Capturing the Gains in Global Value Chains: Trade in Intermediates and Value Added Erosion

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Abstract

Many countries in 1995-2008 have experienced what we call "value added erosion", which describes the phenomenon of the decline in the shares of domestic value added in a country's exports as the country becomes more integrated into the Global Value Chains (GVCs). We argue that the decline of domestic value added share in a country's exports is likely to be caused by the expansion of high value-adding activities performed by foreign lead firms in the upper stream of the GVCs. The variables of interest namely, domestic value added share in exports, and foreign high-skilled labor embodied in a country's exports (a proxy for high value-adding activities in foreign lead firms) were estimated using a multi-regional global input-output model. Using these results with control variables, we applied a panel cointegration model and (when applicable) an OLS fixed effects model to explain and assess the likelihood of value added erosion and its possible determinants.

JEL Codes: F63; F66; D57; C23
Keynotes: Global Value Chains, value added, trade in intermediates

1. Introduction

During the past few decades, the world economy has changed significantly in its way of organizing production and distribution of goods and services globally, an important feature is the emergence and rapid expansion of networks of production activities leading to the final end use, this is known as Global Value Chains (GVCs). Trade in intermediates, as one of the key indications for the degree of prevalence of Global Value Chains (GVCs), became prominent in the 1990s beginning with China's entry into the world production system. The process was accelerated by the urge of setting up low-cost offshore facilities by electronic companies in the early 2000s (Milberg and Winkler 2013). World exports from developing countries grew throughout this period, but its composition also started to change as imports of intermediates increased steadily in the 1990s and speeded up in the 2000s. By end of 2000s, trade in intermediates accounted for about 56% of world trade in case of goods and 73% in case of services (Miroudot et al. 2009; Johnson and Noguera 2012).

The prevalence of GVCs has also been generating increasing volume of literature on GVCs. The existing literature on GVCs can be categorized into three general strands, the first two are based on theoretical issues surrounding the GVCs, and the third one is empirical. The first strand views the prevalence of GVCs as a sign of increased efficiency in the globalized system of production (Baldwin, 2012, 2009; Rossi-Hansberg, 2008; Ali and Durash, 2011). In other words, the expansion of GVCs is essentially the deepening of division of labor at a global scale, which necessarily leads to overall increase productivity following the classical views of Adam Smith. The second strand raises some skepticism around GVCs. Since GVCs require coordination amongst various agents (firms) around the globe, these agents often operate under asymmetric power relations. For example, lead firms in developed countries tend to have monopolistic market and negotiation power over lower tier suppliers from developing countries; in this case, GVCs would result unfair distribution of gains from globalization, and sometime systematic obstacles preventing lower tier suppliers from upgrading (Nolan and Zhang, 2010; Milberg, 2004; Milberg and Winkler, 2013; Kaplinksy, 2000; Heintz, 2006; and Nielson, 2013).

The third strand, which is also the thickest strand, is empirical. People realized that in a world where GVCs were the norm, trade in intermediates must be prevalent. And since country's trade data are given in gross terms, then the standard export and import statistics we are exposed to must be inflated due to trade in intermediates. For example, a country's gross exports must contain foreign import content, and each country's gross imports might also contain domestic content. Thus, recently, considerable amount of efforts has been made to empirically disentangle domestic and foreign contents of a country's foreign trade using various statistical and modeling techniques (Hummels et al., 2001; Koopman et al. 2010; Johnson and Noguera, 2012; Stehrer et al., 2012; Xi and Detert, 2010).This line of efforts has also turned into a few new international databases focusing on GVCs; two widely used ones are Trade in Value-added (TiVA) and World Input-Output Database (WIOD).

The present paper contributes to the second strand of the GVCs literature by making use of the empirical methods in the third strand. Inspired by Milberg (2004) and

Heinz (2006) who propose on the theoretical level the possibility of asymmetric power structure in GVCs resulting lower tier firms in developing countries failing to capture sufficient share of value-added in international division of labor, we empirically found that a country's decline of value added share tends to be associated with the injection of foreign high-skilled labor content in their exports. High-skilled labor content is essentially the empirical approximation of high value-adding activities performed by foreign lead firms with monopolistic market and negotiation power over their foreign suppliers. Some of the key variables in our analysis are obtained using some of the empirical methods from the third strand of GVCs literature.

Section 2 of this paper reviews related literature. Section 3 first decomposes each country's exports into foreign intermediates, domestic intermediates and domestic value-added contents; and then introduces the concept of "value-added erosion". Section 4 presents the econometric model we use to study the phenomenon of "value-added erosion". Section 5 discusses the results of our estimations. And section 6 concludes with policy implications.

2. Background Literature

As mentioned in the introduction, there exists a strand of literatures on Global Value Chains (GVCs) analysis that raised some concerns about the negative effects of international fragmentation of production on some countries' development; especially, their lack of ability to upgrade to higher value-added activities within the global value chains.[1] Milberg (2004) proposes a theory of endogenous asymmetric market structure in GVCs. According to this theory, lead firms on the top of GVCs tend to have monopolistic or oligopolistic market power, whereas lower tier firms tend to face intensive competitive pressures from each other. The asymmetric market structure consequently causes asymmetric bargaining power between lead firms and lower tier firms; hence, firms at the bottom of GVCs tend to face tremendous amount of difficulties with value-added upgrading. Nolan and Zhang (2010) have raised similar concerns, arguing that lower tier firms from developing countries are facing even more difficulties with upgrading after the 2008 financial crisis. Heinz (2006) constructs a model in the unequal exchange tradition to study the distributive dynamics of GVCs. In his model, lead firms specialize in high value-added portion of production chain such as product development, design, branding, and advertising. However, the actual production (which is often low value adding) is subcontracted out to lower tier firms often from other countries. The result for such dynamics is uneven distribution of gains from globalization.

This paper is inspired by those theoretical insights. Heinz (2006) hypothesizes the dynamic process of foreign high value-adding activities eroding the domestic value-added portion of exports. However, this hypothesis has never been validated empirically at the macro-level (to our knowledge). We should notice that the notion of "value added erosion" is already apparent in his theory. Heinz's distinction between high value adding and low value adding activities is also of great importance for us. If we follow the international trade theorists who believe international trade as "trading tasks"[2], then, we

[1] Some authors call this "the middle-income trap".
[2] See Grossman and Rossi-Hansberg (2008)

could approximate high value-adding activities by hours worked by high-skilled workers, and low value-adding activities by hours worked by low-skilled workers. This approximation is consistent with Heinz's argument since the type of activities lead firms likely to perform according to him tends to require high skilled labors. If this was a good approximation, then, we should be able explain domestic value-added erosion by the injection of high skilled foreign labor in a country's import content.

Following the multi-regional input-output method in Jiang (2013), we are able to extract the vector of shares of foreign high skilled labor embodied in each country's exports for the period of 1995-2009. These values are proxies for foreign high value-adding activities in GVCs, which will be an important independent variable in our regression analysis in section 4.

3. Value-added Erosion and Domestic-Foreign Substitution

3.1 Export Decomposition

The WIOD contains a set of national input-output tables for 1995-2009 (Timmer et al., 2012). Using these tables, we are able to decompose each country's exports in to following components: Domestic Intermediate (DI), Foreign Intermediate (FI), and Value-added generated by exports (VAE). These three components can be empirically calculated by equations below:

$$DI = B^{D^T}[I - A]^{-1}X \quad (1)$$

$$FI = B^{M^T}[I - A]^{-1}X \quad (2)$$

$$VAE = \widehat{va}[I - A]^{-1}X \quad (3)$$

Following the input-output method,$[I - A]^{-1}X$ is the vector of total values generated by a country's exports. $B$is called the direct output coefficient matrix. Unlike the input coefficient matrix A, matrix B is acquired by dividing each row of the basic flow matrix Z, by gross outputs. The superscript$D$ and M denote domestic and imported, respectively. $\widehat{va}$in (3) is adiagonal matrix of value-added coefficients. The reason we use B here in our decomposition comes from the following input-output identity:

$$Y = B^T Y + VA \quad (4)$$

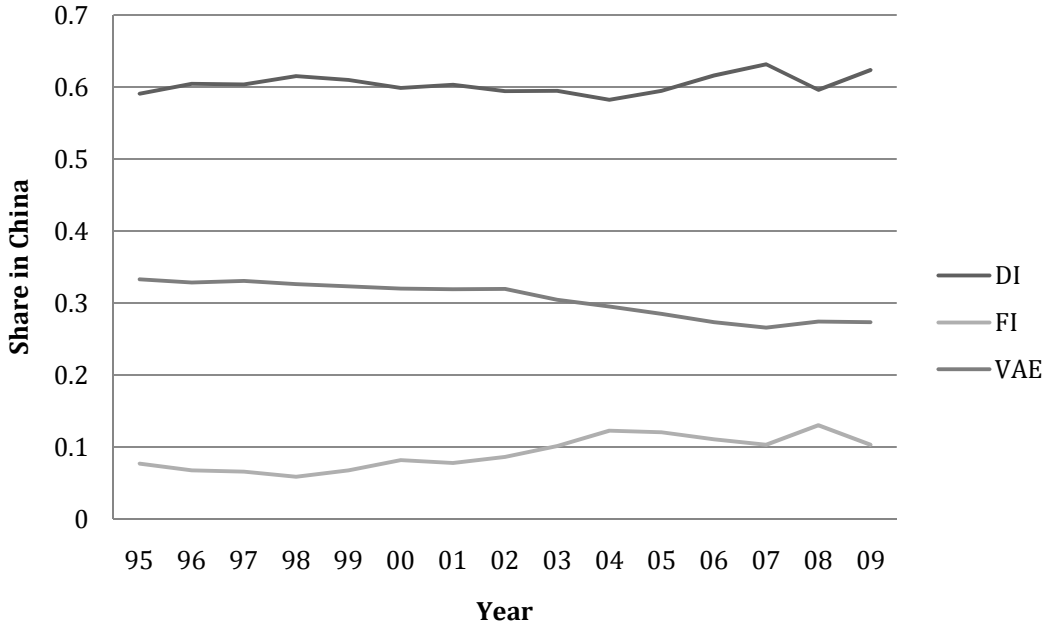
where VA is the vector of value added.Since we are interested in how much value-added is generated in a country's exports, then, using B matrix instead of A is necessary. Behind equations (1) to (3) is an important balancing condition. The sum of the shares has to equal to one.

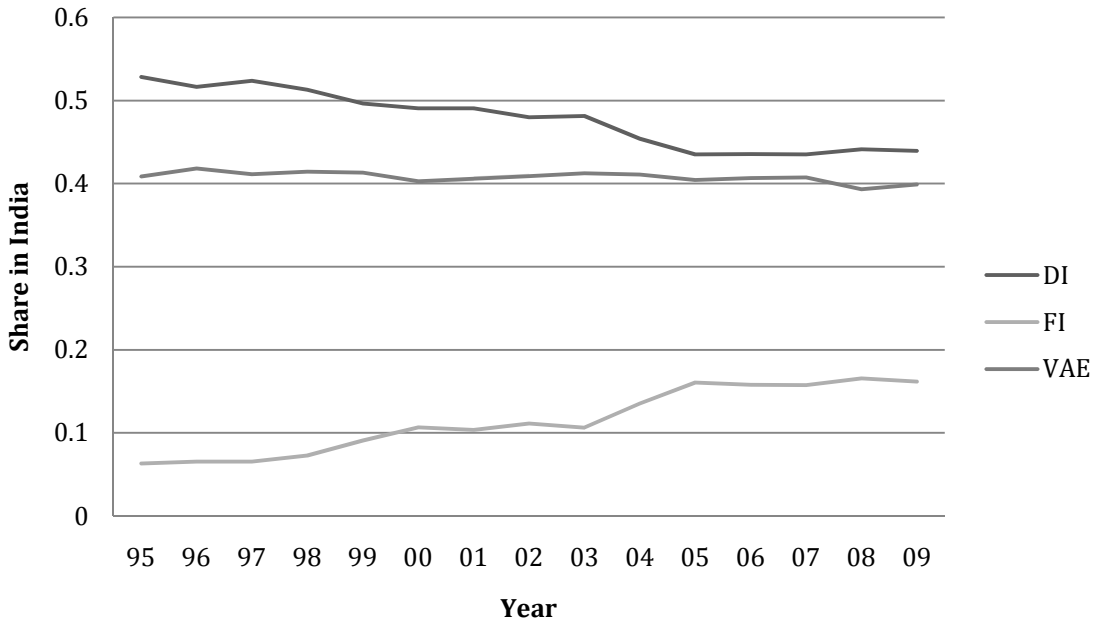
$$\frac{\sum DI + \sum FI + \sum VAE}{\sum [I-A]^{-1}X} = 1 \quad (5)$$

The global trend of steady increase of import content of exports has been well documented in the literature, hence, we should expect to see that the foreign intermediates share have risen in most of countries. Furthermore, according to the balancing condition (5), an increase of foreign intermediates share may result three

possible outcomes. First, domestic intermediate share might reduce to compensate the increase of foreign intermediate share. We call this effect the "domestic-foreign substitution". Second, the increase of foreign intermediate share might be compensated by a reduction of value-added share. We call this effect the "value-added erosion". The third outcome is of course the combination of the previous two effects. From this point of view, the effect of the increase of foreign intermediate share as the result of a country's participation in GVCs should vary from country to country. Figure 1 below takes China and India as examples to illustrate the phenomenon of value-added erosion and domestic-foreign substitution in aggregate.

Figure 1. Composition of Value Generated by Exports, China and India, 1995-2009





Notes: DI: is the domestic intermediate share; FI is the foreign intermediate share; and VAE is domestic value-added share, in exports.
Source: Authors' own calculations.

It is clear from the upper panel that, in the case of China, the increase of foreign intermediate share (FI) over time is compensated for by the decline of domestic value-added share (VAE). Therefore, this is called value-added erosion. In the case of India in the lower panel, the increase of foreign intermediates share over time has been compensated for by the decline of domestic intermediates. Therefore, this is an example of domestic-foreign substitution.

3.2 Value-added Volume vs. Value-added Share

Since the idea of value-added erosion rests on the concept of declining domestic *value-added share* in exports, we think it is important to engage in a brief discussion on the usefulness of the concept of value-added share. The low domestic value-added share for countries participating in GVCs has been brought to attention by a series of literature in the late 2000s, the most widely cited being Xing and Detert, (2010), Koopman et al. (2010), and Kraemer et al. (2011). These findings have also generated a degree of anxiety among policymakers and triggered a series of policy discussions on whether increasing domestic value-added share should be a new policy objective. At the same time, some voices argued that increasing value-added share might be a misguided policy measure, and that the emphasis should be on the total *volume* of domestic value-added rather than in the *share* of domestic value-added. This is because the former is what generates absolute incomes in a country. This line of argument is further backed up by the endogenous growth theory arguing that foreign intermediates facilitate technological diffusion in the home country. Therefore, it would presumably stimulate exports and output growth. In other words, they argue for *complementarity* between domestic value-added and foreign intermediates, because the latter apparently fuels growth of the former. Therefore, the arguments appear to state: as long as foreign intermediates are generating

higher volumes of domestic value-added, the decline of domestic value-added share should not be a concern. (OECD, 2015; López–Gonzálezand Kowalski, 2015)

While we recognize the existence as well as the merits of this position, we make four points below to express an alternative perspective. First, the complementarity between domestic value-added and foreign intermediates is extremely difficult to verify empirically because these two variables are highly endogenous. Any trade expansion would likely lead to a simultaneous increase of both domestic value-added and foreign intermediates in exports. Hence, empirically establishing a causal relationship between these two variables is an extremely difficult task.

Second, regarding the endogenous growth story, while some foreign intermediates in the form of high-tech components might stimulate domestic growth and might increase domestic productivity via technological and information diffusion, it is difficult to see how foreign intermediates in the form of financing, marketing, and advertising will help to spread advanced foreign technology in a country. There is growing evidence that foreign intermediates are increasingly taking on the latter form (Heinz, 2006; Milberg and Winkler, 2010).

Third, if one cannot provide a solid empirical justification for the complementarity between foreign intermediates and domestic value-added in exports, then the validity of the argument emphasizing volume over share has to rest on the assumption that there is always an expanding global effective demand, and growth of the total size of the pie will dominate the decline of the share of the pie. There is no reason to believe in an ever-expanding global effective demand in the future. For instance, in Malta, Canada, Mexico, Ireland, France, and Cyprus the total value added in exports declined during the period 1995-2009. In fact, the 2008 Great Recession has shown the high vulnerability of global demand to shocks emanated from some developed countries, particularly the US (Baldwin, 2009). Furthermore, from a Keynesian perspective, a very uneven global distribution of income may slow down growth of global effective demand.[3] If the global effective demand slows down at some point, capturing larger share of the gains from globalization will be a major concern.

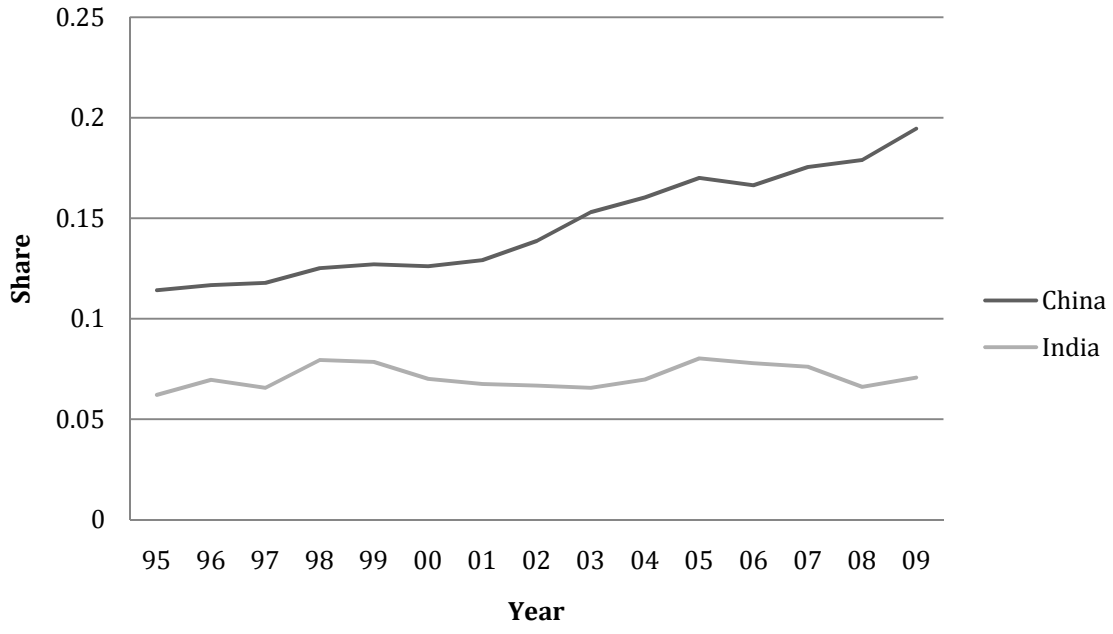
Lastly, the debate over share and volume has its roots in economic ideology. This debate is essentially a mirror image of the heated debate on wage rate versus wage share between neoclassical and post-Keynesian economists. If one believes that the labor market is perfect and that wage rate is determined by the marginal product of labor, then the decline of wage share should not be a major concern. Similarly, if one believes the market structure in GVCs is more or less perfect, then the decline of domestic value-added share should not be a worrisome phenomenon either. However, numerous authors point out the asymmetries of market and bargaining power in GVCs and have raised concerns of the distributional conflicts in GVCs.[4] Therefore, if we believe the distribution of the gains from global production sharing are, to a large extent, the result of asymmetric power relations, then the decline of domestic value-added share should be a policy concern.

[3]See La Marca (2013) and Von Arnim et al. (2012).
[4]See Nolan and Zhang (2010), Gereffi (2012), Milberg (2004), Kaplinsky (2000) and Nicita et al. (2011).

3.3 Value-added Erosion and Foreign High-skilled Labor Content

Now, the question becomes, when facing the steady increase of foreign intermediate share of countries' exports, what determines a country's response? Or more precisely: why would some countries experience value-added erosion as they participate in GVCs by importing more foreign intermediates to produce their export goods? Heinz (2006) hypothesizes a dynamic process of foreign high value-adding activities eroding the domestic value-added portion of exports. However, this hypothesis has never been validated empirically at the industry-level (to our knowledge). We should notice that the notion of "value-added erosion" is already apparent in his theory. Heinz's distinction between high value-adding and low value-adding activities is also of great importance for us. If we follow the international trade theorists who believe international trade is "trading tasks",[5] then we could approximate high value-adding activities by hours worked by high-skilled workers, and low value-adding activities by hours worked by low skilled workers. This approximation is consistent with Heinz's argument since the types of activities that leading firms are likely to perform, according to Heinz, tend to require high skilled labor. If this is a good approximation, we should be able explain domestic value-added erosion by the injection of high-skilled foreign labor in a country's import content of exports.

Figure 2. Share of Foreign High-skilled Labor in Import Content of Exports, China and India



Source: Authors' own calculations.

Figure 2 illustrates the evolution of foreign high-skilled labor share in China and India's aggregate import content of exports. The aggregate results for China and India

[5] See Grossman and Rossi-Hansberg (2008).

seem to verify our hypothesis based on Heinz (2006): China is a country that experienced value-added erosion and is also a country that experienced a surge of foreign high-skilled labor share embodied in its import content of exports. However, this injection in foreign high-skilled labor did not occur in India, a country that also did not experience value added erosion.

The aggregate results for China and India seem to indicate the possible causal relationship between the surge of foreign high-skilled labor embodied in a country's import content of exports and the decline of domestic value-added share over time. China with increasing foreign high-skilled labor share embodied in its exports experienced declining domestic value-added share (value-added erosion), whereas India that did *not* experience foreign high-skilled labor surge was able to maintain its domestic value-added share and went on the path of domestic-foreign substitution. However, we are still interested in finding out whether this relationship holds for all the countries in our panel cross sectors, and whether this is more or less a global pattern across all countries. Moreover, what are the other determinants of domestic value-added share? We address these questions systematically using econometrics in the next section.

4. Empirical Models

Due to the lack of theoretical models in GVC literature, we do not impose an *a priori* fixed parameterization on our model. As mentioned earlier, we suspect that the inflow of Foreign High-Skill Labor content embodied in Exports (FHS) due to a county's participation in GVCs might be one of the greatest causes for the phenomenon of value-added erosion. Seeking for robust control variables, we run several stepwise regressions that could indicate the appropriate parametric form based on the level of information contained in the following candidates: Patent Applications of Residents, Exports over GDP, Natural Resources Rents (% GDP), Trademark Applications, Real Exchange Rate, Patent Applications of Non-Residents, Gross Enrollment ratio in primary education, and the mean tariff applied to manufactured products (henceforth tariff).

In this process we arrived to the following regression that is given by,

$$V_{it} = \alpha + \theta F_{it} + \beta E_{it} + \delta R_{it} + \kappa T_{it} + u_{it} \qquad (6)$$

where V is the share of domestic value added in exports, α is the intercept, F is the FHS, E is the gross enrollment ratio in primary education, which approximates the effect of human capital may have on domestic value added; R is the patent applications of non-residents, which serves as the control variable for the effect of research and development expenditures on value added activities following Neo-Schumpeterian trade literature; T is a vector of Tariffs, which controls for the globalization impacts that may affect the share of domestic value added by, for instance, the weakening or increasing the competition to domestic infant industries of trade and/or by weakening industrial policies; and finally u is a vector of deviations. Variables in equation (1) are I(0), so we apply the regression in levels. The Hausman test rejects the null hypothesis that fixed effects do not exceed the random effects model, leading us to apply the former model to control up to certain

extent for idiosyncratic factors within each country. Through the Variance Inflation Factor, no problems of collinearity were found.

In equation (1) the cross sectional dimension is composed of 38 countries (Taiwan was not included since the World Bank does not have data for this jurisdiction), so the estimates are the result of cross-countries averaging. However, it is also important to ask, what if different countries have different relationships between FHS and its share of domestic value added in exports? Fortunately, the data we work with (WIOD and input-output results from the WIOD) have three dimensions (38 countries, 33 sectors and 15 years), thus country level-panel data estimation is possible. To uncover the heterogeneity between the variables of interest in each country, we now run country-level regression for each country using its 33 industries as the cross sectional dimension.

Since we are only interested in approximating the impact of FHS on the share of domestic value added in exports and not in constructing *the* model of value added determinants, we do not include an exhaustive list of covariates because in many countries there is no sectoral data for the 33 industries. Thus we considered the sectoral variables contained in the World Input Output Database (WIOD) that may affect the trade pattern of these countries. Our country-level model does include a list of control variables based on relevant theories, as explained below. Attempting to fulfill the parsimonious principle, the following empirical model was applied to the sample 1995-2009,

$$V_{it} = \alpha + \vartheta \mathrm{F}_{it} + \gamma \mathrm{X}_{it} + \omega \mathrm{P}_{\mathrm{it}} + \tau \mathrm{K}_{\mathrm{it}} + \rho \mathrm{Y}_{\mathrm{it}} + \mathrm{e}_{\mathrm{it}} \qquad (7)$$

where X is the labor productivity, which indicates the role of labor productivity in stimulating or discouraging the prevalence of certain firms in different sectors by, according to the classical trade theory, changing the country's comparative advantage. P is the output price level, which serves as the control variable for the effect of output prices (at the industry level) may have on domestic value added share following the neoclassical Armington specification (Armington, 1969). K is an index of real capital stock, which controls for capital-intensive industries or for industries where large investment has taken place. Y is the total real output, which controls for the output sold which may affect the current share of domestic value added, and finally e is another vector of deviations. The Variance Inflation Factor is relatively small, reflecting no problems of colinearity.[6]

The series corresponding to 11 countries are I(1) and are not co-integrated. Thus, for this set of countries we applied OLS panel regression with fixed or random effects, as suggested by the Hausman test. We also applied White cross section standard errors for each coefficient of this set of countries. Four other countries gave statistically insignificant results, and their results are omitted here.

The series in (7) corresponding to the rest of the countries (24 countries) are I(1)

[6] Some of our regression tests are in Appendix for the reviewers in the form of printouts to increase reliability. However, the appendix is not intended to be published.

and are co-integrated according to the Kao Residual Co-integration Test (Kao, 1999). Applying differences to this I(1) group of co-integrated series can lead us to bias results (Kao, 1999). Thus, we estimate a co-integration model known as the Fully-Modified Ordinary Least Squares (FMOLS) that corrects for potential endogeneity and serial correlation, if there is any. In addition, FMOLS is able to handle some bias from omitted variables in equation (7) (Pedroni, 2000). Following Kao et al. (1999), a general specification of the FMOLS model that corresponds for a fixed effect panel regression is given by,

$$\mathrm{V_{it}} = \mathrm{C}_i + x_{it}^{'}\Delta + u_{it}, i = 1, \dots, N, t = 1, \dots, T \qquad (8)$$

where $\{\mathrm{V_{it}}\}$ are 1 x 1 IMRs, Δ is a k x 1 vector of slope parameters, $\{\mathrm{C}_i\}$ are the intercepts, and $\{u_{it}\}$ are the stationary disturbance terms. Assuming that $x_{it} = x_{it-1} + \varepsilon_{it}$ and $w_{it} = (u_{it}, \varepsilon'_{it})$, where ε_{it} is i.i.d. with zero mean, the FMOLS estimator is given by

$$\hat{\Delta}_F = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it} - \bar{x}_i)(x_{it} - \bar{x}_i)'\right]^{-1}\left[\sum_{i=1}^{N}(\sum_{t=1}^{T}(x_{it} - \bar{x}_i)\hat{I}_{it}^{+} - T\hat{\theta}_{\varepsilon u}^{+})\right]. \qquad (9)$$

where $\bar{x}_i = \frac{1}{T}\sum_{t=1}^{T} x_{it}$, $\hat{I}_{it}^{+} = \mathrm{I_{it}} - \widehat{\Omega}_{u\varepsilon}\widehat{\Omega}_{\varepsilon}^{-1}\varepsilon_{it}$, and $\hat{\theta}_{\varepsilon u}^{+} = \hat{\theta}_{\varepsilon u} - \hat{\theta}_{\varepsilon}\widehat{\Omega}_{\varepsilon}^{-1}\widehat{\Omega}_{\varepsilon u}$. The $\hat{\theta}_{\varepsilon u}^{+}$is an estimated bias correction term and $\widehat{\Omega}$ is a consistent estimator of Ω –the long-run covariance matrix of $\{w_{it}\}$. The long-run covariance matrix estimators$\widehat{\Omega}_{\varepsilon u}$and $\widehat{\Omega}_{\varepsilon}$will be estimated à la Andrews (1991) using a non-prewhitened kernel approach with Newey-West fixed bandwidth and Bartlett kernel.

Searching for robust results, we also applied a panel weighed estimation of equation (9). By following Kao and Chiang (2000) and Pedroni (2000), the weighted estimator becomes:

$$\hat{\Delta}^{*}{}_{F} = \left[\sum_{i=1}^{N}\sum_{t=1}^{T}(x_{it}{}^{*} - \bar{x}_i{}^{*})(x_{it}{}^{*} - \bar{x}_i{}^{*})'\right]^{-1}\left[\sum_{i=1}^{N}(\sum_{t=1}^{T}(x_{it}{}^{*} - \bar{x}_i{}^{*})\hat{I}_{it}^{*} - T\hat{\theta}_{i\varepsilon u}^{*})\right] \qquad (10)$$

where$x_{it}{}^{*} = \widehat{\Omega}_{i\varepsilon}^{-1/2}x_{it}$, $\hat{\theta}_{i\varepsilon u}^{*} = \widehat{\Omega}_{i\varepsilon}^{-1/2}\hat{\theta}_{i\varepsilon u}^{+}\widehat{\Omega}_{iu.\varepsilon}^{-1/2}$ and $\hat{\theta}_{i\varepsilon u}^{+} = \hat{\theta}_{i\varepsilon u} - \hat{\theta}_{i\varepsilon}\widehat{\Omega}_{i\varepsilon}^{-1}\widehat{\Omega}_{i\varepsilon u}$.The heterogeneity in the variances across countries are control by the estimator shown in (10).

5. Results and Discussion

In this paper we focus our analysis on value added because it is an important measure of incomes generated from trade, henceforth a key parameter for development policy. In fact, Hausmann et al. (2007) find that the ability to gain from globalization depends on exporting goods of higher quality sophistication. And highly sophisticated exports may have relatively high domestic value added. However, on the aggregate level, our results suggest that the share of domestic value added in exports has decreased in 87% of the countries in our sample during the period 1995-2009. In fact, the vast majority of these countries that have experience value-added erosion during that period are countries with a relatively high ratio of exports to GDP (in average 46%), indicating these countries' high dependency to foreign trade. This is significant if we consider the fact that 1995-2009 is the period when globalization intensifies with many free trade

agreements taking effect. For instance, the WTO was created in 1994-95, MERCOSUR was established in 1995, CUFSTA in 1989, NAFTA in 1994, European Economic Community in 1994, AFTA in 1993, and COMESA in 1994, among many others integration efforts.[7]

What factors, then, could explain this erosion in value added that appears to be inherent to today's globalized system of production and distribution? In Table 1 below we show that the major determinant is the greater inflow of foreign high-skilled labor embodied in a country's import content of exports.

Table 1. Panel Fixed Effects Estimation

Dependent Variable: Share of Value Added in Exports				
	(1)	(2)	(3)	(4)
V_{t-1}	.61***	.58***	.56***	.57***
	(0.05)	(0.11)	(0.11)	(0.12)
F_t	-.11**	-.08*	-.12*	-.13*
	(0.05)	(0.05)	(0.07)	(0.07)
T_t		.02	.04	.03
		(.02)	(0.03)	(0.02)
E_t			.06	.07
			(.04)	(.05)
R_t				-.02
				(0.03)
Adj. R^2	0.89	0.88	0.87	0.87
n	532	500	454	436

Notes: The adjusted r-squared is shown. All variables were standardized. A constant was added but not showed for space considerations.
Source: WIOD (2015), World Bank (2015)

An increase in foreign high-skilled labor share in exports (FHS) has a negative and relatively strong effect on value added share in exports. After controlling for other factors such as autocorrelation, acceleration of globalization, human capital, and foreign research and development in patents, the penetration of FHS has a high statistical significance and the highest relative magnitude on the share of value added. These results

[7] AFTA is the Association of Southeast Asian Nations Free Trade Area includes Malaysia, Indonesia, Singapore, Philippines, Brunei and Thailand. COMESA is the Common Market for Eastern and Southern Africa, MERCOSUR is the South American common market, NAFTA is the North American Free Trade Agreement, WTO is the World Trade Organization, and CUSFTA is the Canada and United State Free Trade Agreement.

are consistent with different sample sizes, have a relatively fair fit (as suggested by the r-squared), and conform to our earlier hypothesis based on Heinz's and Milberg's theoretical insights.

The tariffs imposed on manufacture products appear to have some impact on domestic value added share, though the statistical significance is relatively low. Essentially, a positive correlation with the dependent variable implies that countries with weaker industrial policies or countries with limited protections to domestic firms tend to experience the decline of value added share. Another variable that appear to have a positive effect on value added is education, though has a relatively small statistical significance. A similar statistical significance is shown from the number of patent applications from non-residents, which appears to be negatively correlated with the share of domestic value added in exports.

As stated above, in Table 1 we can observe the aggregate results for a set of countries covered by the WIOD. Although a fixed effects model can control for idiosyncratic factors, there may be many country-level differences hidden in that type of analysis. Therefore, in Table 2 we illustrated country-level results from estimating the model outlined in equation (7) with the estimator of equation (10), starting with the 24 countries that have co-integrated series.

Table 2. Results from FMOLS, 1996-2009

Dependent Variable: Share of Value in Added in Exports	Independent Variables					Regression Characteristics		
	FHS	KGCFF	Price	Productivity	Real Output	N	Trend	S.E. of Regression
Australia	.59*** (0.03)	-.08*** (0.004)	-.03*** (0.01)	.14*** (0.01)	-.23*** (0.006)	462	C	0.15
Austria	-.65*** (0.03)	.06*** (0.01)	.44*** (0.01)	-.31*** (0.01)	.50*** (0.008)	384	C	0.18
Brazil	-.05** (0.02)	.76*** (0.008)	-.52*** (0.007)	1.20*** (0.009)	-.23*** (0.004)	462	C	0.23
Canada	-.59*** (0.03)	1.10*** (0.007)	0.46*** (0.02)	-1.26*** (0.008)	-.71*** (0.01)	462	C	0.23
China	-.18*** (0.02)	.11*** (0.004)	.24*** (0.007)	.05*** (0.005)	-.24*** (0.005)	462	C	0.18
Czech Republic	-.12* (0.08)	.46*** (0.07)	.21*** (0.07)	.25*** (0.09)	-.64 (0.08)	396	C, L, L^2	0.12
Germany	.06*** (0.02)	.27*** (0.008)	.35*** (0.01)	-.14*** (0.008)	-.36*** (0.007)	396	C	0.11
Denmark	-.32*** (0.03)	.50*** (0.01)	-.18*** (0.006)	-.35*** (0.01)	-.23*** (0.007)	396	C	0.16
Spain	-.21*** (0.03)	.15*** (0.006)	.02*** (0.007)	-.38*** (0.008)	-.17*** (0.007)	396	C	0.09
Finland	-.99*** (0.03)	.41*** (0.01)	-.51*** (0.01)	-2.47*** (0.01)	.65*** (0.008)	396	C	0.34
Hungary	-.86*** (0.02)	.36*** (0.01)	.03*** (0.01)	.16*** (0.01)	-.45*** (0.01)	396	C	0.17
India	-.11* (0.07)	.14*** (0.06)	-.25*** (0.06)	.09 (0.06)	-.19*** (0.06)	396	C, L, L^2	0.12
Japan	-.05*** (0.02)	.06*** (0.003)	-.47*** (0.01)	-.18*** (0.009)	-.11*** (0.006)	462	C	0.08

Continuation of Table 2

Dependent Variable: Share of Value in Added in Exports	Independent Variables					Regression Characteristics		
	FHS	KGCFF	Price	Productivity	Real Output	N	Trend	S.E. of Regression
Korea	.03 (0.05)	.29*** (0.04)	-.63*** (0.06)	-.02 (0.06)	-.40*** (0.05)	462	C, L	0.09
Lithuania	.12* (0.06)	-.02 (0.06)	.25*** (0.07)	-.03 (0.07)	-.21*** (0.07)	459	C, L, L^2	0.17
Latvia	-.46*** (0.03)	-.10*** (0.01)	.23*** (0.018)	.50*** (0.014)	-.40*** (0.01)	438	C	0.94
Poland	-.19*** (0.08)	-.31*** (0.06)	.09*** (0.07)	.31*** (0.08)	.97*** (0.08)	394	C, L, L^2	0.22
Romania	.32*** (0.02)	.26*** (0.01)	-.02** (0.01)	-.54*** (0.01)	-.11*** (0.01)	437	C	0.38
Russia	-.24*** (0.07)	.11* (0.06)	-.15** (0.07)	.28*** (0.07)	-.19*** (0.06)	462	C, L, L^2	0.11
Slovakia	-.04** (0.02)	.24*** (0.01)	-.06*** (0.02)	-.001 (0.01)	-.20*** (0.01)	459	C	0.29
Sweden	-1.8*** (0.03)	.46*** (0.01)	.27*** (0.01)	-.33*** (0.009)	-.14*** (0.008)	396	C	0.20
Turkey	-.36*** (0.07)	-1.2*** (0.05)	-.15*** (0.06)	.21*** (0.07)	.26*** (0.07)	461	C, L, L^2	0.22
Taiwan	.06 (0.05)	.03 (0.04)	.22*** (0.05)	-.03 (0.05)	-.30*** (0.05)	462	C, L	0.11
USA	.67*** (0.05)	.20*** (0.04)	.44*** (0.05)	-.66*** (0.05)	-.81*** (0.05)	462	C, L	0.11

Notes: Logs were taken. Standard errors (S.E.) are in parentheses. Asterisks indicate the usual significance levels. C stands for constant, L for linear trend; those were chosen based on the residuals distribution.
Source: Author's calculation based on WIOD (2015)

In 19 out of 24 countries showed in Table 2, foreign high-skilled labor embodied in exports has a negative and statistically significant correlation with the share of value added in exports. In three out of these 19 countries FHS was the factor of greatest influence as measured by the level of estimated coefficients: Sweden, Hungary, and Austria. All of these three are European countries with relatively high average incomes. It

is important to point out that the highest losses in value added share took place in countries with a considerable level of average income (for instance, Japan, South Korea, China, Canada, and Belgium).Therefore, value added erosion is not only a poor country's phenomenon; instead, it is a widespread pattern in today's globalized economy. In fact, except for the US, Estonia, UK, Romania, Lithuania, and Greece, the rest of the countries experienced a decline in their domestic share of value added in exports from 1995 to 2009.

For the rest of these 19 countries, either productivity levels or capital stock in an industry was the main determinant for the share of value added in exports. In Russia, Latvia, and Brazil higher sectoral productivity would have the greatest influence on the share of domestic value added in exports in that sector. Similar correlations were observed in six other countries; for those more productive sectors are likely to increase the possibility to capture higher gains from international division of labor. On the other hand, for Turkey, Slovakia, Denmark, and Canada, the main determinant was the level of capital stock by industry. Except for Turkey, Poland, Latvia, and Australia, for the rest of the countries a higher capital stock was correlated with a higher share of value added. In other words, the higher the intensiveness of capital in an industry, the higher the domestic share of value added. This result might imply that capital-intensive industries tend to be integrated with GVCs more than to the domestic economy, or that this set of countries are not able to capture higher trade benefits from capital-intensive sectors, and outputs from these sectors are likely to be more sophisticated.

In the cases of Japan, Korea, and India, the major determinant for the decreases in their share of value added was the increases in output prices. Namely, if the price of output in a given industry went up during the period 1995-2009, its shares of value added in exports would tend to decline. Eleven other countries have a similar response to an increase in their output prices, though to a lesser extent. The reason for the decline of domestic value-added share associated with the increase of domestic price might be found in the loss of international price competitiveness.

For the US, Germany, Indonesia, Czech Republic, China, and Taiwan, the main explanatory factor was the output produced, which had a negative impact on the current share of value added. Except for Turkey, Poland, Finland, and Austria, the rest of the countries show a similar negative relationship between sectoral output and the domestic share of value added in that sector. It might imply that mass production or a growing output is possible to take place without necessarily advancing the share that a given country is capable of capturing from global value chains. This result is in fact consistent with many findings from the second strand of GVCs literatures.

The five countries having a positive relationship between FHS and the share of value added also have a distinctive behavior with the control variables. Those five countries are the US, Lithuania, Romania, Germany, and Australia. Except for Australia, none of these countries had FHS as the main determinant. In the group of countries that do not have co-integrated series, which are shown in Table 3, France and the Netherlands also had a positive correlation between FHS and value added. Except for Lithuania and Romania, it would appear that if the positive relationship between FHS and domestic value-added

share were to exist, it is likely that it will appear in rich countries, though many rich countries have also experienced a decline of domestic value-added share due to FHS.

Other insights that can be obtained from Table 3 are very similar to those in Table 2: a growing capital stock per industries has a positive association with for value added in exports in five additional countries, being the main determinant in three countries. Similarly, a growing real output per industry is related with a decrease in value added in eight industries. Price and productivity were statistically significant in a few countries in Table 3. On the other hand, a negative correlation between FHS and value added in exports in Indonesia was related to a decline in value added, another similarity of Table 3 with Table 2.

Table 3. Panel Regressions with Fixed or Random Effects (as indicated), 1997-2009

Dependent Variable: Share of Value in Added in Exports	Independent Variables					Regression Characteristics		
	FHS	KGCFF	Price	Productivity	Real Output	n	Effects	S.E. of Regression
Belgium	.03 (0.03)	.28** (0.13)	-.61*** (0.14)	-.36*** (0.14)	-.21* (0.12)	429	F	0.10
Bulgaria	-.11 (0.07)	-.21 (0.23)	-.003 (0.13)	-.04 (0.14)	-.19* (0.12)	363	F	0.18
Estonia	.16 (0.11)	.74** (0.26)	-.05 (0.20)	.13 (0.10)	-.63*** (0.15)	429	R	0.38
France	.04** (0.02)	.35*** (0.10)	-.08 (0.08)	-.01 (0.09)	-.26*** (0.09)	363	F	0.25
Greece	.18 (0.14)	.18 (0.26)	.16 (0.25)	.11* (0.06)	-.28 (0.12)	429	F	0.24
United Kingdom	-.07 (0.10)	.10 (0.10)	-.15* (0.08)	-.39*** (0.12)	-.27*** (0.10)	363	F	0.09
Indonesia	-.05* (0.02)	.03 (0.04)	-.19*** (0.02)	.02*** (0.009)	-.32*** (0.03)	429	F	0.09
Ireland	-.12 (0.08)	.02 (0.07)	.22*** (0.09)	-.08 (0.08)	-.11* (0.06)	363	F	0.13
Mexico	.01 (0.03)	-.28* (0.17)	-.01 (0.04)	-.02 (0.04)	-.02 (0.13)	429	F	0.06
Netherlands	.04* (0.02)	.15** (0.06)	-.23*** (0.09)	-.05 (0.10)	-.16* (0.09)	363	F	0.07
Slovenia	-.003 (0.06)	.08* (0.05)	.14 (0.09)	.02 (0.05)	-.40*** (0.04)	429	F	0.13

Notes: Variables are in growth terms. F stands for fixed effects and R for random effects; those were chosen based on the Hausman test. White cross-section Standard errors are in parentheses. Asterisks indicate the usual confidence. A constant and an autoregressive terms were added but not showed for space considerations.
Source: Author's calculation based on WIOD (2015)

5. Conclusions

This paper contributes to the strand of literature concerns withdevelopment difficulties that countries might face while participating in GVCs, by exploring the empirical dimension of this issue. The phenomenon of value-added erosion was inspired

by Milberg (2004) and Heinz (2006) and empirically validated by first applying a multi-regional input-output method to the World Input-Output Database to obtain relevant variables, and then these variables (combined with other control variables) are adopted in our econometric models to systematically explore the phenomenon of value-added erosion by foreign high-skilled labor content as well as other factors that contribute to the general decline of a country's value-added share. Unlike most existing GVCs literatures, value-added *share* is put in the center of our analysis because it would indicate the distributional changes associated with gains from globalization. Such distributional result is particularly relevant in the context of international division of labor with asymmetric power relations between foreign lead firms and domestic suppliers.

In 87% of the countries in our sample the share of domestic value added in exports has decreased between 1995 and 2008. In light of the theoretical insights of Heinz (2006) we find the phenomenon of value added erosion is strongly associated with the increase of foreign high skilled labors embodied in a country's exports. In addition to foreign high skilled labors, value added share is also, to a lesser extent, related to a set of macroeconomic variables.

Following are few policy implications from our analysis. First, from the GVCs perspective, if a policy were to be designed for the majority of countries to prevent themselves from value added erosion, this policy has to encourage domestic producers to perform higher value adding activities and discourage foreign high skilled labor inflows through different means. In other words, it has to promote so-called *Functional Upgrading*(Humphrey2004, Xing and Detert 2010) in the GVCs literatures. We can also expect that a greater inflow of FHS will displace domestic high-skilled workers, if there is any. Having better educated workers will be a fitted strategy to avoid such displacement and maintain (or increase) the high value adding activities within the home country. Second, both econometric specifications suggest that a growing output tend to reduce the share of domestic value added in exports. Therefore, mass production or a fast growth in output appears to be easier to attain when the share of gains that a country can capture in the global division of labor decreases. Third, a higher number of capital intensive industries appear to prevent value-added decline in many countries, perhaps by discouraging the prevalence of low-wage output. Focusing in capital intensive products are appropriate strategies for countries that are seeking to capture a higher share of value added in GVCs.

The third point may indicate the need for further research on the impact of foreign capital vis-à-vis domestic capital on the share of domestic value added. Thus, future research can uncover the impact of Foreign Direct Investment in different sectors and its complementarity with domestic value added. Also, free trade zones (FTZs) may also be a key factor to explore. For instance, the ILO (2007) estimated that in Brazil and China at least 96% of the total exports came from FTZs while in the US it was only 31%. We found that the U.S. value added share has increased during that period while Brazil and China have experience value-added erosion. A possible economic intuition behind this is that firms in FTZs tend to have greater flexibility in choosing where to produce their high value added parts in the world. Another policy suggestion can be that local governing

body might require exporters to have certain amount of their high value adding activities to be performed domestically. In fact, the Chinese government requires the foreign automobile firms to do in those Special Economic Zones (SEZs) in China (Rodrik, 2011). However, there is no time series data of FTZs at this moment to evaluate the generality of these points.

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