

DOMESTIC VALUE ADDITION IN EXPORTS: A CROSS COUNTRY ANALYSIS AND THE CASE FOR INDIA¹

Simran²

Supervised by: Prof. Oindrila De³

Abstract

With the emergence of global value chains (GVCs) and increasing interconnectedness in the world, the role of Domestic Value Added (DVA) content of exports has come to the forefront in determining trade benefits for any nation. Research and Development (R&D) expenditure, a key innovation indicator, is believed to have a positive impact on DVA. This paper empirically confirms that higher R&D expenditure is correlated with higher DVA in Exports, using panel data from the OECD-TiVA and World Development Indicators databases, covering 65 countries over 24 years. Additionally, it examines the "Smile Curve" trend in six manufacturing industries of India, assessing the country's position post-three decades of liberalization, privatization, and globalization (LPG) reforms.

¹ Acknowledgement: I am grateful to Prof. Oindrila De for her invaluable advice and continuous support, due to which I was able to complete this seminar paper. I am also extremely thankful to Prof. Vikarm Dayal, Prof. Saudamini Das and Prof. Girish Bahal for providing their valuable inputs during previous discussions on this paper held at IEG. Further, I am also thankful to IES Officer Mr. Ayush Kumar for his valuable suggestions which helped me in improving the quality of this article.

² IES Officer of 2023 Batch

³ Assistant Professor at IES Unit, IEG

Introduction

Over the last few decades, more and more countries have started to trade. Both the value as well as the volume of trade has increased significantly. The world has also seen the emergence of global value chains (GVCs) which has transformed the world into one single globalised ecosystem. However, in the end, things boil down to personal interests of nations. Domestic Value Added (DVA) content of Exports, which is an estimation of value added, by an economy, in producing goods and services for exports (As defined by OECD), serve as an important indicator of gains from trade. A higher level of DVA in exports is often associated with a robust and expanding economy and greater domestic employment opportunities. Generally, in advanced economies the system of internal value chains is well built and hence they rely less on foreign inputs, which in turn leads to a higher contribution in DVA in Exports by developed nations. Emerging economies do not often enjoy this privilege and hence it is important for them to understand and work upon the drivers of DVA so that they can positively impact their gains from participating in the Global Value Chains. Expenditure on Research and Development (R&D) is often seen as an important indicator to boost innovation in the nation. A higher R&D, also has a positive external effect on trade since it boosts the DVA in exports of a nation and thereby increases its income from trade. This paper attempts to test this hypothesis by using data obtained from the OECD-TiVA (Trade in Value Added) database and the World Development Indicators (WDI) database from the world bank. A panel data is constructed with 65 countries for a period of 24 years starting with 1995 up to 2018. This paper finds a positive correlation between R&D and DVA, which confirms that R&D has positive spill-over effects on trade.

When the trends of DVA are observed as a share of total exports, an empirical regularity often comes into picture which is called the 'Smile Curve'. As a country grows over time and becomes more and more integrated with the rest of the world, the share of DVA in exports, initially falls and then eventually rises, forming a U-shaped curve, which is more commonly called as the 'Smile Curve'. In the second part of the paper, this empirical trend is tested for six manufacturing industries in India to better understand the trajectory of DVA trends and see where India stands in current times

after about three decades of the LPG (Liberalisation, Privatisation and Globalisation) reforms.

Literature Review

In today's highly globalized world, goods and services are rarely produced in a single location and exported directly to consumers. Instead, production involves a complex process with inputs and activities sourced globally, known as global value chains (GVCs) (Sydor 2011). Within GVCs, different countries contribute varying amounts of value to final products, influencing their gains from trade. However, simply integrating into GVCs is insufficient for trade-driven growth. A critical factor determining a nation's income from trade is the Domestic Value Added (DVA) content of Exports.

Countries that have grown both their participation in GVCs and their domestic value added in exports have experienced significant GDP per capita growth (UNCTAD Report 2013). Banga (2013) stresses that linking into Global Value Chains is not enough; policies should aim to enhance forward linkages by exporting domestic value-added content. Caraballo and Jiang (2016) highlight DVA content of exports as a key parameter for development policy.

Veeramani and Dhir (2019) argue that developing countries can benefit greatly from policies strengthening their participation in Global Value Chains, leading to higher gross exports, DVA, and employment. Given India's recent policy focus on industrial consolidation, Aggarwal et al. (2021) stress the need to identify the influence of key production factors on DVA-content of exports. One important factor in this regard is the expenditure on R&D by a nation. Vrh (2018) argues that difference in intangible capital (primarily R&D) plays a major role in influencing the difference in Value Addition by a country.

Innovation is increasingly recognized as a fundamental driver of productivity growth and development in both advanced and emerging economies (Zeng 2017). A growing body of research demonstrates that Research and Development (R&D) expenditure significantly influences trade-related growth.

Coe and Helpman's (1995) analysis highlights the substantial returns on R&D, impacting both domestic output and international spill-overs. This impact is even more

pronounced in economies that are open to foreign trade. Keller (2002) underscores the contribution of both domestic and foreign R&D to higher productivity. Harris and Moffat (2011) emphasize the role of R&D spending in manufacturing, not only by fostering the production of new goods and services but also by enhancing a firm's knowledge assets, facilitating entry into international markets.

Liu et al. (2022) directly link increased R&D expenditure to expanded international trade networks, indicating heightened global interconnectedness. Salim and Bloch (2011) establish a long-term relationship between trade variables and R&D expenditure, with a unidirectional causality running from R&D investment to exports, imports, and net exports. Engelbrecht's (1992) study in Australia reveals a positive effect of R&D intensity on export intensity. Yu and Lou (2018) observe a positive correlation between China's Domestic Value Added (DVA) growth, productivity enhancement, R&D, capital formation, and the synergies between R&D and vertical specialization.

The literature establishes the importance of DVA in determining trade benefits and the crucial role of R&D expenditure as a driver of DVA. Further when we analyse the trends of DVA over a period of time, an empirical regularity comes into picture called the 'Smile Curve'. Baldwin and Ito (2021) define it as a fluctuation in the share of value added in manufactured exports generated within the manufacturing sector itself. Aggarwal (2017) highlights the growing significance of the "smile curve" within global value chains. This paper aims to explore this concept, focusing on six sectors in India, to understand its implications for the country's position in global trade (Meng et al. 2015).

Data and Methodology

For the current analysis, the data is collected from the OECD- TiVA (Trade in Value Added) Database and the World Development Indicators (WDI) database by the World Bank.

Using the above-mentioned sources, a panel data was created for 65 OECD countries over a period of 24 years i.e. from 1995 to 2018.

A brief description of the data used in the paper is given in Table 1.

It must be noted that to estimate the significance of determinants of DVA, the value of DVA content of exports in USD Millions is used, whereas to study the trends in India the Industry wise share of DVA in exports is taken into consideration.

Table 1: Description of Data

Variables	Description	Source
Domestic Value Added content in Exports (Total, Manufacturing & Services)	Value in USD Millions	OECD -TIVA
Domestic Value Added content in Exports	Industry wise share of DVA in exports	OECD -TIVA
Research and Development	Research and development expenditure (% of GDP)	WDI
Researchers per million	The number of researchers engaged in R&D, expressed as per million	WDI
Inward FDI	Foreign direct investment, net inflows (% of GDP)	WDI
Gross capital formation	Gross capital formation (as a % of GDP); Gross domestic investment	WDI
Education Expenditure	Government expenditure on education expressed as a percentage of GDP. Proxy for the human capital in nation.	WDI

Part I: Cross Country Analysis

This paper examines the impact of Research and Development on three different dependent variables, namely total DVA, DVA in manufacturing sector and DVA in Service sector. To measure R&D, two indicators are used (1) Research and Development expenditure as a percentage of GDP and (2) Total number of researchers per million in the population. These two are our key variables of interest.

Other control variables chosen include (1) FDI net inflows, to capture the openness to FDI (2) Gross capital formation to account for the domestic investment in the economy and (3) Government expenditure on education to capture the human capital capabilities of a nation. All the control variables are taken as a percentage of GDP.

The summary statistics of all the variables used are given in table 2.

Table 2: Summary Statistics

Variable	Obs	Mean	Std. Dev.
DVA_x	1,560	143947.8	255710.7
mfg_dva	1,560	75889.04	157188.5
service_dva	1,560	54373.22	103548.7
RnD	1,216	1.327013	.9791812
Researcher~m	1,075	2658.815	1881.6
fdi_inwards	1,553	6.885597	23.53876
Gross_K	1,539	24.08063	5.542082
Edu_Exp	1,261	4.721588	1.393493

The following empirical specifications are estimated for the analysis:

$$DVA_{it} = \beta_1 R\&D_{i,t-1} + \beta_j X_{i,t-1} + \alpha_i + e_{it} \quad (\text{Equation 1})$$

$$DVA_{it} = \beta_1 RPM_{i,t} + \beta_j X_{i,t-1} + \alpha_i + e_{it} \quad (\text{Equation 2})$$

Here DVA_{it} represents the DVA content in exports in country 'i' at time period t. β_1 is the coefficient of interest. R&D stands for expenditure on R&D sector as a percentage of GDP and RPM stands for Researchers per million. These two are the key variables of interest. $X_{i,t-1}$ is the vector of other explanatory variables and β_j are the corresponding coefficients. α_i is the country fixed effect term and e_{it} is the error term.

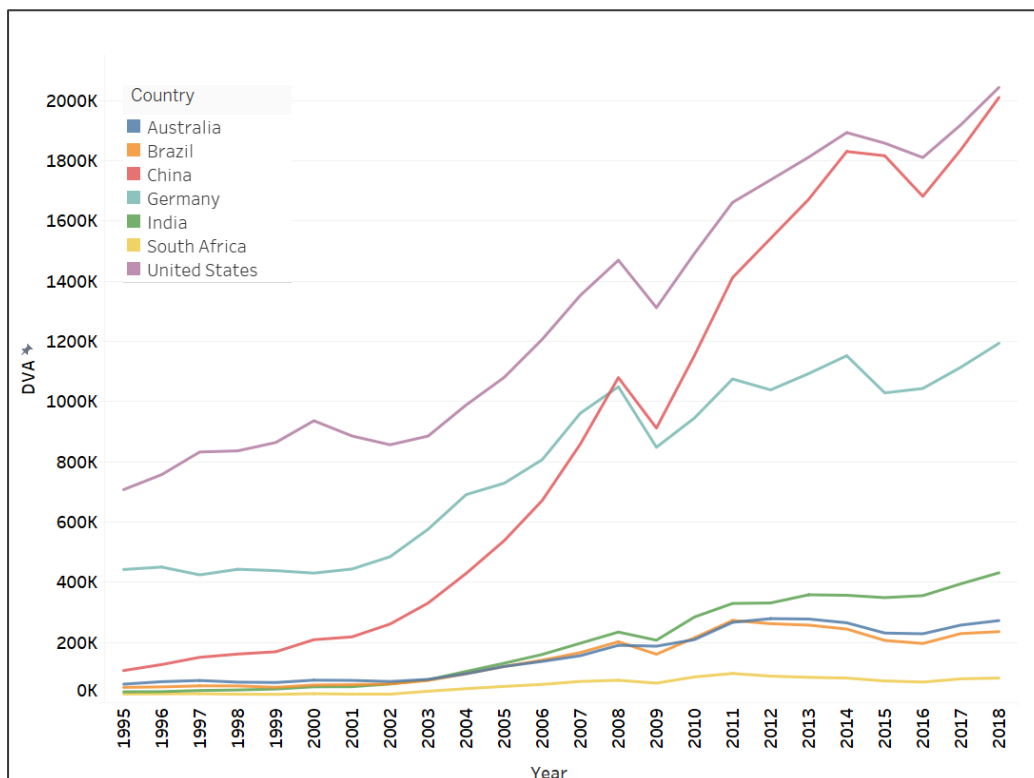
All variables are transformed using a natural logarithm which allows the coefficients to be interpreted as elasticity. To address the potential concerns of endogeneity and to allow for a deferred impact on D.V.A., all explanatory variables are lagged by one year.

All regression specifications are estimated with a fixed effect model. The Breusch-Pagan test and Hausman test confirms that the fixed effect model is better than the pooled estimates and random estimates model (Appendix – Annexure I). In all regressions, standard errors are calculated using White’s heteroscedasticity robust standard errors.

Results

For almost all the 65 countries chosen for the study, DVA content in exports has shown a positively increasing trend over the period of the analysis. Figure 1 shows the trend for some of the countries.

Figure 1: Trends of DVA (Selected few nations)



The results of the regression are presented in Tables 3.

Table 3: Regression Results

	(1) ln_dva	(2) ln_mfg_dva	(3) ln_service~a	(4) ln_dva	(5) ln_mfg_dva	(6) ln_service~a
L.ln_rnd	1.096*** (7.42)	1.037*** (6.80)	1.103*** (7.60)			
L.ln_fdi_in	0.0347 (1.51)	0.0258 (1.17)	0.0367 (1.44)	0.0254* (1.72)	0.0169 (1.10)	0.0317* (1.85)
L.ln_gross_k	0.387** (2.45)	0.339** (2.21)	0.420*** (2.67)	0.318*** (3.03)	0.262** (2.46)	0.377*** (3.45)
L.ln_edu	0.343 (1.62)	0.309 (1.52)	0.400* (1.70)	0.267 (1.04)	0.305 (1.10)	0.260 (1.08)
ln_research~m				1.000*** (6.82)	0.901*** (6.73)	1.055*** (6.85)
_cons	9.370*** (16.41)	8.710*** (15.75)	8.254*** (13.97)	2.183** (2.04)	2.192** (2.11)	0.690 (0.63)
N	923	923	923	856	856	856

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Source: Author's calculations

The estimates confirm that expenditure on R&D as well as number of researchers per million (two key variables of interest, row 1 and row 5 respectively), both are positively as well as significantly correlated with DVA.

The estimated association between total DVA and R&D expenditure is 1.096 (column 1, row 1), which indicates that a 1 percent rise in R&D expenditure, ceteris paribus, is correlated with a 1.09% percent increase in D.V.A. Similar results are seen for the manufacturing as well as the services sector where 1% increase in R&D, ceteris paribus, is correlated with a 1.037% and 1.103% increase in the sectors respectively.

Similarly, in the case of researchers per million (Row 5), a 1% increase in the explanatory variable leads to roughly 1% increase in the dependent variables (total DVA, DVA in manufacturing, DVA in services). All the results are highly significant.

The results obtained are in line with the theoretical predictions. The efficiency or effectiveness of countries' R&D and innovation systems are considered to be the key drivers of firm productivity, efficiency, and export competitiveness. And this is especially significant when countries want to move up the GVCs (Zeng, 2017). Vrh (2018) also emphasized the importance of intangible capital in explaining the differences in DVA content of exports of different nations. The results obtained in the current analysis, clearly indicate that higher R&D expenditure as well as more number of researchers involved in R&D can help in boosting DVA in exports and hence attract higher income for a nation.

For any country to compete at the global level, it is imperative to focus on R&D. India is currently the fifth largest economy in the world, but it lags behind many developed nations when it comes to expenditure on R&D. If India wishes to grow and gain its full potential from trade, it must focus on increasing its Gross expenditure on R&D (GERD) as well as training more people as researchers.

On a side note, table 3 also presents some interesting insights related to the control variables. The domestic gross capital formation appears to have a positive and significant impact on DVA, however the impact of FDI and education expenditure remains insignificant. This indicates that a push to capital expenditure, apart from other benefits, also can positively impact trade gains for a nation.

PART II

The case for India: Smile Curves

India plays a pivotal role in global trade due to its large and diverse economy and it is assumed that it stands to gain several benefits by participating in global value chains. The domestic value-added content of exports for any country can serve as an indicator of a country's export competitiveness (Kittova et al., 2013) and potential income gains from trade.

To see how India has fared so far post liberalization of its economy, trends of DVA content of exports of India should be analyzed. This would not only help us to understand the gains received by India so far but also help in making informed policy decisions depending on the trajectory followed by the country.

When we look at the DVA content of exports for India, over the period of 1995 to 2018, we see an increasing trend (Figure 2). However, if we observe DVA in exports as a share of total exports, the trend is not the same (Figure 3).

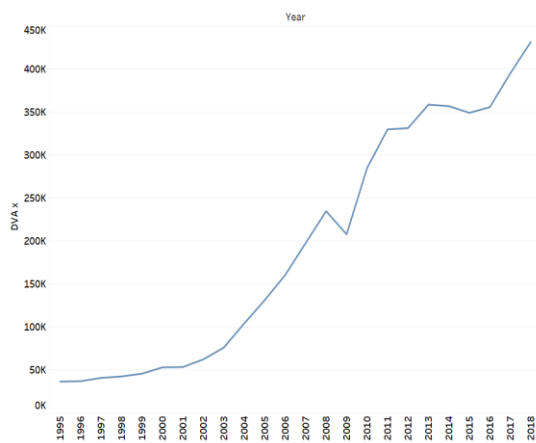


Figure 2: Total DVA in Exports

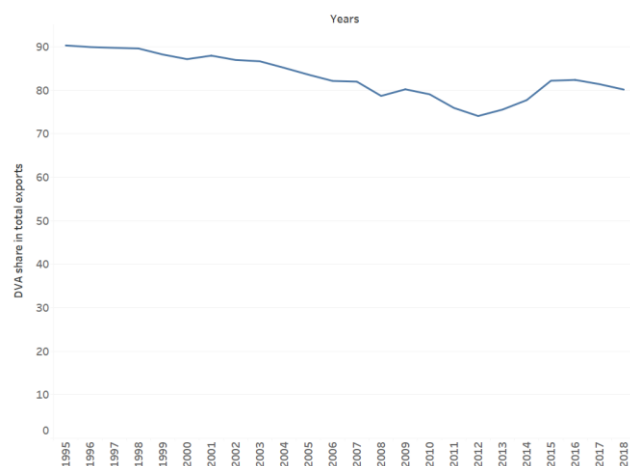


Figure 3: DVA share in total exports

When DVA is considered as a share of total exports, we see a U-shaped curve emerging. This is an empirical regularity often observed in the case of Value Addition which is known as 'The smile curve'.

The concept of the smile curve was first proposed by Stan Shih (1992), the founder of Acer, a technology company headquartered in Taiwan. The concept of smile curve has been widely used in the context of GVCs (e.g., Mudambi, 2008; Shin et al., 2012) (Aggarwal, 2017).

A lot of work has been done on the smile curve at firm level. This paper tries to find out whether or not the trend is also observed at industry level in India.

Using the OECD-TiVA database, industry wise share of DVA as a proportion of total exports is plotted over a period of 24 years (1995-2018) for six industries namely:

1. Textile, leather and related products (D13T15)
2. Chemicals (D19T23)
3. Machinery and equipment (D28)
4. Electrical equipment (D27)
5. Base metals and iron and steel (D24T25)
6. Transport equipment (D29T30)

The values mentioned in the parenthesis is the code classification that is assigned by the OECD-TiVA database. It is different from the HS classification that is more commonly used in the areas of trade (For HS classifications, refer to appendix, annexure II). These particular industries were chosen on the basis of their importance in India's export and import basket. These sectors are found to be deeply integrated with the GVCs (Pathikonda & Farole¹, 2016) It is observed that the selected sectors collectively account for around 30%–40% of the export and import shares in the Indian trade basket, respectively. (Aggarwal et.al.).

The graphs showing individual trends for all the mentioned six industries are given in the Appendix, Annexure III.

Analysis:

For most of the chosen industries we see an initial fall in the DVA share. In some cases such as the chemicals industry, the fall is very stark, whereas in some other industries such as textiles, the fall is quite modest. After the initial fall, eventually the DVA share picks up and we see an upward trend.

One possible reason for the downward fall is higher integration of the India economy with the global value chains. Carballo and Xiang (2016) confirm that in 1995–2008,

many countries experienced “value added erosion”, which is the decline in the sectoral shares of domestic value added in a country’s exports, as the country becomes more integrated into the global value chains (GVCs).

Post integration with GVCs, nations DVA share declines because cheaper foreign imports replace domestic inputs when economies are opened up. Carballo and Xiang (2016) also observed injection of foreign high-skill labor content in the domestic exports as a cause for this decline.

However, eventually, the DVA share did see a rise. Plausible reasons that can be attributed to this trend are productivity enhancement and realization of scale economies of Indian firms over a period of time, which in turn led to substitution of imported inputs with domestic inputs by the exporters.

The Exception

China is an important exception when it comes to following the ‘Smile Curve’ trend. The research done by Dollar et.al (2017) shows that China’s DVA share in exports has been rising over the past decade and the primary reason for the same is the technological advances that have taken place in China.

Consequently, the Chinese DVA ratio is expected to peak and thereafter decline, forming a ‘frown curve’ – the opposite of the Smile Curve.

The case of China shows us what an incredibly important role R&D can play in impacting the DVA in exports of a nation and thereby writing its trade success story.

Discussion and Conclusion

The participation of countries in trade has deepened significantly over the last few decades. And with this increasing participation, there is more focus on how can countries gain from trade. One important indicator to measure trade benefits in the DVA content of exports of a nation. Literature shows that a higher R&D is correlated with higher DVA. The case of China is also proof of the same. R&D otherwise is seen

as an important innovation indicator. However, it also has spill-over effects on trade gains. This paper empirically proves that a higher R&D expenditure as well as higher researchers per million in a population, is positively correlated with higher DVA. One possible policy prescription, that is based on the empirical findings is facilitation of technological upgradation processes in countries. R&D activities need encouragement since they have a positive external effect on various areas of the economy, one of them being trade.

India opened its economy to the rest of the world in 1991 after the LPG reforms. Like all other nations, Indian industries expected to be better off as a result of it. However, in the initial years, India's DVA share as a proportion of exports fell for most industries before it started picking up in the late 2000s. This may appear to be a worrisome trend, but in reality, it is an empirical regularity observed in the area of trade called the 'Smile Curve' effect. Dollar et. al. (2019) stresses that imported goods and services are a key support to a country's competitiveness and a falling share of DVA is not necessarily a negative thing. The six manufacturing industries identified in the paper have followed the empirical trend of Smile Curve. Currently, India appears to be on a path towards higher growth and higher income from trade as most of its industries show an upward trend in DVA post late 2000s. India must further focus on increasing R&D expenditure and training personnel for research, so that it can continue on this upward trend and observe all the potential gains from trade.

Limitations

One limitation of the paper is the problem of missing data. Some observations in the panel data are missing and this may create a problem of sampling bias. Another limitation is that the OECD classifications does not match with HS classifications, due to which the usage of this study in policy sphere may remain limited.

REFERENCES:

Aggarwal, S. (2017). *Smile curve and its linkages with global value chains*. *Journal of Economics Bibliography*, 4(3), 278-286

Aggarwal, S., Chakraborty, D., & Bhattacharyya, R. (2021). *Determinants of domestic value added in exports: Empirical evidence from India's manufacturing sectors*. *Global Business Review*, 09721509211050138.

Baldwin, R., & Ito, T. (2021). *The smile curve: Evolving sources of value added in manufacturing*. *Canadian Journal of Economics/Revue canadienne d'économique*, 54(4), 1842-1880.

Banga, R. (2014). *Linking into global value chains is not sufficient: do you export domestic value added contents?*. *Journal of Economic Integration*, 267-297.

Caraballo, J. G., & Jiang, X. (2016). *Value-added erosion in global value chains: an empirical assessment*. *Journal of Economic Issues*, 50(1), 288-296.

Coe, D. T., & Helpman, E. (1995). *International r&d spillovers*. *European economic review*, 39(5), 859-887

Dollar, D., Khan, B., & Pei, J. (2019). *Should high domestic value added in exports be an objective of policy?*. *Global value chain development report*, 141-153.

Engelbrecht, H. J. (1992). *Australia's industrial R&D expenditure and foreign trade*. *Applied Economics*, 24(5), 545-556.

Harris, R., Moffat, J., 2011. *R&D, innovation and exporting*. SERC (Spatial Economics Research Center) Discussion Paper No. 73, London School of Economics, London, UK

Keller, W. (2002). *Trade and the Transmission of Technology*. *Journal of Economic growth*, 7, 5-24.

Kittová, Z., Steinhauser, D., & Drieniková, K. (2023). *Determinants of domestic value added in exports of the EU countries*. *Acta Oeconomica*, 73(2), 285-303.

Liu, L., Shen, M., Sun, D., Yan, X., & Hu, S. (2022). *Preferential attachment, R&D expenditure and the evolution of international trade networks from the perspective of complex networks*. *Physica A: Statistical Mechanics and its Applications*, 603, 127579.

Mehta, S. (2018). *Tilting towards south: Pattern and determinants of global value chains*. *Seoul Journal of Economics*, 31(1), 63–97.

Mudambi, R. (2008). *Location, control and innovation in knowledge-intensive industries*, *Journal of Economic Geography*, 8(5), 699-725. doi. 10.1093/jeg/lbn024

Pathikonda, V., & Farole, T. (2016). *The capabilities driving participation in global value chains (Policy Research Working Paper 7804)*. World Bank.

Salim, R. A., & Bloch, H. (2009). *Business expenditures on R&D and trade performances in Australia: is there a link?*. *Applied Economics*, 41(3), 351-361.

Shih, S. (1996). *Me-Too is not my Style: Challenge Difficulties, Break through Bottlenecks, Create Values (Taipei: The Acer Foundation)*

Shin, N., Kraemer, K.L., & Dedrick, J. (2012). Value capture in the global electronics industry: Empirical evidence for the smiling curve concept. *Industry and Innovation*, 19(2), 89-107. doi. 10.1080/13662716.2012.650883

Sydor, A. (2011). Global value chains: Impacts and implications—Editor's overview. *Global value chains: Impacts and implications*, 1-16.

Veeramani, C., & Dhir, G. (2019). Reaping gains from global production sharing: Domestic value addition and job creation by Indian exports (No. 2019-024). Indira Gandhi Institute of Development Research, Mumbai, India

Vrh, N. (2018). What drives the differences in domestic value added in exports between old and new EU member states?. *Economic research-Ekonomska istraživanja*, 31(1), 645-663

UNCTAD Report 2013. *Global Value Chains and Development*

Ye, M., Meng, B., & Wei, S. J. (2015). Measuring smile curves in global value chains.

Yu, C., & Luo, Z. (2018). What are China's real gains within global value chains? Measuring domestic value added in China's exports of manufactures. *China Economic Review*, 47, 263-273.

Zeng, D. Z. (2017). Measuring the effectiveness of the Chinese innovation system: A global value chain approach. *International Journal of Innovation Studies*, 1(1), 57-71

Appendix

Annexure I

Results of Breusch-Pagan Test:

For the variables ln_dva l.ln_rnd l.ln_fdi_in l.ln_gross_k l.ln_edu :

Breusch and Pagan Lagrangian multiplier test for random effects

$$\ln_dva[\text{countryx},t] = Xb + u[\text{countryx}] + e[\text{countryx},t]$$

Estimated results:

	Var	sd = sqrt(Var)
ln_dva	2.210202	1.486675
e	.1758196	.4193085
u	1.85969	1.363704

Test: $\text{Var}(u) = 0$

chibar2(01) = 4302.81
Prob > chibar2 = 0.0000

For the variables ln_dva ln_researcher_pm l.ln_fdi_in l.ln_gross_k l.ln_edu:

Breusch and Pagan Lagrangian multiplier test for random effects

$$\ln_dva[\text{countryx},t] = Xb + u[\text{countryx}] + e[\text{countryx},t]$$

Estimated results:

	Var	sd = sqrt(Var)
ln_dva	2.276227	1.508717
e	.1268179	.356115
u	1.809715	1.345257

Test: $\text{Var}(u) = 0$

chibar2(01) = 4951.20
Prob > chibar2 = 0.0000

Results of Hausman Test:

	— Coefficients —		(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	(b) fe	(B) random		
ln_rnd L1.	1.096295	1.03244	.063855	.0242073
ln_fdi_in L1.	.0347287	.0314867	.003242	.000097
ln_gross_k L1.	.3870492	.3847232	.0023261	.
ln_edu L1.	.3430992	.2935706	.0495286	.0144781

b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$\chi^2(4) = (b-B)'[(V_b-V_B)^{-1}](b-B)$
 = 12.43
 Prob>chi2 = 0.0144
 (V_b-V_B is not positive definite)

	— Coefficients —		(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
	(b) fixed	(B) random		
ln_research L1.	1.000002	.9471904	.0528113	.0090709
ln_fdi_in L1.	.0253646	.022187	.0031776	.
ln_gross_k L1.	.3178216	.315558	.0022637	.
ln_edu L1.	.2669397	.2301163	.0368235	.

b = consistent under Ho and Ha; obtained from xtreg
 B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$\chi^2(4) = (b-B)'[(V_b-V_B)^{-1}](b-B)$
 = 29.72
 Prob>chi2 = 0.0000
 (V_b-V_B is not positive definite)

Annexure II

Sector	TIVA Code 2018	HS Code
Textile, leather and related products	D13T15	4101-4115, 4201-4206, 5001-5007, 5101-5113, 5201-5212, 5301-5311, 5401-5408, 5501-5516, 5601-5609, 5701-5705, 5801-5811, 5901-5911, 6001-6006, 6101-6117, 6201-6217, 6301-6310, 6401-6406
Chemicals	D19T23	2801-2853, 2901-2942
Machinery and equipment	D28	8401-8487
Electrical equipment	D27	8501-8548
Base metals and iron and steel	D24T25	7201-7229, 7301-7326, 7401-7419, 7501-7508, 7601-7616, 7801-7806, 7901-7907, 8001-8007, 8101-8113, 8201-8215, 8301-8311
Transport equipment	D29T30	8701-8716

Source: Aggarwal et.al (2021)

Annexure III

