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Global Value Chains' Participation and Logistics Performance in Post-Soviet Economies

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Abstract
Post-Soviet countries have never been analysed in the global value chain (GVC) context. Therefore, in this study, we evaluate the degree of backward participation of GVCs in the manufacturing sector of post-Soviet countries. We also examine the quantitative linkage between GVCs and host countries' logistics performance as a service-link component. We used the UNCTAD-Eora GVC database and employed a structural gravity trade model. The results illustrate a positive correlation between GVC backward participation in manufacturing and income levels in the post-Soviet economies. The empirical estimation using the structural gravity trade model demonstrates a quantitative linkage between GVC backward participation and the logistics performance of the host country. The level of logistics performance accounts for 70–80 percent of the degree of GVC backward participation. Our findings' major policy implication is that post-Soviet economies' logistics performance should be improved by erasing the Soviet era's negative legacy.

JEL Codes: F12, F13, F14, O57.
Keywords: Global value chains, Logistics performance, Post-Soviet countries, Manufacturing, Structural gravity trade model.

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1 Introduction

The disintegration of the Soviet Union in 1991 led to the establishment of 15 countries. In the early stages of their independence, the economies of these countries experienced severe hardships in implementing large-scale market-oriented reforms. However, since then, they have significantly progressed in their economic transition to a market-based economy and in forming linkages with the world economy. They were classified into high- or middle-income groups according to the World Bank income classification in 2020.[2] Although they share commonalities in history, geographical closeness, culture, and language, their profiles are heterogeneous, as illustrated in Table 1. As their populations and gross domestic product (GDP) per capita levels differ widely, the countries fall under different income classifications. Estonia, Latvia, and Lithuania belong to the high-income class and are now members of the European Union (EU) and Organization for Economic Co-operation and Development (OECD), whereas Kyrgyz, Tajikistan, Ukraine, and Uzbekistan are tagged as lower-middle-income, and the remaining countries are classified as upper-middle-income.

Table 1: Profile of 15 Post-Soviet Countries

	Population in 2020 (in thousand)	GDP per capita in 2020 (in US$)	Income class in 2020	Manufacturing % of GDP in 2020	GVC participation in manufacturing in 2017
Armenia	2,963	4,267	Upper-Middle	12.4	21.6
Azerbaijan	10,110	4,232	Upper-Middle	5.8	14.2
Belarus	9,399	6,398	Upper-Middle	21.5	32.6
Estonia	1,331	23,036	High	12.9	56.7
Georgia	3,714	4,275	Upper-Middle	9.3	26.3
Kazakhstan	18,754	9,071	Upper-Middle	13.1	17.5
Kyrgyz	6,592	1,189	Lower-Middle	17.0	31.9
Latvia	1,902	17,549	High	10.8	40.4
Lithuania	2,795	19,981	High	15.7	50.9
Moldova	2,618	4,523	Upper-Middle	10.5	32.5
Russia	144,104	10,115	Upper-Middle	13.3	17.6
Tajikistan	9,538	844	Lower-Middle	13.4	22.0
Turkmenistan	6,031	7,674	Upper-Middle	-	33.4
Ukraine	44,135	3,741	Lower-Middle	10.1	31.6
Uzbekistan	34,232	1,767	Lower-Middle	19.4	13.5
Average	-	-	-	13.2	29.5
Malaysia	32,366	10,351	Upper-Middle	21.4	41.1
Thailand	69,800	7,168	Upper-Middle	25.6	36.7

Sources: Population and manufacturing value-added (percentage of GDP): World Bank Open Data https://data.worldbank.org/. GDP per capita: World Economic Outlook Database, International Monetary Fund https://www.imf.org/en/Publications/WEO/weo-database/2021/October. Income Classification: World Bank https://datahelpdesk.worldbank.org/knowledgebase/articles/906519. GVC participation: UNCTAD-Eora Global Value Chain Database. https://worldmrio.com/unctadgvc/

[2] See the website: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

One of the key issues common in post-Soviet countries was the underdevelopment of the manufacturing sector and the lack of global value chain (GVC) linkages in the sector. Table 1 illustrates that the average manufacturing value added as a percentage of GDP in the post-Soviet countries was 13.2 percent in 2020, which is significantly lower than those of emerging Southeast Asian economies, such as Malaysia (21.4 percent) and Thailand (25.6 percent), and the average of East Asia and Pacific countries, excluding high-income countries (25.2 percent). Table 1 also presents the degree of GVC backward participation in the manufacturing sector in 2017, expressed by the 'foreign value embedded in a country's manufacturing exports' in the United Nations Conference on Trade and Development (UNCTAD)-Eora GVC database[3] (UNCTAD-Eora database). Its average in post-Soviet countries is 29.5 %, which is much lower than that in Malaysia (41.1 percent) and Thailand (36.7 percent).

As Kaldor demonstrated in the eponymous Kaldor's law, the manufacturing sector is considered an engine of economic growth, especially in developing countries.[1] Rodrik also argues that the manufacturing sector shows unconditional labour productivity convergence, absorbs more unskilled labour than other sectors, and does not face the demand constraints of a home market because of its tradability in international markets.[2] Thus, the sluggish manufacturing sector in post-Soviet countries may be a detrimental factor to their sustainable economic development.

Inactive GVC participation in the manufacturing sector is another side of the same coin of sluggish manufacturing activities in post-Soviet countries. GVC has become integral to global economic activities over the last two decades and has been described as the fragmentation of production processes and the international dispersion of tasks among economies in diversified developmental stages, which has led to the emergence of borderless production networks.[3] Kimura and Kimura et al. argue that international production networks typically exist in manufacturing activities, such as machinery industries involving many multi-layered vertical production processes.[4,5] GVC is considered to boost economic growth because specialisation in production processes enhances efficiency and productivity and the durable firm-to-firm relationships promote the diffusion of technology along the chains.[6] Thus, the absence of GVC participation leads to sluggish manufacturing activities.

From a theoretical perspective, Hummels et al. (2001) initially introduced the concept of GVC in terms of 'vertical specialisation'.[7] Koopman et al. then generalised the concept of vertical specialisation by accounting for all sources of value added in gross exports within the framework of multiple countries and sectors, thereby integrating vertical specialisation and value-added trade in the literature.[8,9] Following their GVC conceptualization, value-added trade data have been developed by international organizations such as the OECD, World Trade Organization (WTO), and UNCTAD and the database has enabled the analysis of the value-added contributions of gross exports.

GVC mechanics, characterised by vertical specialisation, have also been discussed by the 'fragmentation' model in the context of intra-industry trade, as in Jones and Kierzkowski (1990, 2005), Deardorff (2001), and Kimura (2006).[4,10,11,12] Jones and Kierzkowski (1990, 2005) argued that a firm's decision on whether to fragment production processes depends on the differences in location advantages (e.g. the differences in factor prices such as wages) and the levels of service-link costs.[10,11] They define service-link costs as bundles of activities that connect fragmented production blocks comprising coordination, administration, transportation, and financial services. Thus, the service-link costs are composed of not only bilateral trade costs, such as transportation costs, but also country-specific costs, such as logistics performance for operating in a given country.

[3] See the website: https://world mrio.com/unctadgvc/ The property of this database is explained in Section 2.

In this study, we aim to assess the degree of GVC backward participation (defined as the foreign value embedded in a country's exports) in the manufacturing sector of post-Soviet countries and examine its quantitative linkage with host countries' logistics performance as a component of the service link. We hypothesise that high-income (Estonia, Latvia, and Lithuania) and other middle-income post-Soviet countries differ substantially in GVC backward participation and that this difference originates from the differences in their logistics performance as host countries. Specifically, we test in this study the hypothesis that the lack in GVC backward participations in middle-income post-Soviet countries is associated with their low logistics performances as a component of the GVC service link. The GVC data were retrieved from the UNCTAD-Eora database. For the analytical framework, we apply a 'structural' gravity trade model to the specification of the estimated equations.

The contributions of this study to the literature are as follows: First, this study targets post-Soviet economies in the GVC analysis. GVCs in the manufacturing and logistics performance context in emerging Asian and Latin American economies have been discussed extensively, such as by Kimura, Kimura et al., Gereffi, and Taguchi and Thet, whereas fewer studies have dealt with these issues in transition economies[4].[4,5,13,14] Analysing transition economies, such as post-Soviet countries, adds a meaningful contribution to the literature. The development paths of these countries differ considerably from those of the emerging Asian and Latin American economies. In particular, institutional factors such as logistics performance are vital in post-Soviet economies because their institutional frameworks have changed dramatically from a centrally planned economy to a market-based economy over the past three decades and some of them may still suffer from chronically immature market-based systems as a negative consequence of having been part of the Soviet Union. The institutional environment affects the development of the GVC and manufacturing sectors.

Second, we employ the UNCTAD-Eora database (compiling value-added trade data) to analyse GVC linkages. GVC, which is characterised by vertical trade, can be expressed by trade in terms of value-added as well as ordinary gross trade values. Previous studies, such as that by Kimura et al., examined the vertical trade of fragmented manufacturing products in intra-industry by using their gross trade values in terms of parts and components in their gravity trade model.[5] However, gross trade values do not necessarily accurately express vertical trade because the traded parts and components can be used to fulfil domestic final demands and not exclusively for processing them for exports. By contrast, the value-added trade data precisely denote vertical trade in the GVC linkage. Thus, by using value-added trade data, we contribute to enriching the evidence on GVC linkages.

Third, we apply a 'structural' gravity trade model setting for the GVC analysis. The traditional gravity trade model explains bilateral trade flows in terms of the economic size of two countries and the distance between them. However, Piermartini and Yotov (2016) argued that the traditional model leads to biased and inconsistent estimates. Therefore, they presented a comprehensive and theoretically consistent econometric specification called a structural model.[15]

The remainder of this paper is organised as follows: Section 2 illustrates the extent of GVC backward participation in the manufacturing sector of post-Soviet countries; Section 3 conducts an econometric analysis by estimating a structural gravity trade model to examine the quantitative linkage between GVC backward participation by the host country and its logistics performance; and Section 4 summarises and concludes the paper.

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[4] Taguchi and Amirjon examined manufacturing exports in Central Asian countries using a gravity trade model. However, they did not analyse their linkage with GVC.[16]

2 Post-Soviet countries' GVC backward participation

In this section, we illustrate the extent of backward participation of GVC in the manufacturing sector of post-Soviet countries using the UNCTAD-Eora database. Regarding GVC forms, Koopman et al. presented the following two types of participation in a vertical specialisation chain:

$$\text{GVC Participation} = FV/E + IV/E \quad (1)$$

where FV, IV, and E represent 'foreign value-added embodied in gross exports', 'domestic value-added embodied as intermediate inputs in other countries' gross exports', and 'gross exports', respectively.[8] The first item (FV/E), representing downstream GVC participation, corresponds to GVC backward participation in this study, while the second item (IV/E), showing upstream GVC participation, is called GVC forward participation, following, for example, the World Bank (2020).[6]

In this study, we focus on backward participation in the manufacturing sector because it is still at a premature stage in post-Soviet economies, as shown in Table 1. Their manufacturing exports depend on foreign inputs and have less capacity to supply industrial inputs (materials, parts, and components for manufacturing) to third countries' exports in their GVC participation process (manufacturing in post-Soviet economies shows a downstream rather than an upstream contribution to GVC). GVC backward participation is significant in the development of manufacturing in emerging market economies, including post-Soviet countries, because participation could involve intermediate inputs containing foreign technology. This can boost the competitiveness of their exports by facilitating the combination of foreign technology with their own labour, capital, and technology (World Bank, 2016).[17]

The UNCTAD-Eora database used in this study offers GVC data with global coverage (189 countries and a 'rest of the world' region) and a time series from 1990 to 2017. The database methodology was described by Casella et al.[5] and provides the country/sector by a country matrix of value-added decomposition in trade.[18] The UNCTAD-Eora database has the following limitations for empirical analyses: 1) the data at the national level for non-OECD small countries are based on assumptions and simulations rather than actual data; and 2) in the balancing process of the data matrix, the relative weight of the adjustment falls disproportionally on the smaller economies. However, Casella et al. and Aslam et al. conducted cross-validation tests between the UNCTAD-Eora and OECD TiVA databases and confirmed their statistical consistency. [18,19] Therefore, we use the UNCTAD-Eora database covering post-Soviet economies in this study. The database makes it possible to decompose the gross exports of countries and their sectors into home and foreign countries' value-added with each country's origin. Using this database, we compute the GVC backward participation in the manufacturing industries[6] of post-Soviet economies in terms of the foreign value-added embodied in gross exports as the percentage of gross exports. We also show the foreign value-added of post-Soviet economies by foreign country origins in terms of the percentage of total foreign value-added.

The other indicators used in this section are per capita GDP in real terms and the logistics performance index (LPI). The per capita GDP data in real terms, representing the development stage of the economies, are retrieved from the UNCTAD Stat database[7] in terms of 'US dollars at constant prices (2015) per capita'. LPI is sourced from the World Bank[8] and measures the performance of customs, infrastructure,

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[5] Value-added-based trade data originated from the work of the OECD and WTO as the 'Trade in Value Added (TiVA)' dataset (see OECD and WTO, 2012).

[6] The manufacturing sector is extracted from the matrix by reorganizing the industry and commodity classifications, as shown in the Appendix.

[7] See the website: https://uncta dstatunctad.org/EN/

[8] See the website: https://lpi.world bank.org/

international shipments, logistics quality and competence, tracking and tracing, and timeliness, taking a value ranging from 1 (very low in performance) to 5 (very high). This study targeted 14 post-Soviet countries: Armenia, Belarus, Estonia, Georgia, Kazakhstan, Kyrgyz, Latvia, Lithuania, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan.[9]

Table 2 shows manufacturing sectors as a percentage of total manufacturing gross exports in the post-Soviet countries. To demonstrate comparative advantages of individual economies, Malaysia and Thailand are also included in the table. The main findings are summarized as follows. First, resource-rich countries such as Azerbaijan, Kazakhstan, Russia, Turkmenistan, and Uzbekistan have relatively larger shares in petroleum and chemical products. Second, Georgia, Moldova and Tajikistan have their comparative advantages in traditional sectors such as food and textile products. Third, compared to Malaysia and Thailand, the post-Soviet economies have lower shares in machinery sectors; less than 30 percent (except Armenia) in electrical and machinery sectors against Malaysia (57.9 percent) and less than 10 percent in transport equipment against Thailand (24.2 percent). This implies that the post-Soviet economies are somewhat weak in sophisticated sectors involving multi-layered production processes typically seen in GVC activities.

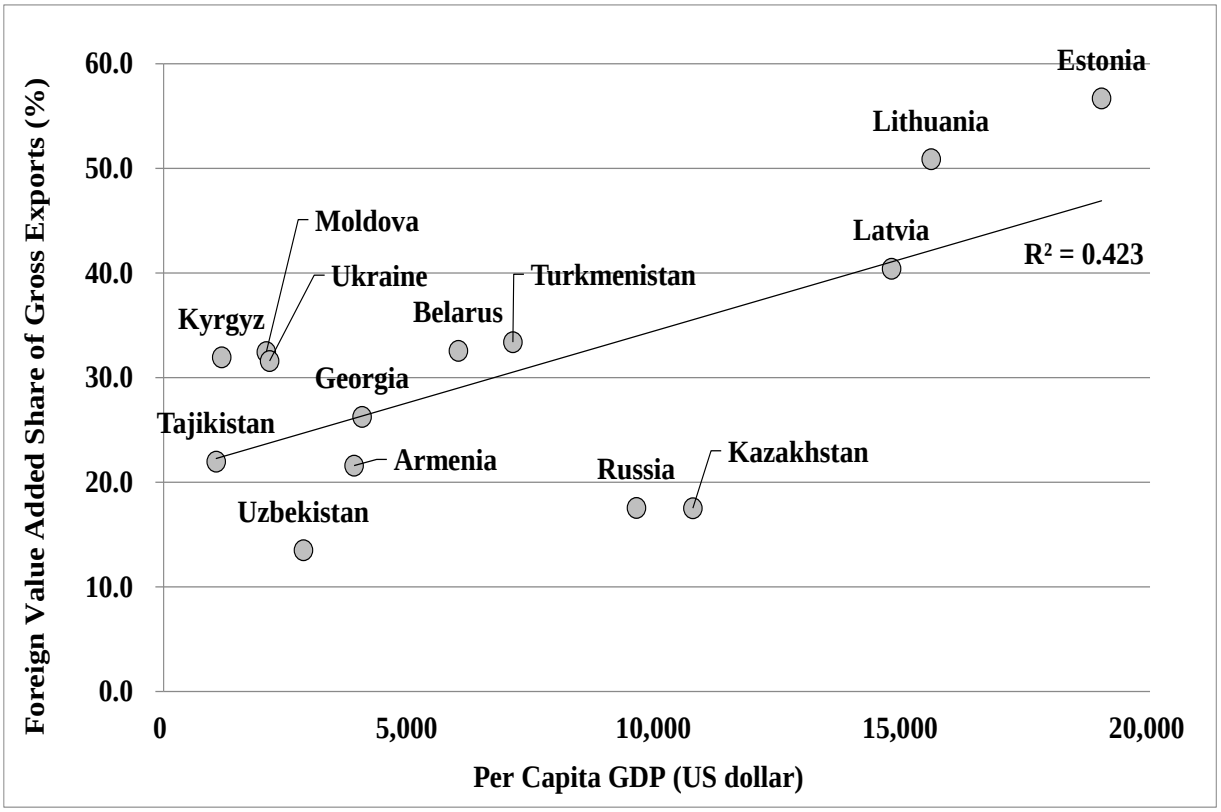
Figure 1 displays the relationship between GVC backward participation (the foreign value-added share of gross exports) in manufacturing and per capita GDP in real terms in the post-Soviet countries in 2017. This shows a positive correlation between them and a gap in the degree of GVC backward participation between high- and middle-income economies. Table 3 presents the foreign value-added share of foreign country origins in the post-Soviet countries in 2017. Large shares of Russia, China, and Germany were commonly observed in the sample countries. Russia ranked first as the foreign value-added share in Georgia, Kazakhstan, Lithuania, Ukraine, and Uzbekistan; China stood first in Estonia and Kyrgyz; and Germany was first in Lativia. Figure 2 displays the relationship between GVC backward participation in manufacturing (in 2017) and LPI (in 2018) in the sample economies, which is one of the main focuses of this study. This reveals that deeper GVC participation is positively correlated with a higher level of logistics performance. For instance, Estonia and Lithuania with higher GVC participations have higher LPI indexes; on the other hand, Tajikistan and Uzbekistan with lower GVC participations have lower LPI indexes. This observation is statistically evaluated using a more sophisticated method as described in the subsequent section.

[9] Azerbaijan is excluded from the sample because it does not have the data for LPI.

Table 2: Manufacturing sector's shares in gross exports (as percentage of total manufacturing) in 2017

	Food Products	Textile Products	Wood Products	Petroleum & Chemical Products	Metal Products	Electrical & Machinery	Transport Equipment	Other
Armenia	11.1	4.7	1.9	11.3	31.0	36.6	0.7	2.6
Azerbaijan	14.7	7.8	0.7	43.2	11.0	17.6	4.3	0.7
Belarus	8.4	11.7	6.7	32.4	10.7	28.0	0.9	1.3
Estonia	11.9	15.5	16.4	9.6	11.3	24.0	5.7	5.7
Georgia	38.2	2.0	4.4	14.4	18.3	16.6	4.8	1.3
Kazakhstan	2.0	0.5	0.1	40.5	49.0	4.0	1.7	2.2
Kyrgyz	9.0	19.2	0.8	23.5	4.6	28.3	5.7	8.9
Latvia	14.7	17.6	21.1	15.2	11.5	13.2	3.1	3.6
Lithuania	17.4	25.0	9.5	20.9	7.5	12.1	2.2	5.3
Moldova	26.0	18.4	7.6	10.5	12.3	13.5	6.4	5.3
Russia	9.8	2.0	2.8	40.9	34.9	7.0	0.2	2.4
Tajikistan	10.6	39.3	0.5	7.9	29.5	7.7	3.0	1.6
Turkmenistan	4.4	43.1	0.1	45.8	1.1	3.6	1.6	0.3
Ukraine	6.7	4.9	2.1	25.3	33.9	18.8	5.2	3.1
Uzbekistan	8.9	31.3	0.7	27.2	15.2	7.6	2.8	6.4
Malaysia	6.1	3.1	7.7	16.3	4.5	57.9	1.2	3.0
Thailand	14.4	8.3	2.5	17.1	3.2	19.8	24.2	10.5

Source: Author's calculation based on UNCTAD-Eora database.



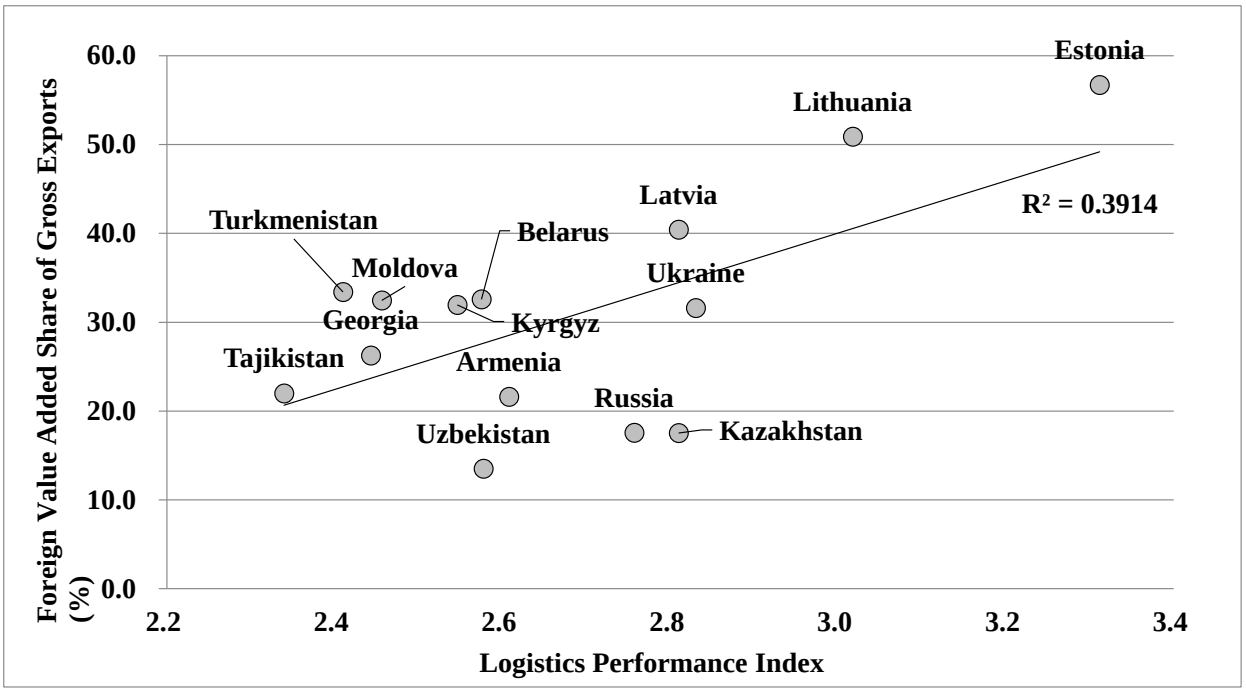
Source: Author's calculation based on UNCTAD-Eora database and UNCTAD Stat

Figure 1: Relationship between GVC backward participation in manufacturing and per capita GDP in post-Soviet countries in 2017

Table 3: Foreign value-added share by foreign country origins in post-Soviet countries in 2017

	Foreign country origins (% of foreign value-added)						
Armenia	Iran	Germany	Russia	UAE	USA	Turkey	China
	13.7	9.0	7.9	6.7	6.0	5.9	5.2
Belarus	Jordan	Bangladesh	China	Tanzania	Viet Nam	Myanmar	Singapore
	6.5	6.1	5.1	5.0	4.9	4.3	3.5
Estonia	China	Germany	Finland	Russia	Sweden	USA	UK
	18.0	11.4	9.9	8.9	5.7	3.4	3.1
Georgia	Russia	China	Germany	Turkey	Azerbaijan	USA	Ukraine
	14.6	10.4	8.0	6.5	5.9	4.8	4.0
Kazakhstan	Russia	China	Germany	USA	UK	Ukraine	Turkey
	40.1	6.7	5.6	5.4	3.0	2.5	2.1
Kyrgyz	China	Russia	Uzbekistan	USA	Kazakhstan	Germany	Turkey
	7.8	7.7	5.9	5.7	4.0	3.8	2.7
Latvia	Germany	Russia	China	Lithuania	Sweden	Poland	Finland
	14.9	14.1	11.8	4.7	4.3	3.5	3.0
Lithuania	Russia	Germany	Netherlands	China	Poland	Italy	USA
	26.2	10.8	7.7	7.5	4.0	3.5	3.3
Moldova	Panama	USA	China	Australia	India	Japan	Iran
	6.2	4.9	4.6	3.8	3.5	2.9	2.3
Russia	USA	Germany	Ukraine	China	Belarus	Poland	Netherlands
	17.5	9.4	8.2	8.1	4.4	3.5	2.9
Tajikistan	Iran	China	Russia	India	Turkey	Germany	Kazakhstan
	17.4	8.2	5.3	5.1	4.5	4.4	3.9
Turkmenistan	UAE	Iran	Russia	Ukraine	Turkey	China	Kazakhstan
	15.7	12.5	11.7	7.1	6.7	5.9	4.7
Ukraine	Russia	Germany	China	Poland	USA	Italy	Turkmenistan
	37.0	9.5	6.0	4.3	3.3	3.1	2.4
Uzbekistan	Russia	China	USA	Turkey	Germany	Iran	Kazakhstan
	11.3	6.8	5.9	4.6	4.4	4.4	4.2

Source: Author's calculation based on UNCTAD-Eora database



Source: Author's calculations based on the UNCTAD-Eora database and the World Bank

Figure 2: Relationship between GVC backward participation in manufacturing (in 2017) and LPI (in 2018) in post-Soviet countries

3 Econometric analysis

In this section, we conduct an econometric analysis by estimating a structural gravity trade model to verify the quantitative linkage between backward participation in GVCs and the logistics performance of the host country, targeting post-Soviet economies. We first specify the estimation models and sample data and then present the estimation outcomes and discussion.

3.1. Specification of estimation models

We apply the structural gravity trade model to examine manufacturing GVC by using directional fixed effects (Equation 2) and the logistics performance of host countries instead of the host country's fixed effects (Equation 3). The models are specified as follows.

$$\ln FVA_{ij,t} = \alpha_0 + \mu_{ij} + \pi_i + \chi_j + \nu_t + \varepsilon_{ij,} \quad (2)$$

$$\ln FVA_{ij,t} = \beta_0 + \mu_{ij} + \beta_1 LPI_{i,t} + \chi_j + \nu_t + \varepsilon_{ij,t} \quad (3)$$

where i, j, and t denote host countries (receiving foreign value-added in exports), origin countries (offering foreign value-added in exports), and trading years, respectively. FVA is the foreign value-added in exports in manufacturing; μ_{ij} is the pair fixed effects between countries i and j; π_i and χ_j are the fixed effects of countries i and j, respectively; LPI is the logistics performance index; ε is an error term; $\alpha_{0,}$ $\beta_{0,}$ and β_1 are the estimated coefficients of Equations (2) and (3), respectively; and ln represents a logarithm form. LPI in Equation (3) contains the overall index and its components: customs (LPI_cus), infrastructure (LPI_inf), international shipments (LPI_shp), logistics quality and competence (LPI_lgs), tracking and tracing (LPI_ttr), and timeliness (LPI_tim). These LPI indices were inserted separately as independent regressors

in the equation because they have a multicollinearity problem. Table 4 reports the bivariate correlations and variance inflation factor (VIF), a method for measuring the level of collinearity between regressors. It shows that the indices have a high bivariate correlation in each combination ranging between 0.6 and 0.9 and high VIF values that are far beyond the criteria of collinearity, namely, 10 points.

Table 4: Correlation matrix and VIF

	LPI	LPI_cus	LPI_inf	LPI_shp	LPI_lgs	LPI_ttr	LPI_tim
LPI	1.000						
LPI_cus	0.885	1.000					
LPI_inf	0.883	0.829	1.000				
LPI_shp	0.893	0.752	0.712	1.000			
LPI_lgs	0.950	0.821	0.870	0.808	1.000		
LPI_ttr	0.906	0.729	0.748	0.750	0.841	1.000	
LPI_tim	0.893	0.677	0.679	0.777	0.828	0.828	1.000
VIF	$6.210*10^3$	$2.306*10^2$	$1.605*10^2$	$2.626*10^2$	$1.650*10^2$	$2.204*10^2$	$2.821*10^2$

Source: Author's estimation

Piermartini and Yotov proposed a structural gravity model which offered the following six recommendations: (i) use panel data, (ii) use interval data to allow for adjustment in trade flows, (iii) include intra-national trade flows, (iv) use directional time-varying fixed effects, (v) employ pair fixed effects, and (vi) estimate gravity using the Poisson pseudo maximum likelihood (PPML) method.[15] Equation (2) conforms to the above recommendation with some modifications owing to the data property. Our estimation method satisfies (i) and (ii) as explained in the next section. We do not apply (iii) because, in this study, we focus on GVC comparisons among post-Soviet economies. Regarding (iv), we adopt a time-invariant effect (π_i and χ_j) because the sample period is only 11 years, from 2007 to 2017, and insert a time dummy (ν_t) to reflect the time-varying factors. Country fixed effects absorb all observable and unobservable country-specific characteristics that influence bilateral trade. We treat the high-income countries of Estonia, Latvia, and Lithuania as benchmark host countries, because they exhibit higher performance in GVC participation and logistics, as demonstrated in Section 2. We incorporate (v) into Equation (2) in terms of μ_{ij}, accounting for the effects of all time-invariant bilateral trade costs. Following (vi), we apply the PPML and ordinary least squares (OLS) estimators to manage the heteroscedasticity of trade data.

The question is: where are the service-link costs positioned in this equation? As mentioned in the introduction, service-link costs contain not only bilateral trade costs, such as transportation costs, but also country-specific costs, such as the costs of operating in a given country. Thus, the service-link costs occupy some portions of the fixed effects of the host and origin countries (π_i and χ_j) and the pair fixed effects (μ_{ij}). We focus on the logistics performance of the host country as part of the service-link costs. Thus, the major concern in Equation (2) is the volume of the host country's fixed effects (π_i). In this context, Equation (3) replaces the fixed effects (π_i) with the logistics performance ($LPI_{i,t}$) of host countries. Then, we demonstrate the contribution of the host country's logistics performance to country-specific fixed effects using the estimated coefficient β_1.

3.2. Data

The FVA and LPI data are retrieved from the UNCTAD-Eora and World Bank databases, respectively, as described in Section 2. The sample economies and periods are set as follows. The host countries are the 14 post-Soviet countries, as in Section 2, and the origin countries of FVA are selected from the top seven trading partners with the host countries, as shown in Table 3, which covers more than half of the total FVA on average in the host countries. For the sample period, we select discrete years such as 2007, 2010, 2012, 2014, 2016, and 2017 because of the LPI data availability constraint.[10] We then constructed panel data for six years with a combination of host and origin countries ($6 \times 14 \times 7 = 588$) for the estimation.

For the subsequent panel estimation, we investigate the stationary property of the constructed panel data of ln FVA and LPI by employing the following panel unit root tests: the Levin, Lin, and Chu test as a common unit root test and the Fisher-ADF (Augmented Dickey-Fuller) and Fisher-PP (Philips-Perron) tests as individual unit root tests.[20,21,22,23] The common unit root test assumes that there is a common unit root process across cross-sections, whereas the individual unit root test allows for individual unit root processes that vary across cross sections. These tests are conducted based on the null hypothesis that a level of panel data has a unit root by including 'intercept' in the test equations. Table 5 reports that all the tests reject the null hypothesis of a unit root at the 99 percent significance level for all variables. Thus, using the level of panel data for estimation is justified in this study.

[10] The UNCTAD-Eora database has data up to 2017. The LPI data for 2018 is applied as 2017 data because the LPI does not have 2017 data.

Table 5: Panel unit root tests

	Levin, Lin, and Chu Test	Fisher-ADF Chi-square	Fisher-PP Chi-square	Im, Pesaran, and Shin W-stat
ln (FVA)	-25.842 ***	351.194 ***	602.400 ***	-5.184 ***
LPI	-47.373 ***	423.403 ***	578.876 ***	-11.329 ***
LPI_cus	-21.499 ***	286.212 ***	371.256 ***	-5.330 ***
LPI_inf	-26.030 ***	272.602 ***	399.744 ***	-4.899 ***
LPI_shp	-35.725 ***	474.218 ***	619.338 ***	-11.823 ***
LPI_lgs	-22.562 ***	331.651 ***	474.004 ***	-6.880 ***
LPI_ttr	-35.173 ***	407.355 ***	540.026 ***	-9.654 ***
LPI_tim	-26.902 ***	353.682 ***	378.350 ***	-7.687 ***

Note: *** denotes statistical significance at 99 percent level.
Source: Author's estimation.

3.3. Estimation outcomes and discussion

Table 6 reports the estimation outcomes, where columns (i) and (ii) correspond to Equation (2) and columns (iii)–(x) to Equation (3). The OLS estimation is presented by columns (i) and (iii) and the PPML by columns (ii) and (iv)–(x). As both OLS and PPML estimations show similar results, we focus mainly on those from the PPML estimation.

Table 6: Estimation outcomes

Estimation	(i)	(ii)	(iii)	(iv)
Equation	(2)	(2)	(3)	(3)
Methodology	OLS	PPML	OLS	PPML
LPI			3.308 ***	3.440 ***
			(27.886)	(11.095)
Dummy: Armenia	-2.939 ***	-2.940 ***		
	(-12.802)	(-31.525)		
Dummy: Belarus	-2.652 ***	-2.660 ***		
	(-10.003)	(-6.953)		
Dummy: Georgia	-2.332 ***	-2.336 ***		
	(-10.775)	(-8.295)		
Dummy: Kazakhstan	-0.192	-0.193 **		
	(-0.838)	(-2.144)		
Dummy: Kyrgyz	-2.919 ***	-2.921 ***		
	(-12.713)	(-33.249)		
Dummy: Moldova	-5.417 ***	-5.401 ***		
	(-23.592)	(-21.125)		
Dummy: Russia	2.285 ***	2.279 ***		
	(9.955)	(11.130)		
Dummy: Tajikistan	-4.199 ***	-4.196 ***		
	(-12.267)	(-12.947)		
Dummy: Turkmenistan	-0.650	-0.651 *		
	(-1.280)	(-1.952)		
Dummy: Ukraine	0.436 *	0.433 ***		
	(1.899)	(4.865)		
Dummy: Uzbekistan	-2.589 ***	-2.583 ***		
	(-11.959)	(-9.373)		
i Fixed Effects	Yes	Yes	No	No
j Fixed Effects	Yes	Yes	Yes	Yes
i,j Fixed Effects	Yes	Yes	Yes	Yes
t Fixed Effects	Yes	Yes	Yes	Yes
RESET p-vals	0.484	0.882	0.000	0.002

Estimation	(v)	(vi)	(vii)	(viii)	(ix)	(x)
Equation	(3)	(3)	(3)	(3)	(3)	(3)
Methodology	PPML	PPML	PPML	PPML	PPML	PPML
LPI_cus	3.068 *** (6.070)					
LPI_inf		3.197 *** (6.683)				
LPI_shp			3.148 *** (6.571)			
LPI_lgs				3.494 *** (10.282)		
LPI_ttr					3.098 *** (6.648)	
LPI_tim						2.712 *** (8.393)
i Fixed Effects	No	No	No	No	No	No
j Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
i,j Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
t Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
RESET p-vals	0.000	0.000	0.000	0.002	0.000	0.000

Note: ***, **, and * denote statistical significance at the 99, 95, and 90 percent levels, respectively. The T-statistics are shown in parentheses.
Source: Author's estimation.

The major concern in the results of Equation (2) are the coefficients of the fixed effects in host countries (those in origin countries and the coefficients of the pair fixed effects are omitted for brevity). Most coefficients show significantly negative values, except those of Russia, Turkmenistan, and Ukraine, because the benchmark countries (Estonia, Latvia, and Lithuania) show high performance in GVC participation. This result is consistent with the observations shown in Figure 1. Examining the Ramsey RESET p-values at the bottom of Table 6, both OLS and PPML estimations of Equation (2) pass the misspecification test. The test detects model specification errors from the possible omission of variables with the null hypothesis that the model does not suffer from misspecification errors. The hypothesis is not rejected in the estimation of Equation (2), thereby justifying the model specification.

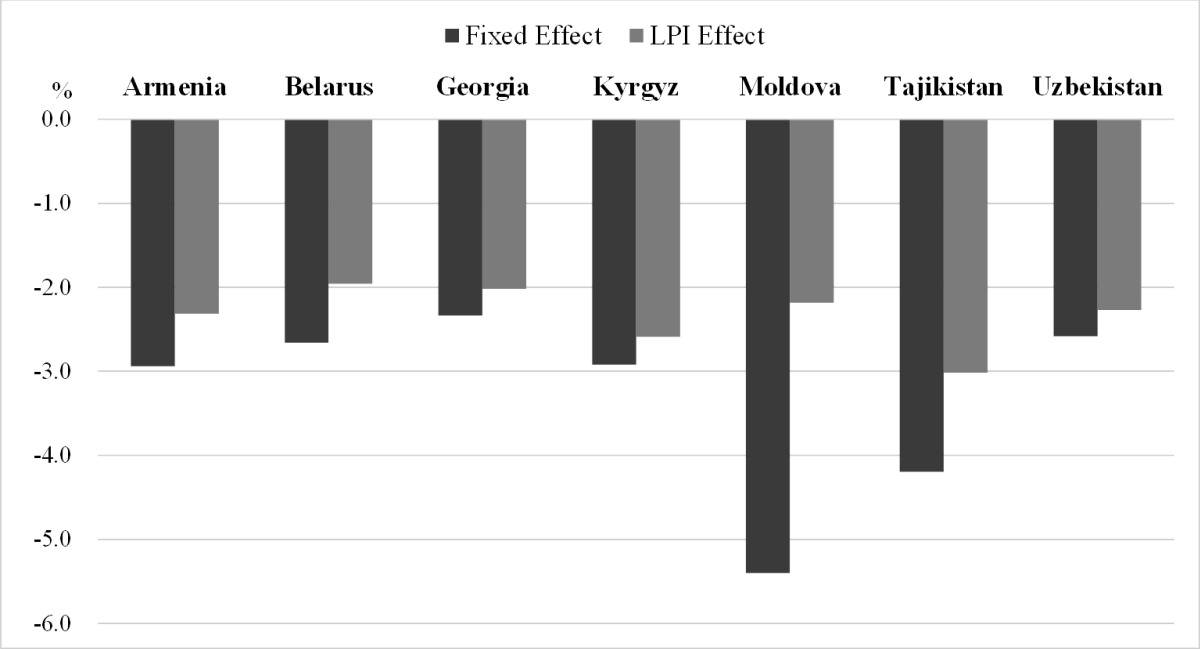
Turning to the outcomes of Equation (3), replacing the fixed effects with the LPI of host countries, the coefficients of LPI have significantly positive values, as expected. The overall index and the six components have almost the same size of positive coefficients, approximately three. However, the RESET p-values suggest that the OLS and PPML estimations of Equation (3) do not pass the misspecification test, probably because of omitted variables in the estimations, implying that logistics performance itself cannot cover all host country-specific fixed effects. Further, the significantly positive coefficients of LPI indicate that the logistics performance of host countries has some effect on explaining the degree of their GVC backward participation. This result leads to questioning the statistical degree of logistics performance's contribution to the fixed effects on host countries that reflect the extent of GVC backward participation.

Table 7 and Figure 3 compare the host countries' fixed effects and their effects on logistics performance, with a focus on the overall LPI during the period average of 2007–2017. Column (a) of Table 6 displays the coefficients of the host countries' fixed effects in Column (ii) (PPML estimation) in Table 6. Column (b) shows the period averaged LPIs of the host countries, and Column (c) computes their LPI deviations from the average LPI of the benchmark countries (Estonia, Latvia, and Lithuania). The LPI effects in Column (d) are then calculated by multiplying the LPI deviations by the LPI coefficient (3.440) estimated in Column (ii) of Table 6. In Column (e), the LPI effects in Column (d) are divided by the coefficients of the fixed effects in Column (a) for comparison purposes. Kazakhstan, Russia, Turkmenistan, and Ukraine are excluded from the ratio calculation in Column (e) because Russia and Ukraine have positive fixed effects, and Kazakhstan and Turkmenistan do not have robust fixed effects as their coefficients are insignificant in the OLS estimation in Column (i) of Table 6.

Table 7: Host country's fixed effect and logistics performances

	Host Countries' Fixed Effects	LPI	LPI (b) - Benchmark LPI	(c) × 3.440 *** [coefficient]	(d) / (a)
	(a)	(b)	(c)	(d)	(e)
Armenia	-2.940 ***	2.452	-0.673	-2.316	0.788
Belarus	-2.660 ***	2.556	-0.569	-1.958	0.736
Georgia	-2.336 ***	2.538	-0.587	-2.019	0.865
Kazakhstan	-0.193 **	2.652	-0.473	-1.627	-
Kyrgyz	-2.921 ***	2.372	-0.753	-2.590	0.886
Moldova	-5.401 ***	2.490	-0.635	-2.185	0.405
Russia	2.279 ***	2.597	-0.528	-1.815	-
Tajikistan	-4.196 ***	2.249	-0.876	-3.014	0.718
Turkmenistaı	-0.651 *	2.309	-0.816	-2.808	-
Ukraine	0.433 ***	2.754	-0.371	-1.275	-
Uzbekistan	-2.589 ***	2.465	-0.660	-2.271	0.879

Note: ***, **, and * denote statistical significance at the 99, 95, and 90 percent levels, respectively
Source: Author's estimation



Source: Author's calculation based on Table 7

Figure 3: Comparison between host country's fixed effect and LPI effect

The results in Column (e) of Table 7 and Figure 3 suggest that the host countries' logistics performances account for their country-specific effect to a comparable extent, with a reasonable range of the LPI-fixed effect ratio of 0.7–0.8, except for Moldova. This finding implies the existence of a robust linkage between host countries' logistics performance and the degree of their GVC backward participation in post-Soviet economies. Our findings on the linkage between GVC participation and logistics performance are in line with those in emerging ASEAN economies. [14,24] This outcome is also consistent with the analyses by the World Bank, which show that GVC integration is highly sensitive to logistics performance.[6,17]

4 Conclusions

Most post-Soviet countries have been plagued with an underdeveloped manufacturing sector that also lacks GVC linkages, despite the heterogeneities in their economic profiles. In this study, we attempted to assess the degree of backward participation of GVC in manufacturing in post-Soviet countries and examine its quantitative linkage with host countries' logistics performance as a service-link component. This study's major contributions were to analyse post-Soviet countries in the context of GVC participation and logistics performance for the first time, use the UNCTAD-Eora database to investigate GVC linkage, and employ a structural gravity trade model setting for the specification of estimated equations.

The statistical observations presented a positive correlation between GVC backward participation in manufacturing and income level in the post-Soviet economies and a gap in GVC participation among them. There was higher GVC participation in high-income countries (Estonia, Latvia, and Lithuania) and lower GVC participation in middle-income countries. The results also illustrate that higher GVC backward participation is positively correlated with a higher level of logistics performance. The empirical estimation using the structural gravity trade model identifies a quantitative linkage between GVC backward participation and the logistics performance of the host country. Factor analysis also demonstrated that the level of logistics performance accounts for 70–80 percent of the degree of GVC backward participation. Thus, our hypothesis that the lack in GVC backward participations in middle-income post-Soviet countries

is associated with their low logistics performances was empirically verified, thereby implying the necessity of their policy responses in this field.
The policy implication of this study is that a policy space for post-Soviet economies should exist, particularly for middle-income countries, to improve their logistics performance (as this is a manageable elements) by erasing the Soviet era's negative legacy. Improving logistics performance contributes to backward GVC participation, thereby attracting foreign technology through foreign intermediate inputs and leading to manufacturing development by utilising and upgrading their comparative advantages, which would be an engine of economic growth.
A limitation of this study is the lack of detailed studies on individual countries. Thus, further research should be conducted to extract country-specific policy prescriptions and recommendations based on scientific evidence to improve the logistics performance for GVC participation in manufacturing. Another limitation is that this study relies only on the structural gravity trade approach. However, there are other approaches, including ordinary panel estimations. A comparison of the results among different approaches may lead to a robust conclusion.

Conflict of interest: The author declares no conflicts of interest in this paper.

References

Kaldor N (1967) Strategic Factor in Economic Development. Ithaca, Cornell University.

Rodrik D (2013) Unconditional convergence in manufacturing. Q J Econ, 128(1), 165–204.

UNCTAD (2013) World investment report—global value chains: Investment and trade for development. New York and Geneva, The United Nations.

Kimura F (2006) International production and distribution networks in East Asia: Eighteen facts, mechanics, and policy implications. Asian Econ Policy Rev, 1(2), 326–344.

Kimura F, Takahashi Y, Hayakawa K (2007) Fragmentation and parts and components trade: Comparison between East Asia and Europe. N Am J Econ Finance, 18(1), 23–40.

World Bank (2020) World development report 2020: Trading for development in the age of global value chains. Washington, The World Bank.

Hummels D, Ishii J, Yi KM (2001) The nature and growth of vertical specialization in world trade. J Int Econ, 5, 75–96.

Koopman R, Powers W, Wang Z, Wei SJ (2010) Give credit where credit is due: Tracing value added in global production chains. NBER Working Paper, No. 16426.

Koopman R, Wang Z, Wei SJ (2014) Tracing value-added and double counting in gross exports. Am Econ Rev, 104, 459–494.

Jones RW, Kierzkowski H (1990) The role of services in production and international trade: A theoretical framework, In: Jones, R.W. and Krueger, A. (eds.), The Political Economy of International Trade: Essays in Honor of Robert E. Baldwin. Oxford, Blackwell.

Jones RW, Kierzkowski H (2005) International trade and agglomeration: an alternative framework. J Econ, 10, 1–16.

Deardorff AV (2001) Fragmentation in simple trade models. N Am J Econ Finance, 12, 121–137.

Gereffi G (2018) Global Value Chains and Development: Redefining the Contours of 21st Century Capitalism. Cambridge, Cambridge University Press.

Taguchi H, Thet MS (2021) Quantitative linkage between global value chains' backward participation and logistics performance in the host country: a structural gravity model analysis of emerging ASEAN economies. Asia-Pacific Journal of Regional Science, 5, 453–475.

Piermartini R, Yotov, YV (2016) Estimating trade policy effects with structural gravity. WTO Staff Working Papers, ERSD-2016-10.

Taguchi H, Amirjon A (2021) Manufacturing exports and institutional qualities in Central Asian countries. Asia-Pacific Journal of Accounting & Economics Online. https://doi.org/10.1080/16081625.2021.2012703

World Bank (2016) Making global value chains work for development. Washington: The World Bank.

Casella B, Bolwijn R, Moran D, Kanemoto K (2019) Improving the analysis of global value chains: The UNCTAD-Eora Database. Transnatl Corp, 26(3), 115–142.

Aslam A, Novta N, Rodrigues-Bastos F (2017) Calculating Trade in Value Added. IMF Working Paper, No. 17/178.

Levin A, Lin CF, Chu C (2002) Unit root tests in panel data: Asymptotic and finite-sample properties. J Econom, 108, 1–24.

Choi I (2001) Unit root tests for panel data. J Int Money Finance, 20, 249–272.

Maddala GS, Wu SA (1999) Comparative study of unit root tests with panel data and a new simple test. Oxf Bull Econ Stat, 61, 631–652.

Im KS, Pesaran MH, Shin Y (2003) Testing for unit roots in heterogeneous panels. J Econom, 115, 53–74.

Taguchi H, Zhao J (2022) China's global value chain linkage and logistics performances in emerging ASEAN economies. International Studies of Economics, 17, 126–155.

Appendix Table A 1: Classification for manufacturing

Sample Economies	Items of Manufacturing
Armenia Belarus Moldova Tajikistan Turkmenistan	Food & Beverages; Textiles and Wearing Apparel; Wood and Paper; Petroleum, Chemical and Non-Metallic Mineral Products; Metal Products; Electrical and Machinery; Transport Equipment; Other Manufacturing
Estonia Latvia Lithuania	Products of agriculture, hunting and related services; Products of forestry, logging and related services; Fish and other fishing products; services incidental of fishing; Coal and lignite, peat; Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying; Uranium and thorium ores; Metal ores; Other mining and quarrying products; Food products and beverages; Tobacco products; Textiles; Wearing apparel; furs; Leather and leather products; Wood and products of wood and cork (except furniture), articles of straw and plaiting materials; Pulp, paper and paper products; Printed matter and recorded media; Coke, refined petroleum products and nuclear fuels; Chemicals, chemical products and man-made fibers; Rubber and plastic products; Other non-metallic mineral products; Basic metals; Fabricated metal products, except machinery and equipment; Machinery and equipment n.e.c.; Office machinery and computers; Electrical machinery and apparatus n.e.c.; Radio, television and communication equipment and apparatus; Medical, precision and optical instruments, watches and clocks; Motor vehicles, trailers and semi-trailers; Other transport equipment; Furniture, other manufactured goods n.e.c.; Secondary raw materials
Georgia	Cereals and other crops n.e.c.; Fruit, nuts, beverage and spice crops; Vegetables, horticultural specialties and nursery; Live animals and animal products; Agricultural services; Products of forestry, logging and related services; Fish and other fishing products, services incidental to fishing; Coal and lignite, peat; Crude petroleum and natural gas, services incidental to oil and gas extraction excluding surveying; Uranium and thorium ores, metal ores; Other mining and quarrying products; Grain mill products, starches and starch products, prepared animal feeds; Bread, fresh pastry goods and cakes, rusks and biscuits, preserved pastry goods and cakes; Meat and meat products, processed and preserved fish and fish products; Animal and vegetable oils and fats; Dairy products and ice cream; Other food products; Mineral waters and soft drinks; Alcoholic beverages; Tobacco products; Textiles and wearing apparel, furs; Leather and leather products; Wood and products of wood and cork (except furniture), articles of straw and plaiting materials; Pulp, paper and paper products; Coke, refined petroleum products and nuclear fuels, industrial gases; Chemicals, chemical products and man-made fibres; Rubber and plastic products; Other non-metallic mineral products; Basic metals and fabricated metal products; Office machinery and computers, machinery, equipment and apparatus n.e.c.; Radio, television and communication equipment and apparatus, medical, precision and optical instruments, watches and clocks; Transport equipment; Furniture, other manufactured goods n.e.c.

Sample Economies	Items of Manufacturing
Kazakhstan Ukraine Uzbekistan	Oil Products; Refineries; Gas & Gas Products; Coal; Combustible Shales; Peat; Ferrous Ores; Ferrous Metals; Coking Products; Fire Resistant Mater; Metal Products; Non-ferrous Ores; Non-ferrous Metals; Mineral Chemistry and Basic Chemicals; Chemical Fibers; Synthetic Resins; Plastic Products; Paints & Lacquers; Synthetic Paints; Synthetic Rubber; Organic Chemicals; Tires; Rubber & Asbestos; Other Chem. Products; Energy & Power Equip.; Hoisting Technology; Mining M&E; Transportation Railway Equipment; Electrotechnical M&E; Cable Products; Pumps & Chem. Equip.; Machine Tools; Forging/Pressing M&E; Casting M&E; Precision Instruments; Synthetic Diamonds; Tools and Dies; Autos & Parts; Bearings; Tractors & Agri. M&E; Construction M&E; Communal M&E; Light Industry M&E; Processed Food M&E; Trade & Dining M&E; Printing M&E; Household Appliances; Sanitary Engineering; Shipbuilding; Radio Electronics; Other Industries M&E; Metal Construction; Metal Products; M&E Repair; Logging; Sawmills & Lumber; Plywood; Furniture; Paper & Pulp; Wood Chemistry Prod.; Cement; Asbestos Products; Roofing & Insulation; Prefab Concrete; Wall Materials; Construction Ceramics; Linoleum Products; Other Construction Materials; Glass & Porcelain; Cotton Products; Flax Products; Wool Products; Silk Products; Hosiery/Knitwear; Other Textile Prod.; Sewn Goods; Leather; Sugar; Bread & Baked Prod.; Confections; Vegetable Oils; Perfume Oils; Distilleries; Wines; Fruit/Vegetables; Tobacco; Other Food; Meat Products; Dairy Products; Fish Products; Microbiology; Flour & Cereals; Animal Feed; Pharmaceuticals; Medical Equipment; Medical Products; Other Products
Kyrgyz	Flour milling; Sugar refining; Meat processing; Dairy industry; Animal feed industry; Juices, fruits & vegetables processing and canning; Beer and Vodka production; Mineral water; Other food industry; Tobacco processing; Tobacco products (cigarettes); Cotton ginning; Cotton yarn; Cotton fabric; Wool yarn; Wool fabric; Knitted items production (cotton + wool + synthetics); Clothing (cotton + wool + synthetics); Hides and skins processing; Final leather cloths; Shoes, other; Timber production and woodwork; Paper and cardboard production, publishing and printing; Oil refining; Fertilizer production; Paint production; Pharmaceutical production; Other chemicals; Rubber and plastic production; Glass sheets; Bricks; Production of products of concrete, asbestos and cement; Cement; Other non-metal mineral products; Gold; Other metallurgy; Metal fabrics production; Machinery and equipment; House appliances; Electric machines and equipment; Bulbs; Production of spare parts and engines for vehicles; Other machinery and equipment; Furniture production; Other industry sectors and reprocessing
Russia	Food products, beverages and tobacco; Textiles, textile products, leather and footwear; Wood and products of wood and cork; Pulp, paper, paper products, printing and publishing; Coke, refined petroleum products and nuclear fuel; Chemicals excluding pharmaceuticals; Pharmaceuticals; Rubber & plastics products; Other non-metallic mineral products; Iron & steel; Non-ferrous metals; Fabricated metal products, except machinery & equipment; Machinery & equipment, nec; Office, accounting & computing machinery; Electrical machinery & apparatus, nec; Radio, television & communication equipment; Medical, precision & optical instruments; Motor vehicles, trailers & semi-trailers; Building & repairing of ships & boats; Aircraft & spacecraft; Railroad equipment & transport equip nec.; Manufacturing nec; recycling (include Furniture)

Source: The UNCTAD-Eora Global Value Chain Database