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Evidence from EXIOBASE-3

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Abstract

In this study, we investigate the impact of energy GVC participation on value-added growth in 49 regions for the period of 1995 – 2022. Our findings reveal that backward GVC participation in crude oil, coal and natural gas leads to a decline in value-added growth for the full sample. In contrast, forward participation in total energy, coal, and crude oil significantly drives the value-added growth. Moreover, our results suggest that the value-added growth effects vary by income level and types of energy sources. While both backward and forward participation in coal has positive effects in developing countries, backward (forward) has a negative (positive) effect in developed countries. On the other hand, backward participation in natural gas exerts a negative (positive) effect in developing (developed) countries. Therefore, to capture the effects of energy GVC participation it is crucial to distinguish between backward and forward participation, income levels, and types of energy sources.

Keywords: Energy resources, global value chains, developing countries, resource curse

JEL Classifications: F14, F63, O13

1. Introduction

Global value chains (GVCs) distribute production tasks across various countries and have emerged as a dominant theoretical framework for understanding international trade patterns. While numerous studies have explored specific value chains like those in cars, textiles and electronics (e.g., Xing, 2020; Jha and Kumar, 2022; Sturgeon and Kawakami, 2010), energy GVCs have largely been neglected in empirical studies, despite their undeniable importance for development and economic activity (see, Katz and Pietrobelli, 2018; Korinek, 2020).

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In addition to providing one of the key inputs, energy sectors represent over half of total exports and contribute significantly to GDP in many resource-rich countries (e.g., Iizuka et al., 2018; Pietrobelli et al., 2018). Yet, it is commonly perceived that energy exports have minimal or even negative impact (see Baglioni and Campling, 2017). This perception is largely influenced by the historical association of energy commodity specialization with weak economic performance in resource-rich countries, called resource curse (e.g., Sachs and Warner, 2001; Arezki and van der Ploeg, 2010; Murshed and Serino, 2011). Recently, however, this narrative has been challenged by some researchers (e.g., Pietrobelli et al., 2018; Katz and Pietrobelli, 2018). For instance, Andersen (2012) and Marin et al. (2015) argue that the resource curse is not a universal phenomenon, suggesting that energy sector specialization can drive innovation and knowledge spillovers (see also Crespi et al., 2017).

In this study, we aim to investigate whether participation in energy GVCs has any effects on total value-added growth for 49 regions based on EXIOBASE-3 from 1995 to 2022 (see, Stadler et al., 2018). The rationale for examining this is that specialization in energy industries might not necessarily be the 'curse'. Rather they might provide significant opportunities for export diversification, financial resources and higher value-added activities as discussed in Savona and Bontadini (2023). Additionally, energy sectors are diverse in terms of value-chain linkages and rent generation which makes the effects of energy GVCs highly heterogeneous across countries (see, Isham et al., 2005).

Investigating energy GVCs could offer a new perspective on the natural resource curse which often focuses on export dependency, resource abundance or rents (see, Sachs and Warner, 2001; Brunnschweiler, 2008) while overlooking the role of value-added trade. Our study addresses this issue by considering how energy GVC integration affects total value-added growth, by employing both backward and forward GVC linkages. Unlike some studies using energy exports as an aggregate measure (Chang et al., 2013), we disaggregate energy GVCs into three distinct sectors to account for the potentially heterogeneous impacts on value-added growth. We also differ by data considerations from other studies (see, Savona and Bontadini, 2023). These studies use OECD MRIOs for calculating GVCs which lack the sectoral detail for energy sectors compared to EXIOBASE-3 provides.

Our empirical results indicate that higher participation in total energy and other energy GVCs negatively impacts total value-added growth for the full sample. Conversely, forward participation in energy GVCs—excluding natural gas—shows a consistent positive effect on value-added growth. Furthermore, it seems that the effects of energy GVCs differ by income levels and types of energy sources. Notably, higher forward participation in natural gas is linked to a slower value-added growth rate, lending evidence for the resource curse hypothesis in developing countries.

This study is constructed as follows: second part reviews the literature, third part presents model and data, fourth part discusses empirical results, and the last part concludes and presents relevant policy implications.

2. Literature Review

Participating in energy GVCs could exacerbate the effects of natural resource curse, depending on how a country’s value chains are managed. Several mechanisms indicate how energy GVCs lead to resource curse. The higher integration into energy GVCs concentrate production factors on energy industries which lead to less diversified export baskets and impede the development of other industries. The undiversified export baskets could increase the exposure to volatility of energy prices which can reinforce the negative effects of energy GVC participation (see, Aye et al., 2014; Elder and Serletis, 2011). The concentration of production factors is one of the core aspects of the resource curse where resource abundance can lead to uneven growth rates between energy industries and downstream industries (see, Corden, 1984; Brahmbhatt et al., 2010). Also, enclave-like production structures might also exacerbate the resource curse through GVCs which can stifle the value-added growth (see, Gallagher and Zarsky, 2007; Dietz, 1985; Heeks, 1999).

While much of the literature argues that natural resources act as a 'curse' for economic growth, recent studies suggest that resource exploitation can favor other industries through spillovers and innovation (see, Izuka and Katz, 2018; Crespi et al., 2017; Katz and Pietrobelli, 2018). Emerging opportunities for innovation and strong linkages between lead firms and suppliers are also becoming evident in energy sectors (see, Andersen, 2012; Marin et al., 2015). Furthermore, the energy sector faces continuous pressure to innovate to mitigate environmental impacts particularly (see, Ovadia, 2014; Dantas, 2011). In this context, a related study by Savona and Bontadini (2023) tests whether specialization in natural resource industries can favor the high-tech manufacturing industries and knowledge intensive business services (KIBS). They find natural resource specialization, particularly in agriculture industries, show a positive relationship between KIBS export performance, whereas this positive link is absent for countries specializing in energy industries.

3. Model, Data and Methodology

To investigate whether energy GVCs have any impact on total value-added growth, we utilize a simple growth model as below:

$$Y_{i,c,t} = a + \beta\ Controls_{i,c,t} + \beta_1\ Energy\ GVC\ Participation_{\ i,c,t} + v_t + z_{i,c} + \varepsilon_{i,c,t} \qquad (1)$$

In equation (1), $Y_{i,c,t}$ represents value-added growth rate and $Controls_{i,c,t}$ are control variables which consists of capital stock per worker and total GVC participation. v_t, $z_{i,c}$, $\varepsilon_{i,c,t}$ represent time dummies, industry-country dummies and the error term, respectively. Energy GVC participation is disaggregated into backward and forward linkages to capture effectively resource curse dynamics within production networks. All our data are sourced from EXIOBASE-3, which is particularly advantageous for energy GVC research, covering 49 regions and over the period 1995-2022. Table 1 summarizes the mean values from our five-year averaged dataset.

Backward GVC participation is defined by the share of foreign value-added in exports, whereas forward participation accounts for the domestic value-added embedded in third countries' exports (see Koopman et al., 2014). We utilize a complex measure of forward participation (see, Wang et al., 2013) to capture the fluctuations in value-added caused by energy GVCs. Additionally, to capture the difference between energy importers and exporters a dummy variable is included in equation (1) to identify energy-importing countries. Lastly, we apply a two-way fixed effects framework to estimate equation (1), controlling for individual heterogeneity and unobserved factors of value-added growth.

[INSERT TABLE 1 HERE]

4. Empirical Results

We report our baseline results in Table 2 for the full sample. When accounting for control variables, our results indicate that being an energy importer positively contributes to value-added growth, while capital stock per worker has a negative effect on it. Also, total value-added growth is positively affected by both types of GVC participation. The positive impact of GVC participation suggests that integration into global production networks can enhance efficiency, boost productivity and strengthen competitiveness, leading to high value-added growth (see Constantinescu et al., 2019; Reddy and Sashidharan, 2024). For the full sample, integration into total energy and various types of energy backward GVCs have an adverse impact on total value-added growth. This result might be related to import competition where domestic sectors might struggle to compete with cheaper foreign alternatives provided by backward GVC participation. Therefore, crowding out effect may occur (see, Colantone et al., 2014). However, all forward energy GVC participations, except for natural gas, increases the total value-added growth. This result can reflect the value-addition through multiplier effects across sectors, boosting productivity and economic activity in related industries (see, Urata and Baek, 2019).

[INSERT TABLE 2 HERE]

We also investigate the effects of energy GVC differ by income level. Because one would expect that developing countries are more prone to natural resource curse (see, Mehlum et al., 2006). We present the results for developing and developed countries in Table 3. For developing countries, the effects of backward GVC participation in crude oil and natural gas are consistent with those observed in the full sample, whereas the impact of backward participation in coal differs. Since coal is a reliable energy supply to generate electricity, the operation of factories and services might depend on coal industries' imported inputs. We also find that the effects of participation in forward GVCs except natural gas are nearly identical with those obtained for the full sample. Specifically, it seems that higher forward GVC participation in natural gas is associated with lower value-added growth which aligns with resource curse arguments (see, Sachs and Warner, 2001; Davis and Tilton, 2005). Lastly, it seems that being an energy importer is significant for reaching higher value-added growth in developing countries.

For developed countries, the results for total energy backward participation, coal and crude oil have very similar effects as in the full sample. On the other hand, higher backward participation in natural gas enhances total value-added growth. We also find that higher forward participation in coal and crude oil enhances the total value-added growth rate. This result might be in line with arguments presented by Crespi et al. (2017) and Katz and Pietrobelli (2018) who indicate specialization in energy sectors though forward GVC participation might increase innovation, learning and spillovers effects. Finally, being an energy importer is detrimental for value-added growth in developed countries.

[INSERT TABLE 3 HERE]

5. Conclusions

In this study, we investigate the relationship between energy GVCs and total value-added growth by using EXOBASE-3 database from 1995 to 2022 for 49 regions. Our findings suggest that participating in total energy and other energy backward GVCs has a detrimental effect on total value-added growth for the full sample. However, forward participation in energy GVCs—except for natural gas—consistently enhances total value-added growth. We also investigate the effects of energy GVCs by considering income level because the symptoms of Dutch disease or resource curse are more common in developing ones. It appears that higher forward participation in natural gas is linked to slower growth in total value-added which is consistent with resource curse narrative. As for developed countries, we find that higher backward (forward) participation in natural gas (coal and crude oil) enhances total value-added growth. Finally, our results clearly show that it is important to distinguish between the backward and forward energy GVC participation, income levels, and types of energy sources. Otherwise, empirical findings and hence policy proposals would be misleading.

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TABLES

Table 1: Mean Values

	Full Sample		**Developing Countries**		**Developed Countries**	
Variable	Obs.	Mean	Obs.	Mean	Obs.	Mean
Value-Added Growth	42254	3.557	19825	4.460	18109	2.729
log(K/L)	42254	1.259	19825	0.750	18109	2.365
BP	42254	6.223	19825	6.323	18109	6.315
FP	42254	8.502	19825	8.575	18109	8.232
Total Energy BP	34613	8.070	15983	8.692	14310	8.504
Total Energy FP	34613	13.44	15983	12.453	14310	12.887
Coal BP	30882	9.500	15357	8.877	11205	10.733
Coal FP	30882	13.078	15357	12.541	11205	12.585
Crude Oil BP	25308	8.642	10593	12.128	10395	6.910
Crude Oil FP	25308	13.827	10593	12.454	10395	13.319
Natural Gas BP	28274	8.773	10862	10.338	13092	9.299
Natural Gas FP	28274	11.544	10862	11.136	13092	10.508

Table 2: Full Sample

	(1)	(2)	(3)	(4)	(5)
log(K/L)	-0.364***	-0.316***	-0.273***	-0.156***	-0.184***
	(0.014)	(0.016)	(0.017)	(0.015)	(0.013)
BP	0.084***	0.112***	0.122***	0.127***	0.077***
	(0.005)	(0.007)	(0.007)	(0.007)	(0.006)
FP	0.026***	0.018***	0.015***	0.019***	0.018***
	(0.004)	(0.005)	(0.005)	(0.006)	(0.005)
Energy Importer	0.051	0.176**	0.247***	0.289***	-0.151
	(0.077)	(0.079)	(0.082)	(0.107)	(0.095)
Total Energy BP		-0.005**			
		(0.003)			
Total Energy FP		0.011***			
		(0.003)			
Coal BP			-0.013***		
			(0.003)		
Coal FP			0.014***		
			(0.003)		
Crude Oil BP				-0.034***	
				(0.002)	
Crude Oil FP				0.010***	
				(0.003)	
Natural Gas BP					-0.018***
					(0.002)
Natural Gas FP					0.000
					(0.003)
Observations	42,254	34,613	30,882	25,308	28,274
R-squared	0.161	0.179	0.191	0.184	0.176

Notes: Clustered robust standard errors in parentheses. Time and country-industry dummies are included in all specifications, but not reported.

Table 3: Developing and Developed Countries

	Developing Countries					Developed Countries				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
log(K/L)	-0.629***	-0.641***	-0.649***	-0.372***	-0.493***	0.607***	0.629***	0.852***	0.067	0.634***
	(0.024)	(0.033)	(0.033)	(0.043)	(0.041)	(0.026)	(0.044)	(0.081)	(0.042)	(0.047)
BP	0.128***	0.137***	0.134***	0.122***	0.107***	0.006	0.020***	0.016*	0.035***	0.015*
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)	(0.005)	(0.007)	(0.009)	(0.006)	(0.008)
FP	0.040***	0.027***	0.030***	0.039***	0.029***	-0.004	-0.006*	-0.014***	-0.024***	-0.008**
	(0.006)	(0.006)	(0.007)	(0.007)	(0.006)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
Energy Importer	1.098***	1.336***	1.329***	1.450***	0.826***	-1.428***	-1.279***	-1.136***	-1.149***	-1.398***
	(0.063)	(0.067)	(0.069)	(0.090)	(0.077)	(0.031)	(0.036)	(0.040)	(0.038)	(0.036)
Total Energy BP		0.005					-0.007***			
		(0.004)					(0.003)			
Total Energy FP		0.031***					-0.000			
		(0.005)					(0.003)			
Coal BP			0.026***					-0.013***		
			(0.004)					(0.003)		
Coal FP			0.034***					0.005*		
			(0.005)					(0.003)		
Crude Oil BP				-0.045***					-0.050***	
				(0.003)					(0.004)	
Crude Oil FP				0.016***					0.007***	
				(0.005)					(0.003)	
Natural Gas BP					-0.061***					0.006***
					(0.003)					(0.002)
Natural Gas FP					-0.009**					0.004
					(0.004)					(0.003)
Observations	19,825	15,983	15,357	10,593	10,862	18,109	14,310	11,205	10,395	13,092
R-squared	0.279	0.302	0.310	0.327	0.329	0.242	0.281	0.341	0.325	0.293

Notes: Clustered robust standard errors in parentheses. Time and country-industry dummies are included in all specifications, but not reported.

APPENDIX

Table A1: Country List

Australia*	Indonesia	Spain*
Austria*	Ireland*	Sweden*
Belgium*	Italy*	Switzerland*
Brazil	Japan*	Taiwan*
Bulgaria	Korea (Republic of)	Turkey
Canada*	Latvia	United States*
China	Lithuania	RoW Asia and Pacific
Croatia	Luxembourg*	RoW America
Cyprus	Malta	RoW Europe
Czechia	Mexico	RoW Africa
Denmark*	Netherlands*	RoW Middle East
Estonia	Norway*	
Finland*	Poland	
France*	Portugal	
Germany*	Romania	
Great Britain*	Russia	
Greece	Slovakia	
Hungary	Slovenia	
India	South Africa	

Notes: Asterisk (*) represents the developed countries.