

Value Added Erosion in Global Value Chains: An Empirical Assessment

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Abstract

Many countries in 1995-2008 have experienced what we call the “value-added erosion”, which describes the phenomenon of 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). 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 foreign lead’s firm’s high value-adding activities) were estimated using a multi-regional global input-output model. Using these results as well as other control variables we applied a panel cointegration 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

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). In terms of total trade volume, world trade in parts and components increased from \$502 billion in 1992/1993 to \$11,762 billion by 2005/2006 (Wim et al. 2011).

The prevalence of GVCs demands a different approach to analyze international trade. Taking exports as an example, in absence of intermediates trade in GVCs, a country’s exports contain domestic intermediates and domestic value-added only. However, in a world where GVCs were the norm, a country’s exports would also contain foreign intermediates. In this paper, we first used the World Input-output Database (WIOD) to decompose each country’s exports into the aforementioned three components. Second, we sought for possible determinants for the decline in value added that was observed in the vast majority of countries. We found that the share of foreign intermediates in most of the countries’ exports have increased from 1995-2008, which is consistent with the findings in the GVCs and “trade in intermediates” literature. In this

paper, we argue 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.

2. Background Literature

A strand of literatures in Global Value Chains (GVCs) analysis has 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) proposed 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) constructed 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 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

The WIOD also contains a set of national input-output tables for 1995-2009. 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:

¹ Some authors call this "the middle-income trap".

² See Grossman and Rossi-Hansberg (2008)

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

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

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

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 superscripts D and M denote domestic and imported, respectively. $\widehat{v\alpha}$ in (3) is a diagonal 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.

What explain a country's tendency to have value-added erosion in response to the increase of foreign intermediates embodied in exports? Borrowing the insights from Heinz (2006), we think the answer might lie in the high skilled foreign labor embodied in a country's exports. If the increase of foreign intermediates share is accompanied with more high skilled foreign labors that tend to perform higher value-adding activities, then domestic value-added share is likely to be "eroded" by the increase of foreign intermediates share.

4. A Model

We are interested in evaluating the factors that could be exacerbating the value-added erosion in exports that most of the countries in our sample experienced. Due to the lack of theoretical models in GVC literature, we do not impose an *a priori* fixed parameterization on our model. Instead, we follow a semi-parametric approach and evaluate the following candidate regressors: Foreign High-Skill Labor content embodied in Exports (FHS), Capital Stock with 2005 PPPs, 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 Tertiary Education, and the mean tariff applied to manufactured products (henceforth tariff).

As mentioned earlier, we suspect that the inflow of FHS due to a county's participation in GVCs might be one of the greatest causes for the phenomenon of value-added erosion. We applied panel data regressions to search for potential factors that can explain this relatively new trade pattern. 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 candidates. In this process we arrived to the following regression that is given by,

$$\mathbf{V} = \mathbf{F}\theta_x + \mathbf{X}\varphi_x + \mathbf{P}\rho_x + \mathbf{K}\delta_x + \mathbf{T}\vartheta_x + \mathbf{u} \quad (6)$$

where \mathbf{V} is $t \times 1$ vector of the share of value added in exports, \mathbf{F} is a vector of FHS in i , \mathbf{K} is a vector of capital stock, \mathbf{P} is a vector of patent applications of residents, \mathbf{X} is a vector of real exchange rates, \mathbf{T} is a vector of Tariff, and \mathbf{u} is a vector of deviations. Through the Variance Inflation Factor, no problems of collinearity were found.

\mathbf{P} serves as the control variable for the effect of research and development expenditures on value added activities, \mathbf{K} controls for countries where large investment has taken place, \mathbf{X} can indicate the role of exchange rates in stimulating the inflows of foreign intermediates, and \mathbf{T} controls for the globalization impacts that may affect the share of domestic value added by, for instance, increasing the competition to domestic infant industries or by weakening industrial policies.

The series in (6) are $I(1)$ and, according to the Panel Augmented Dickey-Fuller (ADF) test and the Group ADF test, are cointegrated. To rectify this process, we applied a Dynamic OLS (DOLS) to correct for potential endogeneity and serial correlation if there is any (Kao et al. 1999). The augmented cointegrating equation associated with (6) is,

$$\begin{aligned} V_{it} = & C + \rho_f F_{it} + \rho_x X_{it} + \rho_p P_{it} + \rho_k K_{it} + \rho_t T_{it} + \gamma_{f,0} \Delta F_{it} + \gamma_{f,-j} \Delta F_{i,t+j} + \\ & \gamma_{f,j} \Delta F_{i,t-j} + \gamma_{x,0} \Delta X_{it} + \gamma_{x,-j} \Delta X_{i,t+j} + \gamma_{x,j} \Delta X_{i,t-j} + \gamma_{p,0} \Delta P_{it} + \gamma_{p,-j} \Delta P_{i,t+j} + \gamma_{p,j} \Delta P_{i,t-j} + \\ & \gamma_{k,0} \Delta K_{it} + \gamma_{k,-j} \Delta K_{i,t+j} + \gamma_{t,j} \Delta T_{i,t-j} + \gamma_{t,0} \Delta T_{it} + \gamma_{t,-j} \Delta T_{i,t+j} + \gamma_{t,j} \Delta T_{i,t-j} + v_{it} \quad (7) \end{aligned}$$

where j are the leads and lags chosen by following different information criteria, such as Akaike Information Criterion (AIC), to remove long-run correlations among the innovations. The long-run variance of the error term is estimated by,

$$\hat{\lambda}_v^2 = \frac{\hat{\sigma}_e^2}{(1 - \hat{\varphi}_1 - \dots - \hat{\varphi}_q)^2}, \hat{\sigma}_e^2 = \frac{1}{T-q} \sum_{t=q+1}^T k(t,b) \hat{e}_t^2$$

where $\hat{\varphi}_j (j = 1, 2, \dots, q)$ are estimated from an $AR(q)$ process fitted to v_{it} , whose estimated residuals are given by \hat{e}_t^2 . Following Andrews (1991), $k(t,b)$ is a weight where k is a symmetrical Bartlett kernel function and $b > 0$ is a Newey-West fixed bandwidth. The q lag length was selected from AIC.

5. Results

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 sophistication. However, the share of 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 on 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.³ It is also evident from IMF (2007): "Trade integration accelerated in the 1990s, as former Eastern bloc countries integrated into the global trading system and as developing Asia –one of the most closed regions to trade in 1980- progressively dismantled barriers to trade" (p. 137).

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

- Table 1 about here -

An increase in FHS had a negative and relatively strong effect on value added share in exports. After controlling for other factors such as countries with high capital stock, acceleration of globalization, investment in research and development, and exchange rate competitiveness, the penetration of FHS had the highest statistical significance and the highest relative magnitude on the share of value added. This result is invariant to different sample sizes and to the addition of control variables. Also, it conforms to our earlier hypothesis based on Heinz's and Milberg's theoretical insights.

The tariffs imposed on manufacture products appear to have some impacts on domestic value added share. 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.

Increases in the real exchange rate had a positive but small impact on the dependent variable. In general, countries with higher real exchange rate had lower chances of value-added erosion. Countries like the US and UK who had an increase in their value added share, also had a

³ AFTA is the Association of Southeast Asian Nations Free Trade Area includes Malaysia, Indonesia, Singapore, Phillipines, 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.

relatively high real exchange rate when compared to countries like Canada or Russian Federation where the share of value added decreased. A possible explanation is that when a currency appreciates, the decrease in the relative price of foreign intermediates are translated more in to a domestic-foreign substitution of intermediates than in a substitution of high value adding activities.

Other variable that had a positive effect on value added is the number of patent applications from residents, though in lower magnitude. Loosely speaking, this could imply that value-added erosion is less likely to occur within countries with higher domestic research and development.

The effect of countries with a higher capital stock (in absolute terms) remains too small to be economically meaningful at this time. However, it is important to point out that some great losses in value added share took place in countries with a considerable level of capital stock (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.

5. Conclusions and Policy Implications

In 87% of the countries in our sample the share of domestic value added in exports have decreased between 1995 and 2008. In Malta, Canada, Mexico, Ireland, France, and Cyprus the total value added in exports declined during this period. In light of the theoretical insights of Heinz (2006) we found 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 was also, to a lesser extent, related to a set of macroeconomic variables.

There are some policies implications from our analysis. First, from the GVCs perspective, if a policy were to be designed for countries to prevent themselves from value added erosion, this policy has to encourage domestic producers to perform more value adding activities and discourage foreign high skilled labor inflows through different means. In other words, it has to promote so-called *Functional Upgrading* in the GVCs literature (Humphrey 2004; Xing and Detert 2010). We can also expect that a greater inflow of FHS will displace domestic high-skilled workers, if there is any. Having better educated workers can be a fitted strategy to avoid such displacement and maintain (or increase) the high value adding activities within the home country. Second, appreciation appears to prevent value-added decline, perhaps by encouraging the preferences of importing foreign low-skilled intermediates over high-skilled intermediates. Third, the consistent signs of tariff and patent application may suggest that industrial policies that target the development of domestic capital are appropriate strategies for countries that are seeking to capture a higher portion of value added in GVCs.

In future research, 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 31%. We found that the U.S. value added share has increased during that period while Brazil and China have experienced value-added erosion. A possible economic intuition behind this is that firms in FTZs may tend to have greater flexibility in

choosing where to produce their high value added parts in the world. Another policy suggestion can be that countries require to these foreign companies that certain amount of their high value added activities have to be produced domestically. In fact, the Chinese government requires the foreign automobile firms to do this in their Special Economic Zones in China (Rodrik 2011). However, there is no time series data of FTZs at this moment to evaluate the generality of these claims.

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Table 1. Panel DOLS Estimation

Dependent Variable: Share of Value Added in Exports					
	(1)	(2)	(3)	(4)	(5)
F	-0.26*** (0.02)	-0.24*** (0.017)	-0.18*** (0.017)	-0.22*** (0.02)	-0.16*** (0.03)
K		-0.00000002*** (.0000000005)	-0.00000002*** (.0000000004)	-0.00000002*** (.0000000006)	-0.00000002*** (.0000000007)
P			.00000004 (0.0000001)	-0.0000002* (0.00000001)	.0000003*** (.0000001)
X				-0.0006 (0.000)	.0002*** (.000009)
T					.005*** (0.0009)
R²	0.82	0.83	0.83	0.94	0.94
N	503	532	496	364	321

Notes: This is weighed panel estimation. The adjusted r-squared is shown. The constant is a deterministic variable in the cointegration.

Source: Feenstra et al. (2013), WIOD (2013), World Bank (2014)