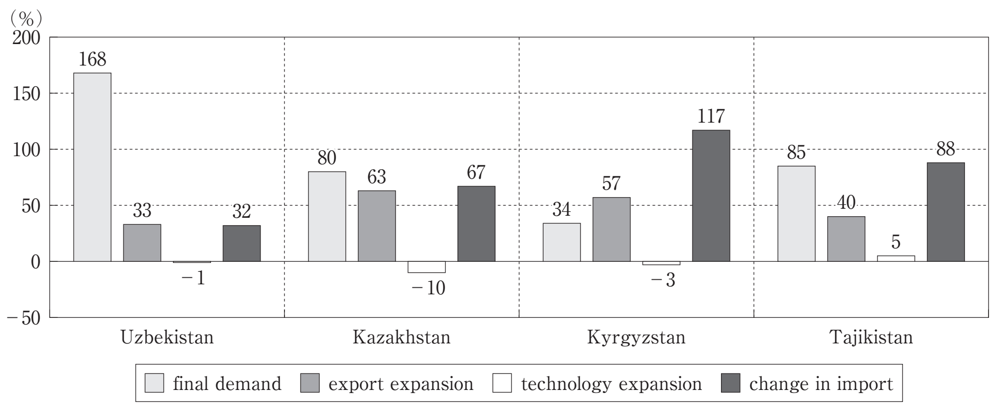
of forward linkage greater than one have an above-average influence on other industries' production. Thus, we can trace the strong forward linkage effect.

Considering the results, Uzbekistan and Kazakhstan have similar situation with above-average number of industries influencing others, e.g., agriculture, food, mining and quarrying and textile industries' inputs are most influential on other domestic sectors' production outputs. The number and industrial diversification varies across countries. Tajikistan's industrial diversification has not changed, and it has a smaller number of industries demonstrating strong forward linkage effect. Only in Kyrgyzstan, sectors of transportation equipment and real estate are sectors with an above-average amount of influence on the rest of sectors' output. However, it is quite difficult to distinguish whether more or fewer industries with strong forward linkage effects are crucial for other domestic production output, as the scope of changes is relatively small.

4.3 Factor decomposition of the structural change

Based on methodology presented in section 3.1.3, we find the change in domestic final demand. Moreover, we calculated the change in export earnings, change in technology and import spending, as well as output by industries and in national economies, overall.

Figure 4. Structural shifts in national economies in 10 years period.



Source: EORA data set, authors calculations

Given the data in Figure 4, we can observe that there has been a tendency toward increasing domestic final demand across all countries in the region, with Uzbekistan in the leading position (168%); although its export expansion is the lowest among the considered countries, its total productivity level or total output exhibits the highest growth (14.8%). Kazakhstan, despite holding the leading position in exports in the region (63%), has the lowest coefficient reflecting the implementation of new technologies' in production processes (−10%). Kyrgyzstan's import spending is the highest among all of the other countries, and its country expenditures for imported services and goods increased more than 117%;

Tajikistan has the next highest spending, and its imports increased 88% within 10 years. Uzbekistan experienced a 32% increase in its imports, while Kazakhstan's import spending grew by 67%.

Certainly, there are biases involved in conducting a comparative analysis of countries' economic structures, as such nations differ in terms of their general economic features, such as a country's GDP, GDP per capita, land, population, and so forth. In spite of this possibility, we selected these countries for their virtually identical economic transition histories and their location as neighboring countries.

Further, we implemented a deviation proportional growth (DPG) analysis, which helped us to identify the degree of change in sector composition of production, in terms of the concept of deviation from proportional growth (Fujikawa and Kuang-hui, 1995).

Table 6 shows the results of the DPG decomposition analysis. We aggregated 28 industries' worth of table data into 9 main industries, including agriculture, manufacturing, chemicals and others. Equation (20) was applied here; therefore, results included deviations from two components of final demand (domestic final demand and export expansion) and changes in two coefficients (import coefficients and input coefficients); this represents technological change.

δX is a vector of DPGs and its value is zero if all the sectors expand at the average ratio, λ, which corresponds to the situation of proportional growth (Fujikawa and Kuang-hui, 1992). Each element of δX is the DPG of each sector. λ was determined based on equation (18), which means that:

- DPG is positive when the sector is growing faster than the average;
- DPG is zero when the sector's expansion ratio is equal to X;
- DPG is negative when the sector's growing ratio is less than X.

Thus, the sign of DPG shows whether a sector has increased its output share, and its absolute value depends on the actual growth rate and production level of the sector. The summary of DPG is therefore zero (Fujikawa and Kuang-hui, 1995).

Table 6 indicates, in the terms of DPG, the degree of change in output composition and represents results for Central Asian countries during the 2005-2015 period, and gives values in USD, deflated by PPP of each country for specific period.

However, the relative degree of change and the relative magnitude of the causes toned not be measured by currency units; they were divided by the sum of positive DPGs and multiplied by 100. They have therefore been normalized in such a way that summary of all positive (separately negative) DPGs is equal to 100, as is shown in Table 7. A normalization process can make the table clearer and render the comparison between periods and economies easier.

In Table 7, the DPG shows that agriculture, services and construction increased their output deviations in Uzbekistan, while, rather surprisingly, mining and manufacture

Table 6. DPG decomposition results for Central Asian countries, 2005-2015 (bln. USD)

	UZB					KAZ				
	DPG ($ based)	Deviation of				DPG ($ based)	Deviation of			
		Domestic final demand	Technology change	Export	Import		Domestic final demand	Technology change	Export	Import
Agriculture, forestry and fishing	916.10	2,027.28	979.72	−2,532.66	−441.77	1,004.57	13,538.72	−15,776.72	1,542.52	−1,700.05
Mining and quarrying	−767.28	42.65	−580.67	−460.15	−230.89	−56,489.43	555.03	−50,007.25	−8,518.16	−1,480.96
Manufacturing	−4,109.88	2,490.03	−4,246.55	−3,299.66	−946.30	2,493.15	14,381.44	−17,684.49	−1,532.42	−7,328.62
Chemicals	−654.75	103.25	−615.81	−552.09	−409.90	3,634.67	403.94	431.35	142.28	−2,657.10
Metals	−527.08	102.51	−184.21	−611.51	−166.13	−1,196.85	1,116.34	−4,001.53	−624.65	−2,313.00
Machinery	−100.00	295.27	−410.03	−246.50	−261.25	1,540.05	1,905.14	−2,336.80	166.41	−1,805.31
Other manufacturing	−460.58	268.66	−621.25	−472.37	−364.38	326.94	350.89	−1,573.71	22.30	−1,527.45
Construction	4,060.61	3,952.04	−415.71	−205.61	−729.88	25,614.88	20,358.86	−3,018.88	1,199.11	−7,075.80
Services	1,642.86	2,442.74	489.59	−2,146.00	−856.53	23,072.02	27,692.98	−12,865.15	1,315.13	−6,929.06
Total	0.00	11,724.43	−5,604.91	−10,526.54	−4,407.03	0.00	80,303.32	−106,833.19	−6,287.49	−32,817.37

	KGZ					TJK				
	DPG ($ based)	Deviation of				DPG ($ based)	Deviation of			
		Domestic final demand	Technology change	Export	Import		Domestic final demand	Technology change	Export	Import
Agriculture, forestry and fishing	−950.63	−322.91	−2,552.64	580.32	−1,344.59	179.66	27.58	207.38	−79.24	−23.94
Mining and quarrying	−4,342.91	229.54	−4,330.28	−106.72	135.45	−108.91	−0.34	−78.52	−5.32	24.72
Manufacturing	1,317.83	−849.19	−188.83	189.84	−2,166.01	−550.84	203.98	343.43	−946.15	152.10
Chemicals	139.63	36.02	−262.34	464.20	98.25	93.00	61.24	276.61	−15.72	229.13
Metals	−2,100.84	4.49	−1,396.21	−856.34	−147.22	−151.85	3.28	285.63	−374.52	66.24
Machinery	1,872.08	270.37	989.14	1,029.68	417.10	340.59	111.02	491.14	−14.77	246.80
Other manufacturing	−16.75	66.16	0.38	−81.31	1.98	−68.90	33.97	−19.48	−38.03	45.36
Construction	2,251.69	317.01	1,005.95	951.97	23.24	181.13	97.49	167.30	−14.57	69.08
Services	1,829.91	−969.80	947.32	1,302.52	−549.87	86.12	789.63	118.28	−296.44	525.35
Total	0.00	−1,218.31	−5,787.52	3,474.14	−3,531.68	0.00	1,327.85	1,791.77	−1,784.77	1,334.85

decreased their deviations. Agriculture and construction accounted for 75% of positive deviations. In Kazakhstan, construction and services accounted for 84% of the economy's positive deviations.

The last total row of Table 7 indicates how input coefficients influence and produce positive deviations. Not every observed country received its benefit in export earnings, as the highest positive deviation from exports was achieved by Kyrgyzstan.

The deviation from technology expansion is the second factor that yielded positive deviations for Tajikistan. In particular, technological improvement can be observed in the machinery sector. However, based on results of the DPG analysis results, technological

Table 7. DPG decomposition for Central Asian countries, 2005-2015.

	UZB					KAZ				
	Normalized DPG	Deviation of				Normalized DPG	Deviation of			
		domestic final demand	Technology change	export	import		domestic final demand	Technology change	export	import
Agriculture, forestry and fishing	13.84	30.63	14.80	−38.26	−6.67	1.74	23.47	−27.35	2.67	−2.95
Mining and quarrying	−11.59	0.64	−8.77	−6.95	−3.49	−97.93	0.96	−86.69	−14.77	−2.57
Manufacturing	−62.09	37.62	−64.15	−49.85	−14.30	4.32	24.93	−30.66	−2.66	−12.70
Chemicals	−9.89	1.56	−9.30	−8.34	−6.19	6.30	0.70	0.75	0.25	−4.61
Metals	−7.96	1.55	−2.78	−9.24	−2.51	−2.07	1.94	−6.94	−1.08	−4.01
Machinery	−1.51	4.46	−6.19	−3.72	−3.95	2.67	3.30	−4.05	0.29	−3.13
Other manufacturing	−6.96	4.06	−9.39	−7.14	−5.50	0.57	0.61	−2.73	0.04	−2.65
Construction	61.34	59.70	−6.28	−3.11	−11.03	44.40	35.29	−5.23	2.08	−12.27
Services	24.82	36.90	7.40	−32.42	−12.94	40.00	48.01	−22.30	2.28	−12.01
Total	0.00	177.12	−84.67	−159.02	−66.58	0.00	139.21	−185.20	−10.90	−56.89

	KGZ					TJK				
	normalized DPG	Deviation of				normalized DPG	Deviation of			
		domestic final demand	Technology change	export	import		domestic final demand	Technology change	export	import
Agriculture, forestry and fishing	−12.83	−4.36	−34.44	7.83	−18.14	20.40	3.13	23.55	−9.00	−2.72
Mining and quarrying	−58.60	3.10	−58.43	−1.44	1.83	−12.37	−0.04	−8.92	−0.60	2.81
Manufacturing	17.78	−11.46	−2.55	2.56	−29.23	−62.56	23.17	39.00	−107.46	17.27
Chemicals	1.88	0.49	−3.54	6.26	1.33	10.56	6.96	31.42	−1.79	26.02
Metals	−28.35	0.06	−18.84	−11.55	−1.99	−17.25	0.37	32.44	−42.54	7.52
Machinery	25.26	3.65	13.35	13.89	5.63	38.68	12.61	55.78	−1.68	28.03
Other manufacturing	−0.23	0.89	0.01	−1.10	0.03	−7.83	3.86	−2.21	−4.32	5.15
Construction	30.38	4.28	13.57	12.85	0.31	20.57	11.07	19.00	−1.66	7.85
Services	24.69	−13.09	12.78	17.58	−7.42	9.78	89.68	13.43	−33.67	59.66
Total	0.00	−16.44	−78.09	46.88	−47.65	0.00	150.81	203.49	−202.70	151.60

improvement has not demonstrated the desired level of improvement in Uzbekistan; instead, that coefficient decreased its deviation from proportional growth value in total productivity.

Finally, the third factor impacting the decisive change in proportional growth is expected to be reflected in import coefficients, which indicate whether import substitution took place. Surprisingly, import substitution shows negative DPGs across all sectors in Uzbekistan; moreover, only in Tajikistan we can observe positive change in import coefficients.

5. Conclusion

The main purpose of this study is to explore the structure of production for Uzbekistan's economy and compare it with the economies of other Central Asian countries for the period between 2005 and 2015, using an input-output approach.

In general, the Uzbek economy has exhibited a good transformation, from an agriculturally oriented country to a more value-added and manufacturing industry-oriented nation. However, over the given scope of time, we found industries that remained relatively unchanged, in terms of the values of their forward or backward linkages. This may be attributed to the significantly slow speed of transformation. Further, based on available data and results of input-output analysis, we did not reveal radical structural shifts in the Uzbek economy. The sector of food, agriculture and textile are ranked as the industries that are most influential on other industries in an economy over 10 years. Despite that there has been a 2.8-point increase in export expansion (see Figure 3). Uzbekistan exporters' earnings were at a relatively low level, compared to their neighboring counterparts. Along with that, domestic production has increased tremendously, nearly 168% (see Figure 4); however, relative to other Central Asian countries, Uzbekistan's change in import expenditures for services and goods over the observed time was relatively low; it increased only 32%.

Results from deviation proportional growth analysis, as shown in Table 7, also revealed that agriculture, services and construction served as main factors in the production of positive deviations in Uzbekistan, accounting for nearly 75% of total positive deviations. At the same time, results showed that the DPG of technology expansion, export earnings and import substitution decreased its value in terms of the country's total productivity.

This indicates that the structure of the Uzbek economy remained relatively unchanged, in terms of its dominant focus on agriculture, food and textile industries, despite the fact that, currently, the government is focusing on increasing its export-oriented and import-substituted production.

To achieve this, the government prioritizes the attraction of foreign investments, provides favorable conditions for the development of joint companies with foreign shares, and strongly stimulates the development of small businesses and private entrepreneurships, by simplifying tax burdens and limiting external interference in their activities. Since independence, Uzbek government established several primary paths to development. However, despite progress in industrial achievements, Uzbekistan still faces a number of obstacles that are impeding its desired productivity growth. There is still high dependency on imports, so, in 2016, Uzbekistan has exported goods and service in the total amount of 7.6

billion USD, while import volume has reached 10.1 billion USD, and this resulted in a negative trade balance (www.adb.org/statistics). Moreover, the most imported goods are used to manufacture export-oriented products rather than for to further domestic consumption, which reflects the low efficiency of the existing policy and regulation to foster economic integration and, thereby achieve a greater value added in the country.

So, on the threshold of future changes, Uzbek authorizes have targeted the period between 2017 and 2030 to launch a new development program aimed at, among other goals, providing sustainable economic growth and liberalizing the economy.

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Notes

1) See Chenery, Shishido and Watanabe, (1962) for detailed mathematical derivations, pp. 105

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