Measuring the Impact of Intermediate Import Reduction Using an Input-Output Framework

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- Since February 2022, trade sanctions imposed on Russia contributed to the reduction in intermediate imports and lead to restructuring of supply chains in Russian economy. However, the impact of these measures has been less severe than initially anticipated.

- We calculate the effects of trade sanctions affecting intermediate imports using an input-output approach combined with econometrics tools to simulate output response for certain industries under various import reduction scenarios.

- We examine how the results depend on whether we distinguish between domestic and imported products as different products or distinguish between products only by their kind; we address this problem in terms of output response similarity.

- Our analysis also includes the calculation of output multipliers to account for interindustry linkage effects.

- The method can be readily applied to other economies and to other cases involving reductions in intermediate imports.

Methodology

Data

Multiregional input-output tables (MRIO) developed by the Asian Development Bank (ADB) for the years 2010-2022.

Methodology

Import reduction impact

The reduction in output is proportional to the largest relative change in inter-industry flows.

$$\frac{\Delta X_j}{X_j} = min \frac{\Delta z_{ij}}{z_{ij}}$$

Assumption 1: imported products are not identical to domestically produced goods of the corresponding type.

$$\frac{\Delta X_j}{X_j} = min\left(\frac{\Delta z_{ij}^M}{z_{ij}^M}, \dots, \frac{\Delta z_{nj}^M}{z_{nj}^M}\right)$$

Assumption 2: there is equivalence between domestically produced and imported products.

$$\frac{\Delta X_j}{X_j} = min\left(\frac{\Delta z_{ij}^M}{z_{ij}^M + z_{ij}^D}, \dots, \frac{\Delta z_{nj}^M}{z_{nj}^M + z_{nj}^D}\right)$$

Methodology

Regression analysis

Examining the relationships between the dynamics of intersectoral flows and product output, a panel regression based on time series of sectoral output X_j and intermediate consumption z_{ij} with fixed country-specific effects is estimated.

$$\log X_{jCT} = \beta_d \log Z^d_{ijCT} + \beta_m \log Z^m_{ijCT} + \lambda_T + \alpha_C + \varepsilon_{ijCT}$$

To check the homogeneity of imported and domestic products for the output of a given industry, a quite simple approach is used: the equality of the coefficients for two regressors (imported inputs and domestic inputs) is tested using the standard linear restriction test.

The hypothesis of equality of the coefficients is not rejected => output reacts in the same way to changes in intermediate imports and intermediate domestic products; they can be considered homogeneous.

Otherwise => output has different sensitivities to changes in the volume of intermediate imports or domestic products used; there is no homogeneity.

Methodology

	The impact of changes in intermediate imports of products of one industry	Aggregated impact of changes in intermediate imports of products of several industries
No substitution (NS), Without regression-based estimates	$reduction * \frac{SI}{Im}$	$max(reduction * \frac{SI}{Im})$
Substitution (S), Without regression-based estimates	$reduction * \frac{SI}{Im + D}$	$max(reduction * \frac{SI}{Im + D})$
No substitution (NS), Regression-based estimates	$reduction * coef * \frac{SI}{Im}$	$max(reduction * coef * \frac{SI}{Im})$
Substitution (S), Regression-based estimates	$reduction * coef * \frac{SI}{Im + D}$	$max(reduction * coef * \frac{SI}{Im + D})$

reduction – reduction of imports limited by sanctions, %

coef – elasticity of output with respect to intermediate consumption of products of a given industry, based on regression analysis

SI – the volume of intermediate imports of products of a given industry from countries that have imposed sanctions

Im – volume of intermediate imports of products of a given industry

D – volume of intermediate consumption of domestic products of a given industry/industries

Methodology

Two scenarios are considered, in which imports affected by sanctions imposed by specific countries are initially reduced by **10%** and **50%**, respectively.

In total, **35** countries represented in the ADB MRIO database are classified as having imposed sanctions, including EU member states, Switzerland, Norway, the United Kingdom, the United States, Canada, Australia, Japan, and South Korea.

We analyze the impact of intermediate inputs from **3** sanctioned industries: machinery, electrical and optical equipment, and transport equipment, on the output of **6** sectors: mining and quarrying, machinery, electrical and optical equipment, transport equipment, construction, and air transport.

Results

Reduction of intermediate imports for selected industries, %

Industry	Intermediate input	Sanctioned import share		Reduction of intermediate imports, % imports	
		% intermediate imports	% intermediate input	Scenario	
				10%	50%
Air transport	Electrical and optical equipment	45.41	7.91	4.54	22.71
	Machinery	60.45	27.68	6.05	30.23
	Transport	70.64	28.74	7.06	35.32
Construction	Electrical and optical equipment	45.85	6.71	4.59	22.93
	Machinery	61.84	27.95	6.18	30.92
	Transport	71.78	40.00	7.18	35.89
Electrical and optical equipment	Electrical and optical equipment	47.08	8.61	4.71	23.54
	Machinery	63.98	34.54	6.40	31.99
	Transport	73.51	47.64	7.35	36.76
Machinery	Electrical and optical equipment	45.03	8.71	4.50	22.52
	Machinery	59.39	28.82	5.94	29.70
	Transport	69.75	36.77	6.98	34.88
Mining and quarrying	Electrical and optical equipment	44.65	8.88	4.46	22.32
	Machinery	58.75	27.72	5.88	29.38
	Transport	69.22	32.71	6.92	34.61
Transport	Electrical and optical equipment	42.44	9.56	4.24	21.22
	Machinery	54.04	29.90	5.40	27.02
	Transport	65.15	35.10	6.52	32.57

Results

Testing the hypothesis of coefficient equality for imported and domestically produced goods

Industry	Intermediate input	Test statistics	p-value	
Air transport	Electrical and optical equipment	14.89	0.00	***
	Machinery	3.95	0.05	*
	Transport	9.74	0.00	**
Construction	Electrical and optical equipment	28.86	0.00	***
	Machinery	0.07	0.79	
	Transport	0.10	0.75	
Electrical and optical equipment	Electrical and optical equipment	8.29	0.00	**
	Machinery	3.86	0.05	*
	Transport	4.09	0.04	*
Machinery, nec	Electrical and optical equipment	13.59	0.00	***
	Machinery	1.83	0.18	
	Transport	2.24	0.13	
Mining and quarrying	Electrical and optical equipment	9.92	0.00	**
	Machinery	0.17	0.68	
	Transport	0.09	0.76	
Transport equipment	Electrical and optical equipment	15.35	0.00	***
	Machinery	7.71	0.01	**
	Transport	0.01	0.93	

Results

Equations

Industry	Intermediate input	β	SE	p	
Air transport	Electrical and optical equipment	0.25	0.04	0.00	***
	Machinery	0.27	0.03	0.00	***
	Transport	0.23	0.04	0.00	***
Construction	Electrical and optical equipment	0.20	0.03	0.00	***
	Machinery	0.09	0.03	0.00	**
	Transport	0.04	0.02	0.14	
Electrical and optical equipment	Electrical and optical equipment	0.19	0.06	0.00	**
	Machinery	0.13	0.03	0.00	***
	Transport	0.05	0.02	0.01	**
Machinery, nec	Electrical and optical equipment	0.13	0.03	0.00	***
	Machinery	0.12	0.04	0.00	**
	Transport	0.05	0.03	0.05	
Mining and quarrying	Electrical and optical equipment	0.24	0.04	0.00	***
	Machinery	0.23	0.04	0.00	***
	Transport	0.09	0.04	0.01	**
Transport equipment	Electrical and optical equipment	0.24	0.03	0.00	***
	Machinery	0.18	0.03	0.00	***
	Transport	0.10	0.05	0.03	*

Results

Simple multipliers

	Sector-to-economy multiplier	Sector-to-sector multiplier
Mining and quarrying	1.47	1.03
Machinery, nec	1.95	1.05
Electrical and optical equipment	2.07	1.12
Transport equipment	1.90	1.21
Construction	1.94	1.01
Air transport	2.30	1.01

Results

Impact of reduced intermediate imports from three industries used in transport equipment: industry output

Industry	Scenario	NS	S	Regression-based estimates
Electrical and optical equipment	10%	4.24	0.96	1.00
	50%	21.22	4.78	4.99
Machinery	10%	5.40	2.99	0.96
	50%	27.02	14.95	4.78
Transport	10%	6.51	3.51	0.35
	50%	32.57	17.55	1.77
Aggregate impact	10%	6.51	3.51	1.00
	50%	32.57	17.55	4.99

+ multiplicative effects:

Industry	Scenario	NS	S	Regression-based estimates
Electrical and optical equipment	10%	5.15	1.16	1.21
	50%	25.74	5.80	6.06
Machinery	10%	6.56	3.63	1.16
	50%	32.78	18.13	5.80
Transport	10%	7.90	4.26	0.43
	50%	39.52	21.29	2.15
Aggregate impact	10%	7.90	4.26	1.21
	50%	39.52	21.29	6.06

Results

Impact on industry output

Industry	Intermediate input	NS	S	Regression-based estimates	NS	S	Regression-based estimates
			10%			50%	
Air transport	Electrical and optical equipment	4.57	0.80	1.16	22.86	3.98	5.79
	Machinery	6.09	2.79	1.66	30.43	13.93	8.32
	Transport	7.11	2.89	1.66	35.55	14.47	8.31
Construction	Electrical and optical equipment	4.62	0.68	0.93	23.12	3.38	4.66
	Machinery	6.24	2.82	0.27	31.18	14.09	1.33
	Transport	7.24	4.03	0.14	36.19	20.17	0.72
Electrical and optical equipment	Electrical and optical equipment	5.26	0.96	1.01	26.28	4.80	5.05
	Machinery	7.14	3.86	0.92	35.72	19.28	4.62
	Transport	8.21	5.32	0.42	41.04	26.59	2.10
Machinery, nec	Electrical and optical equipment	4.73	0.91	0.62	23.64	4.57	3.08
	Machinery	6.24	3.03	0.36	31.18	15.13	1.81
	Transport	7.32	3.86	0.21	36.62	19.31	1.04
Mining and quarrying	Electrical and optical equipment	4.59	0.91	1.11	22.94	4.56	5.55
	Machinery	6.04	2.85	0.67	30.19	14.24	3.33
	Transport	7.11	3.36	0.32	35.56	16.81	1.59
Transport equipment	Electrical and optical equipment	5.15	1.16	1.21	25.74	5.80	6.06
	Machinery	6.56	3.63	1.16	32.78	18.13	5.80
	Transport	7.90	4.26	0.43	39.52	21.29	2.15

Results

Impact of reduced intermediate imports from three industries used in transport equipment: total output in the economy

	Scenario	Reduction in output in the economy, %		
		NS	S	Regression-based estimates
Electrical and optical equipment	10%	0.23	0.05	0.05
	50%	1.13	0.25	0.26
Machinery	10%	0.29	0.16	0.05
	50%	1.43	0.79	0.25
Transport	10%	0.35	0.19	0.02
	50%	1.73	0.93	0.09
Aggregate impact	10%	0.35	0.19	0.05
	50%	1.73	0.93	0.26

Thank you!