Hypothetical Extraction, Contraction, and Expansion Models

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HYPOTHETICAL EXTRACTION

Possible reasons:

- Estimating the hotel's importance to the economy.
- Simulating a scenario where all the hotels in the economy are non-operational or are wiped out.

HYPOTHETICAL CONTRACTION

Possible reasons:

- Estimating the importance of a specific classification of the hotel sector to the economy.
- Simulating a scenario where the hotel sector experienced a negative shock that potentially affected its production and demand.

HYPOTHETICAL EXPANSION

Possible reasons:

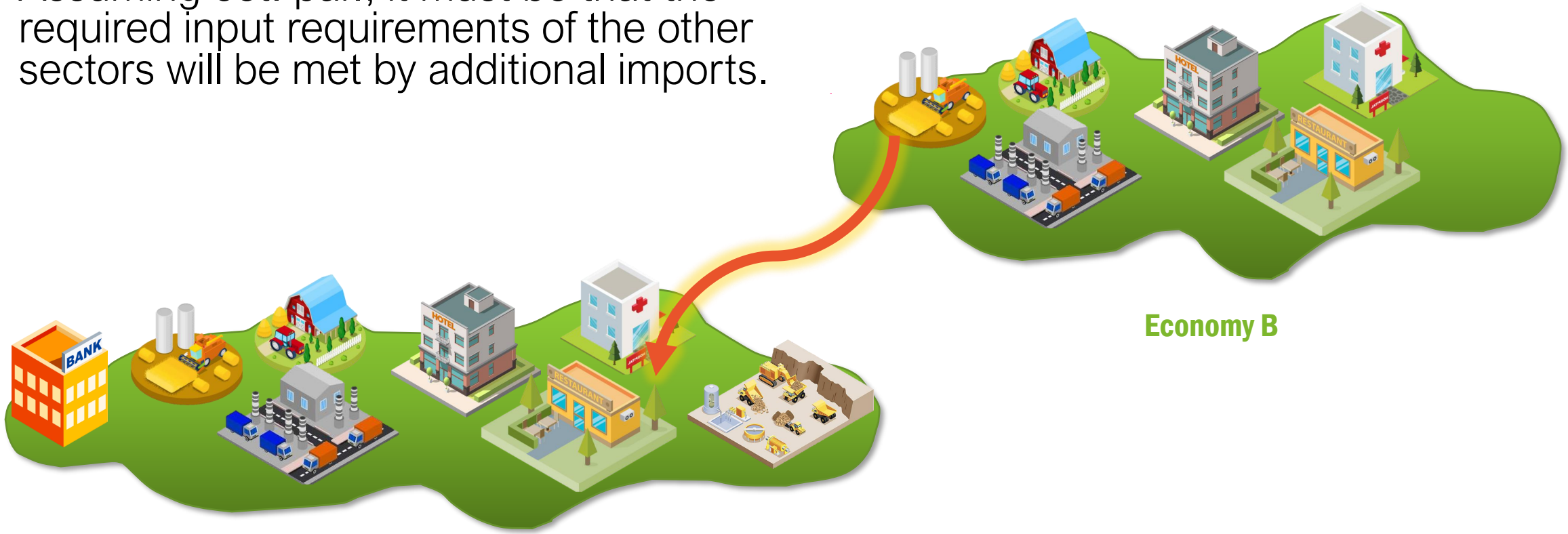
- Simulating a scenario where the hotel sector experienced a positive shock that potentially affected its production and demand.

Outline

- Hypothetical Extraction Model
- Hypothetical Contraction Model
- Hypothetical Expansion Model
- Worksheet illustration of the methodologies

Applicable only with a national IO table and not with a multi-regional IO table.

Assuming cet. par., it must be that the required input requirements of the other sectors will be met by additional imports.



Hypothetical Extraction Model

Hypothetical Extraction Model

- Main objective: to quantify total output losses due to the extraction of a sector in the economy.
- Typically, large industries and industries that are highly interconnected in the economy's production structure are found to be important.
- Thus, it provides a measure of a sector's "importance" to the economy or a sector's "linkage" to other sectors, allowing us to identify the key sectors.

- Another main idea: to provide a hypothetical situation wherein a sector is no longer operational or is completely shut down.
- It examines the effect of the extraction on the remaining sectors in the economy, taking into consideration both the direct and indirect effects to output.

Hypothetical Extraction Model

		Sector 1	Sector 2	Sector 1	Final Demand			Exports	Gross Output
		Agri	Industry	Services	HFCE	GFCF	GOV		
Sector 1	Agri	Z_{11}	Z_{12}	Z_{11}	c_1	i_1	g_1	e_1	x_1
Sector 2	Industry	Z_{21}	Z_{22}	Z_{21}	c_2	i_2	g_2	e_2	x_2
Sector 3	Services	Z_{11}	Z_{12}	Z_{11}	c_1	i_1	g_1	e_1	x_1
Imports		m_1	m_2	m_1	m_c	m_i	m_g	m_x	M
VA		va_1	va_2	va_1					VA
Gross Output		x_1	x_2	x_1	C	I	G	X	Total

Backward dependence

Forward dependence

Total dependence

Hypothetical Extraction Model

Total Dependence

- If this sector is extracted, how much loss will the economy incur?
- It follows the model $\boldsymbol{i'x^{-i} - i'x}$, i.e.,:

$$(\boldsymbol{I} - \boldsymbol{A^{-i}})^{-1}\boldsymbol{y^{-i}} - (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{y}$$

A^{-3}	Sector 1	Sector 2	Sector 3
Sector 1	Z_{11}/x_1	Z_{12}/x_2	0
Sector 2	Z_{21}/x_1	Z_{22}/x_2	0
Sector 3	0	0	0

FD
y_1
y_2
0

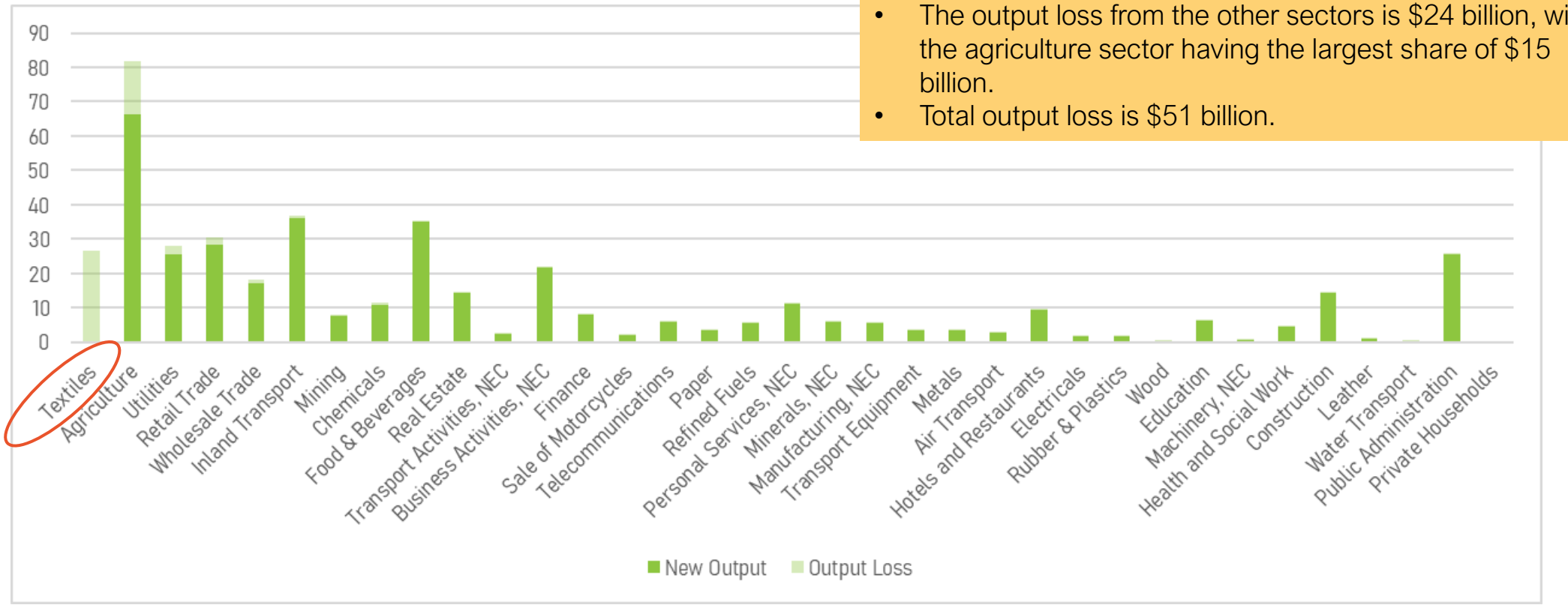
Where $\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$

EXAMPLE

Hypothetical Extraction Model

Impact to output of Pakistan 2020

- Direct output loss of $27 billion from the textiles sector.
- The output loss from the other sectors is $24 billion, with the agriculture sector having the largest share of $15 billion.
- Total output loss is $51 billion.

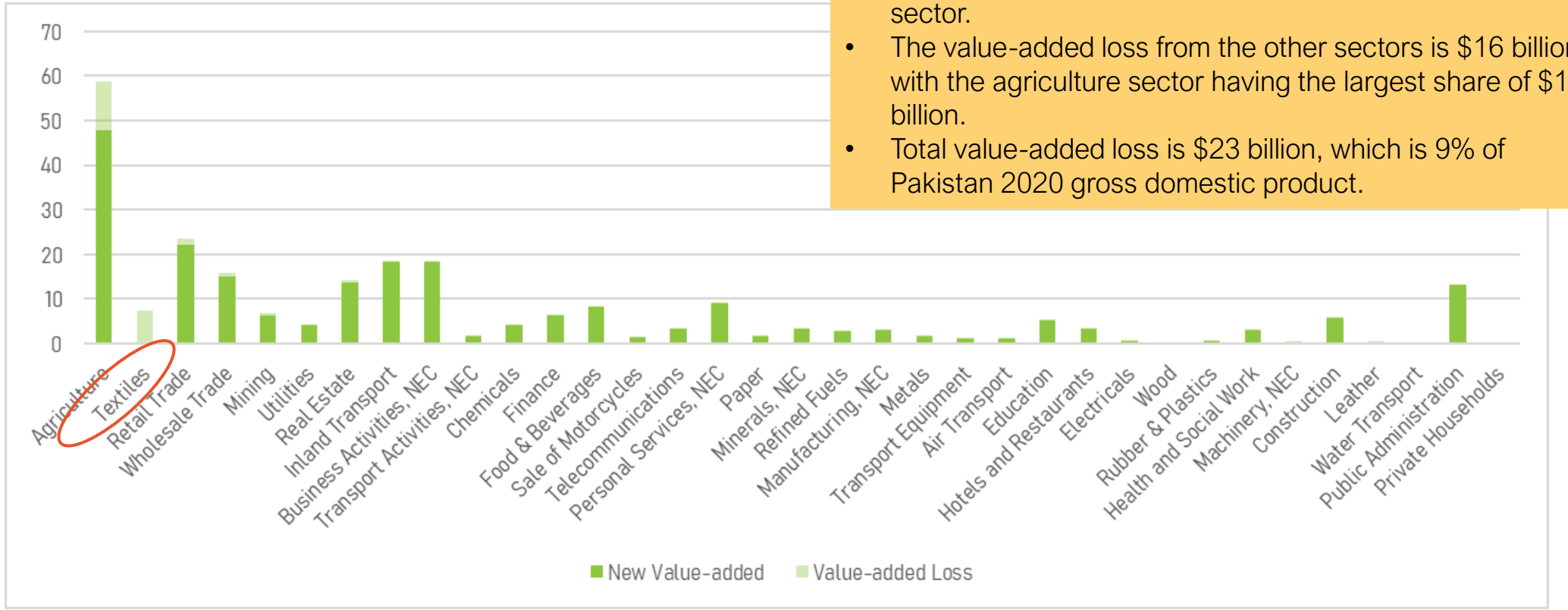


EXAMPLE

Hypothetical Extraction Model

Impact to value-added of Pakistan 2020

- Direct value-added loss of $7 billion from the textiles sector.
- The value-added loss from the other sectors is $16 billion, with the agriculture sector having the largest share of $11 billion.
- Total value-added loss is $23 billion, which is 9% of Pakistan 2020 gross domestic product.



Hypothetical Extraction Model

Backward Dependence

- Assume that the sector have no intermediate inputs. The output loss per sector provides insight as to how dependent the extracted sector is to the other sectors.
- It follows the model $\overline{\boldsymbol{x_{cj}}}^{-i} - \boldsymbol{x}$, i.e.,:

$$(\boldsymbol{I} - \boldsymbol{A_{cj}}^{-i})^{-1}\boldsymbol{y} - (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{y}$$

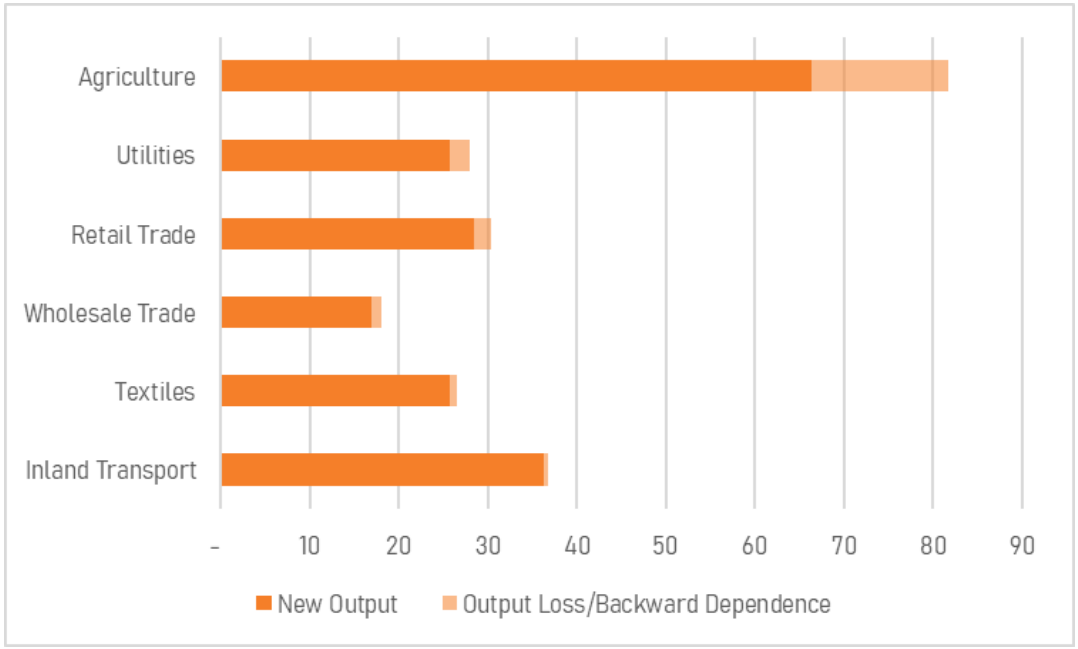
A^{-3}	Sector 1	Sector 2	Sector 3
Sector 1	Z_{11}/x_1	Z_{12}/x_2	0
Sector 2	Z_{21}/x_1	Z_{22}/x_2	0
Sector 3	Z_{31}/x_1	Z_{32}/x_2	0

Where $\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$

EXAMPLE

Hypothetical Extraction Model

Backward dependence of the textiles sector (Pakistan 2020)



- The agriculture sector has the highest backward dependence, as $15 billion of output will be lost if the textiles sector is non-operational.
- Note that the textiles sector also depend on itself for inputs, where there is $772 million expected output loss.

Hypothetical Extraction Model

Forward Dependence

- Assume that the sector have no intermediate sales. The output loss per sector provides insight as to how dependent the extracted sector is to the other sectors.
- It follows the model $\overline{\boldsymbol{x}_{rj}}^{-i} - \boldsymbol{x}$, i.e.,:

$$\boldsymbol{v}'(\boldsymbol{I} - \boldsymbol{B}_{rj}{}^{-i})^{-1} - \boldsymbol{v}'(\boldsymbol{I} - \boldsymbol{B})^{-1}$$

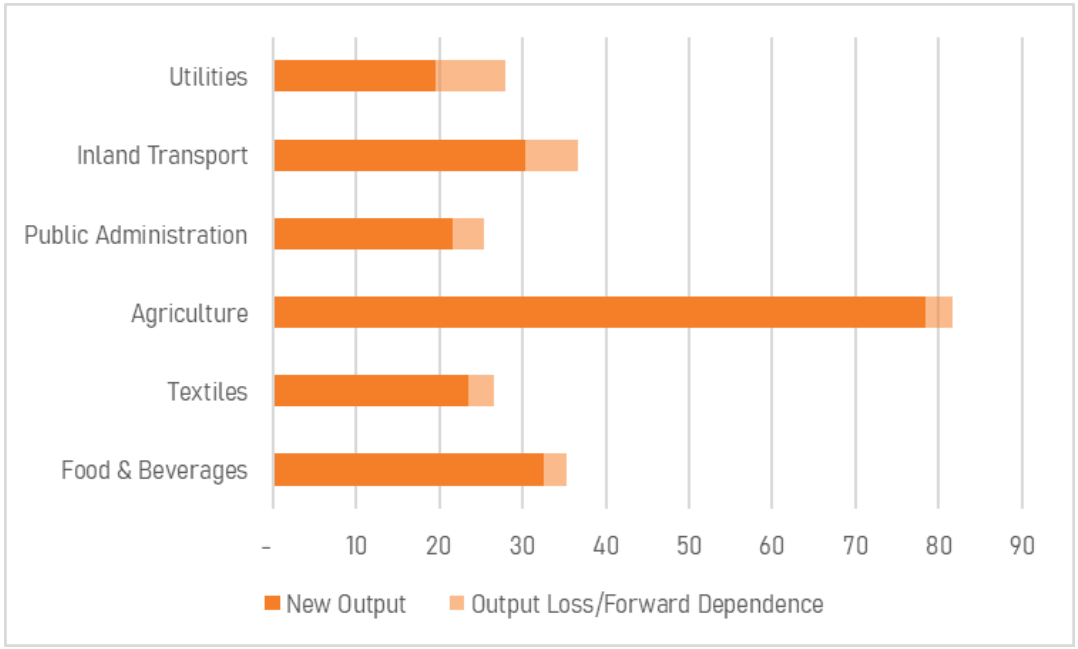
B^{-3}	Sector 1	Sector 2	Sector 3
Sector 1	Z_{11}/x_1	Z_{12}/x_1	Z_{13}/x_1
Sector 2	Z_{21}/x_2	Z_{22}/x_2	Z_{23}/x_2
Sector 3	0	0	0

Where $\boldsymbol{G} = (\boldsymbol{I} - \boldsymbol{B})^{-1}$

EXAMPLE

Hypothetical Extraction Model

Forward dependence of the textiles sector (Pakistan 2020)



- The utilities sector has the highest forward dependence, as $8 billion of output will be lost if the textiles sector is non-operational.
- Note that the textiles sector also depend on itself for inputs, where there is $3 billion expected output loss.

Hypothetical Extraction Model

VBY Approach

- For a measure of impact comparable to gross domestic product, the gross value-added would be a more useful measure of impact.
- Using the VBY matrix, the decrease in gross value-added would indicate the impact to an economy's GDP after a sector's extraction.

$$\hat{\boldsymbol{v}}^{-\boldsymbol{i}}\,(\boldsymbol{I}-\boldsymbol{A}^{-i})^{-1}\hat{\boldsymbol{y}}^{-i}-\hat{\boldsymbol{v}}(\boldsymbol{I}-\boldsymbol{A})^{-1}\hat{\boldsymbol{y}}$$

VBY	Sector 1	Sector 2	Sector 3
Sector 1	vby_{11}	vby_{12}	vby_{13}
Sector 2	vby_{21}	vby_{22}	vby_{23}
Sector 3	vby_{31}	vby_{32}	vby_{33}

VBY	Sector 1	Sector 2	Sector 3
Sector 1	vby_{11}	vby_{12}	0
Sector 2	vby_{21}	vby_{22}	0
Sector 3	0	0	0

Where $\boldsymbol{L}=(\boldsymbol{I}-\boldsymbol{A})^{-1}$

Hypothetical Extraction Model

VBY Approach

- The resulting GVA loss can be disaggregated between the direct and indirect effects.

$$GVA_{loss} = FL + BL - DC + Indirect$$

1

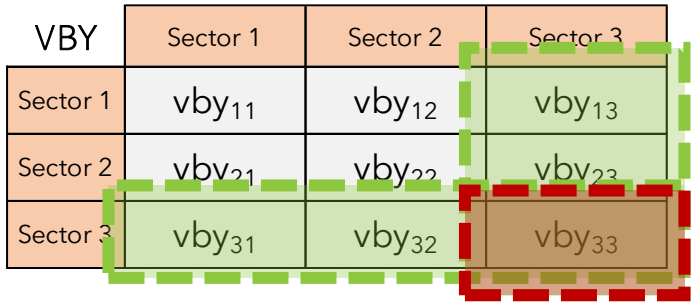
VBY	Sector 1	Sector 2	Sector 3
Sector 1	vby_{11}	vby_{12}	0
Sector 2	vby_{21}	vby_{22}	0
Sector 3	0	0	0

−

VBY	Sector 1	Sector 2	Sector 3
Sector 1	vby_{11}	vby_{12}	vby_{13}
Sector 2	vby_{21}	vby_{22}	vby_{23}
Sector 3	vby_{31}	vby_{32}	vby_{33}

= GVA_{loss}

2



Hypothetical Extraction Model

VBY Approach

3

$$Indirect = GVA_{loss} - (FL + BL - DC)$$

Note:

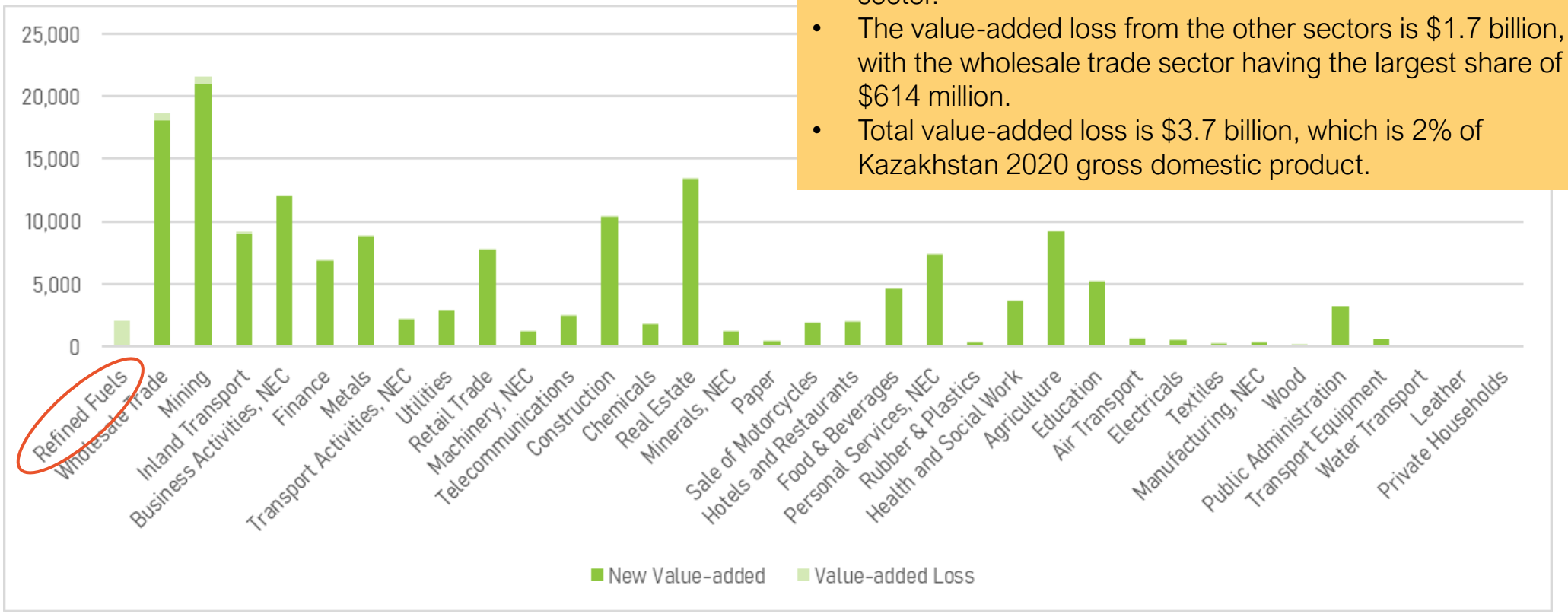
The resulting gross value-added (GVA) loss can be compared to the gross domestic product (GDP) to get its % impact to GDP. This gives an idea as to the size of the sector in the economy and how significant it is to an economy's GDP.

EXAMPLE

Hypothetical Extraction Model

VBY Approach (extracting the refined fuels sector of Kazakhstan)

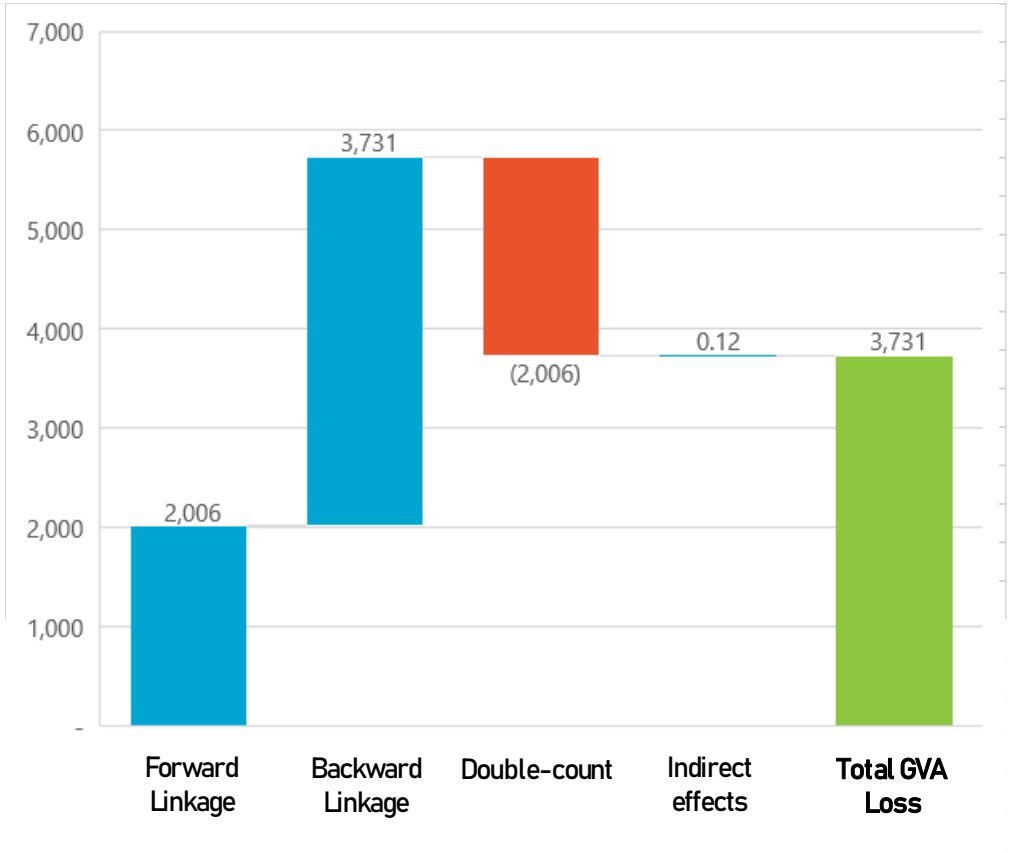
- Direct value-added loss of $2 billion from the mining sector.
- The value-added loss from the other sectors is $1.7 billion, with the wholesale trade sector having the largest share of $614 million.
- Total value-added loss is $3.7 billion, which is 2% of Kazakhstan 2020 gross domestic product.



EXAMPLE

Hypothetical Extraction Model

VBY Approach (extracting the refined fuels sector of Kazakhstan)



Total gross value-added loss is $3.7 billion, 2% of Kazakhstan 2020 gross domestic product.

- The effect to the Kazakhstan's gross domestic product is mainly brought by the direct linkages to the refined fuels sector.
- A small percentage of the losses are attributed to the lost transactions between other sectors.
- This means that the refined fuel sector is important to the economy as it is heavily interlinked with the other sectors, both forward and backward.

Hypothetical Contraction and Expansion Models

Hypothetical Contraction Model

- Main objective: to quantify total output losses due to the contraction of a sector in the economy.
- Estimating the importance to the economy of a specific industry within a sector.
- Makes use of external data in finding a negative shock ranging from 0% to 100% to be incorporated into the model.

- Another main idea: to provide a hypothetical situation wherein a sector contracts due to various disruptions in their production or in their demand.
- It examines the effect of the contraction on the remaining sectors in the economy, taking into consideration both the direct and indirect effects to output.

Hypothetical Contraction Model

- If this sector is contracted by some shock $\boldsymbol{s}$, where $\boldsymbol{s} = (\boldsymbol{1} - \boldsymbol{s_0})$, how much loss will the economy incur?
- It follows the model $\boldsymbol{i'x^*} - \boldsymbol{i'x}$, i.e.,:

$$(\boldsymbol{I} - \boldsymbol{A^*})^{-1}\boldsymbol{y^*} - (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{y}$$

A^{-3}	Sector 1	Sector 2	Sector 3
Sector 1	Z_{11}/x_1	Z_{12}/x_2	$s(Z_{13}/x_3)$
Sector 2	Z_{21}/x_1	Z_{22}/x_2	$s(Z_{23}/x_3)$
Sector 3	$s(Z_{31}/x_1)$	$s(Z_{32}/x_2)$	$s(Z_{33}/x_3)$

FD
y_1
y_2
$s(y_3)$

Where $\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$

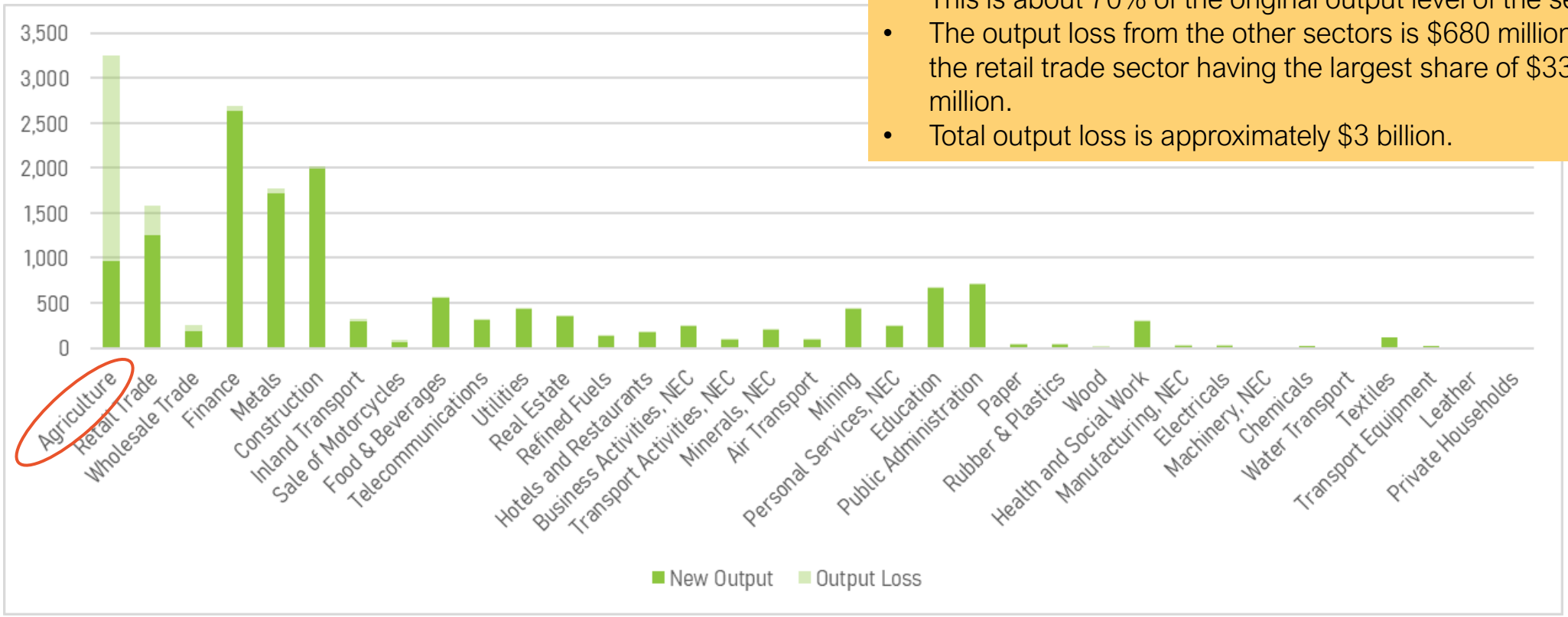
EXAMPLE

Hypothetical Contraction Model

Impact to output of Kyrgyz Republic 2020

Suppose a 50% contraction of the agriculture sector

- Total output loss of $2 billion from the agriculture sector. This is about 70% of the original output level of the sector.
- The output loss from the other sectors is $680 million, with the retail trade sector having the largest share of $334 million.
- Total output loss is approximately $3 billion.



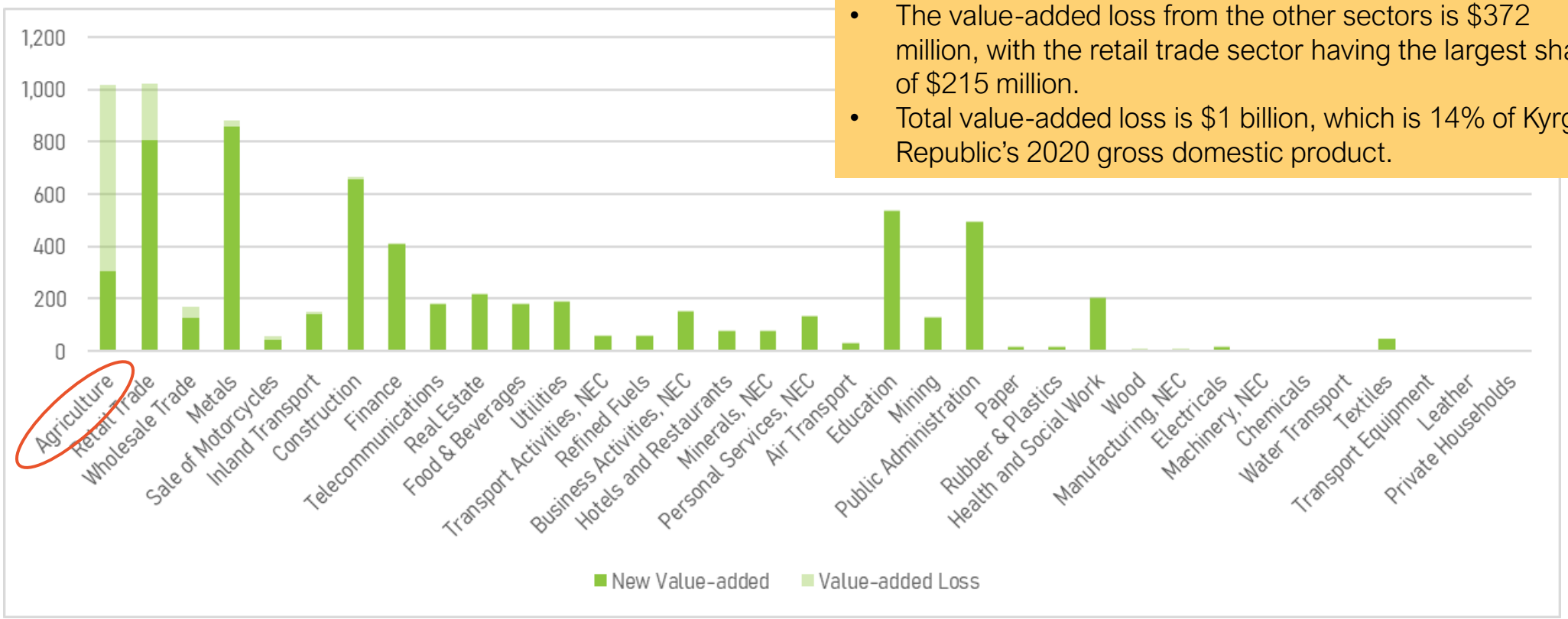
EXAMPLE

Hypothetical Contraction Model

Impact to value-added of Kyrgyz Republic 2020

Suppose a 50% contraction of the agriculture sector

- Total value-added loss of the agriculture sector is $716 million.
- The value-added loss from the other sectors is $372 million, with the retail trade sector having the largest share of $215 million.
- Total value-added loss is $1 billion, which is 14% of Kyrgyz Republic's 2020 gross domestic product.



Hypothetical Expansion Model

- Main objective: to quantify total output gains due to the expansion of a sector in the economy.
- Makes use of external data in finding a positive shock ranging from 0% to 100% to be incorporated into the model.
- Considers a hypothetical situation wherein a sector expands due to favorable conditions that affected their production or their demand.
- It examines the effect of the expansion on the remaining sectors in the economy, taking into consideration both the direct and indirect effects to output.

Hypothetical Expansion Model

- If this sector expanded by some shock $\boldsymbol{s}$, where $\boldsymbol{s} = (\mathbf{1} + \boldsymbol{s_0})$, how much will the economy gain?
- It follows the model $\boldsymbol{i'x^*} - \boldsymbol{i'x}$, i.e.,:

$$(\boldsymbol{I} - \boldsymbol{A^*})^{-1}\boldsymbol{y^*} - (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{y}$$

A^{-3}	Sector 1	Sector 2	Sector 3
Sector 1	Z_{11}/x_1	Z_{12}/x_2	$s(Z_{13}/x_3)$
Sector 2	Z_{21}/x_1	Z_{22}/x_2	$s(Z_{23}/x_3)$
Sector 3	$s(Z_{31}/x_1)$	$s(Z_{32}/x_2)$	$s(Z_{33}/x_3)$

FD
y_1
y_2
$s(y_3)$

Where $\boldsymbol{L} = (\boldsymbol{I} - \boldsymbol{A})^{-1}$

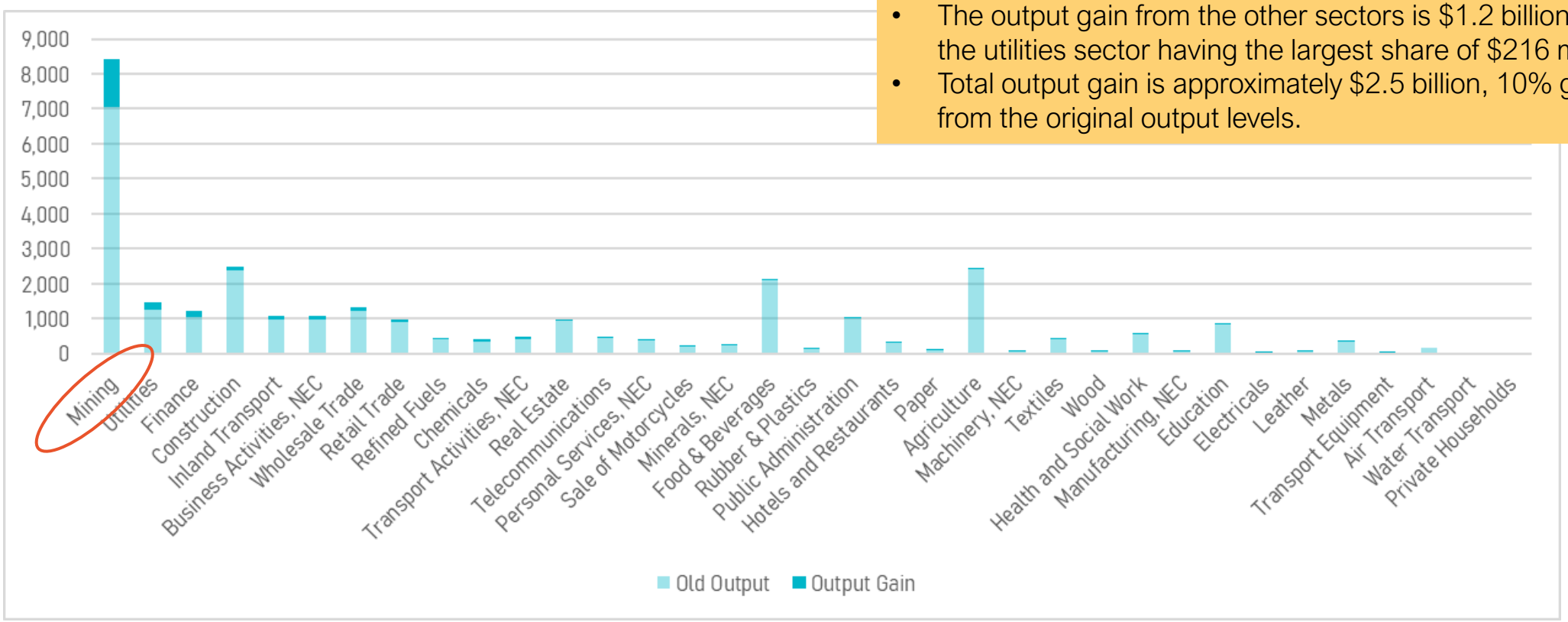
EXAMPLE

Hypothetical Expansion Model

Impact to output of Mongolia 2020

Suppose a 20% expansion of the mining sector

- Total output gain of $1.3 billion from the mining sector. This is about 25% increase for the sector.
- The output gain from the other sectors is $1.2 billion, with the utilities sector having the largest share of $216 million.
- Total output gain is approximately $2.5 billion, 10% gain from the original output levels.



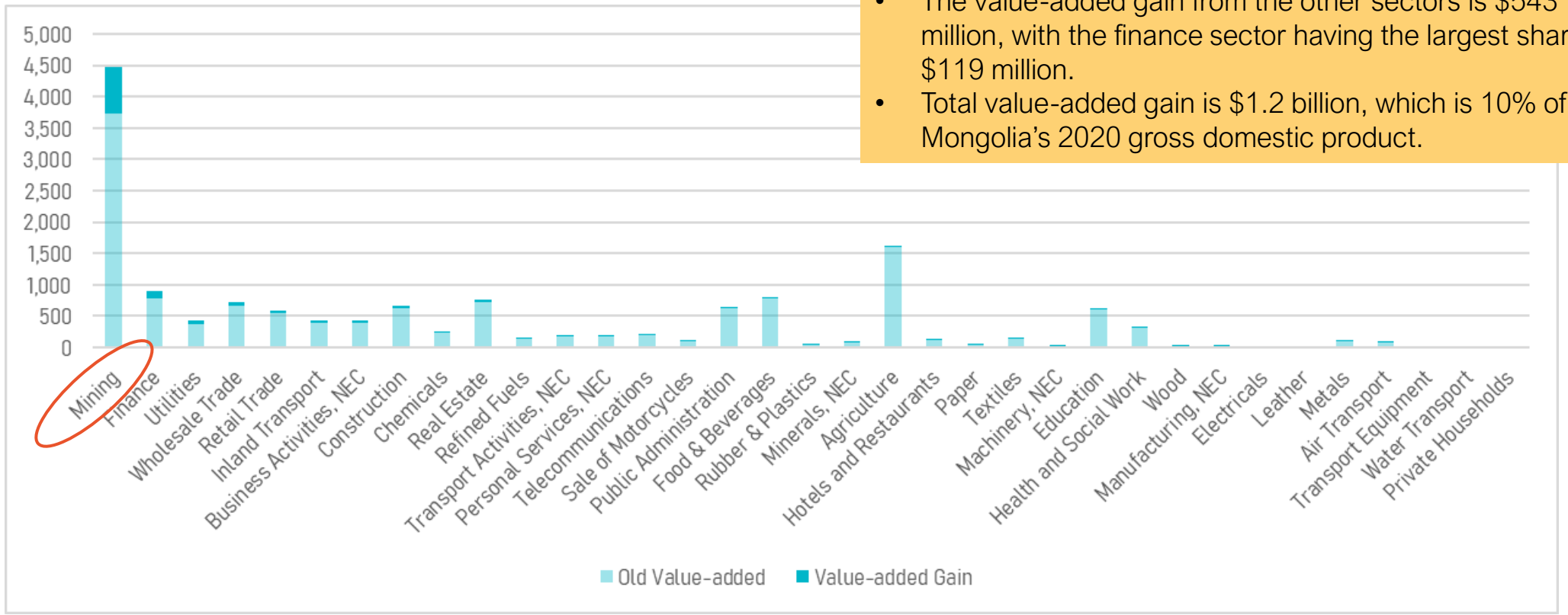
EXAMPLE

Hypothetical Expansion Model

Impact to value-added of Mongolia 2020

Suppose a 20% expansion of the mining sector

- Total value-added gain of the mining sector is $736 million.
- The value-added gain from the other sectors is $543 million, with the finance sector having the largest share of $119 million.
- Total value-added gain is $1.2 billion, which is 10% of Mongolia's 2020 gross domestic product.



Summary

- Hypothetical models allow for measurement of a sector's importance to the economy, as well as simulating scenarios that allows for either a total shut down of a sector, a contraction of a sector, or an expansion of a sector.
- Using the IO framework not only allows for an economy-wide analysis of the impact but also allows for a sector-level analysis, both in output and value-added terms. The impact can also be further disaggregated between direct and indirect effects.
- These models are only applicable using national IOTs due to its implicit assumption of holding all things constant and reallocating the lost required input requirements to additional imports.

Reference

Miller, R. E., & Blair, P. D. (2009). Input-output analysis: foundations and extensions. Cambridge university press.

Image Sources

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