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Titolo della tesi : THREE ESSAYS IN INTERNATIONAL TRADE AND CAPITAL FLOWS

Abstract:

The thesis embodies three chapters addressing three research questions in international trade and capital flows. The first chapter, titled "The Euro's effect on trade: An analysis of “old” and “new” EMU members provides new empirical evidence of the "euro effect" on bilateral trade flows by shedding light on the experience of “new” EMU members. The study covers the period 1988-2015. Our results show a positive but statistically insignificant euro's effect on bilateral trade. That notwithstanding, the “euro effect” is positive for the “new” EMU members. We also find an increase in the concentration of exports between “new” and “old” EMU members.

In the second chapter titled "The impact of FDI on output growth volatility: A country-sector analysis", we analyse the relationship between FDI and output growth volatility by focusing on the manufacturing sector of OECD countries for the period 1990-2015. We find a positive and statistically significant relationship between inward FDI stock and sectoral output volatility. Our results also indicate that high capital-intensive sectors have larger volatility than low capital intensive sectors. These results are robust to the use of different definitions of output volatility. Moreover, we find consistent results when we exploit information on FDI targeting practices.

The third chapter, titled “Trade liberalization and its impact on income distribution in Ghana”, uses a Computable General Equilibrium (CGE) model to study the impact of trade liberalisation on income of households using 2013 Social Accounting Matrix (SAM) for Ghana. We find that import tax reduction negatively affects the income and consumption of rural-farm households. We also find further losses in crop capital rent and demand for labour. We, instead, show that trade liberalisation benefits urban households in terms of growth in income and consumption.

Firma dello studente

The Euro's effect on trade: An analysis of "old" and "new" EMU members

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Abstract

This paper provides new empirical evidence of the "euro effect" on bilateral trade by allowing for a heterogeneous impact on "new" and "old" EMU members. By applying a Poisson estimator and focusing on a sample of 38 countries, our results show a positive but statistically insignificant euro's effect on bilateral exports. However, disaggregating this effect, we report a relatively large euro's effect on bilateral trade for the "new" EMU countries. We also find no evidence of trade diversion, thus corroborating existing evidence. These results are robust to a number of sensitivity checks and, especially, to the use of a larger sample of countries. Finally, using country-pair and country-industry-pair data, our results indicate a reduction in export concentration in the bilateral trade of "old" EMU countries. Instead, we find an increase in concentration in trade between "new" and "old" EMU countries.

JEL classifications: F4, F14, F15, F33, C33

Keywords: Gravity model, Bilateral exports, Euro, Poisson estimator

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1 Introduction

Since 2004, the European Union (henceforth, EU) has gained thirteen "new" member countries [1]. Some of these "new" members further deepened their integration in Europe by joining the European Monetary Union (henceforth, EMU). Slovenia joined the EMU in 2007, Malta and Cyprus in 2008, Slovakia in 2009, Estonia in 2011, Latvia in 2014 and Lithuania in 2015[2]. The adoption of the euro allowed these "new" EMU members, which are small and open economies, to mitigate the risk of exchange rate fluctuations among themselves and in their trade relationships with other "old" EMU members. Moreover, the use of the euro reduced the severity of exchange rate fluctuations with non-EMU countries.

A consensus among economists is yet to be reached on the euro's effect on trade. Indeed, existing evidence of the euro's effect on EMU members is mixed, by disclosing both positive, negative and insignificant effects of the euro adoption on trade. We aim at contributing to this strand of literature by providing new evidence on the topic, and in particular, by studying the role the euro may have played for the "new" EMU members' trade. For this reason, we include all the member countries of the EMU in our empirical analysis. We then test the existence of a heterogeneous euro's effect on trade according to the structural characteristics of "old" and "new" EMU members. We do this by identifying different euro's effects on trade flows taking place within the group of "old" members, within the group of "new" member and

[1] Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.

[2] Throughout the paper, we define as a "new" EMU member, any country from this list.

between old and new EMU members.

More important, we extend the analysis to cover the impact of the euro's effect on bilateral export concentration of trade in the euro area. We use 2-digit and 6-digit Harmonised System (HS) data to compute the Herfindahl-Hirschman Index (HHI) which represents our measure of export concentration. Despite the important role the EMU membership may have played for the "new" EMU countries, existing evidence on the euro's effect on trade is widely focused on the "old" EMU members, and neglects the "new" EMU countries. Hence, our findings not only add to the scant literature of the euro's effect on the "new" EMU members but can be considered a good policy perspective for the EU countries[3] in transit to the EMU.

We analyze the euro's effect on bilateral trade and export concentration using a theory-consistent empirical model following existing studies by Head and Mayer (2014), Rose (2017) and Larch et al., (2017). In our empirical analysis, we exploit the most recent (as at the time of writing) IMF-Direction of Trade (DOT) data spanning 1988 to 2015. We report estimates using the Pseudo Poisson Maximum Likelihood (henceforth, PPML estimator).

As suggested by Santos Silva and Tenreyro (2006 henceforth, SST), the Poisson estimator accommodates zero trade flows, and Larch et al., (2017) provides the algorithm for solving high-dimensional fixed effects using a Poisson estimator. We control for both time-varying country-specific and country-pair fixed effects, thus addressing both the "multilateral resistance" and endogeneity issues. We report results for the baseline model by focusing on a sample which includes both zero and non-zero trade flows.

[3]Poland, Romania, Bulgaria, Croatia, Hungary and Czech Republic.

After two decades since the introduction of the euro, we believe that there is room for renewed empirical studies. Also, the availability of more recent data and a longer post-euro time span could help in better identifying the euro's effect on trade. In this paper, we argue that empirical studies should pay attention to both the "old" and "new" EMU member countries and compare their experience.

To the best of our knowledge, our paper is one of the few studies that disaggregate the euro's effect by identifying different effects associated to the trade flows involving old and new EMU member countries . The other existing recent works (Zymek et al., 2017; Larch et al., 2017; Cislik et al., 2014) do not include Latvia and Lithuania in the EMU estimates. Furthermore, differently, from Cislik, Michalek and Mycielski (2014), we adopt a Poisson model in our empirical strategy. In addition, we enrich the analysis by shedding light on the impact of the euro adoption on the export concentration in the euro area, which is a novelty to the study of the euro's effect on trade.

Anticipating our results, we show a statistically non-significant euro's effect on trade. Our results are consistent with a number of recent studies (Larch et al., 2017; Mika and Zymek, 2017; Ciéslik et al., 2012, 2014) which focus on samples covering a large number of countries. However, disaggregating the effect, we report a relatively large euro's effect on trade of between 49-60 percent of bilateral exports for the "new" EMU member. Our results also indicate that the euro adoption has led to an increase in concentration of export in trade between "old" and "new" EMU countries. We, however, find a reduction in export concentration in trade among the "old" EMU members.

The rest of the paper is organized as follows. Section 2 reviews the existing literature, Section 3 offers a discussion of our methodology, Section 4 presents our results, Section 5 shows some sensitivity analysis and Section 6 concludes.

2 Literature Review

An understanding of how monetary variables, especially exchange rates, influence trade flows has long been pursued by monetary and trade economists. The general consensus by economists on the ambiguous effect of exchange rates volatility on trade has driven researchers to focus on the study of currency unions and on their trade effects. Economists' thought of currency unions as having microeconomic benefits but macroeconomic costs (Rose, 2000) was only a theoretical possibility until the creation of the European Monetary Union.

In the wake of the European monetary integration in 1999, Rose (2000) applied a gravity[4] model in order to answer a simple question "What is the currency union effect on international trade". In his cross-sectional study of 186 countries, characterized mainly by poor, small and open economies, Rose (2000) concluded that countries with a common currency trade three times as much than they would have otherwise.

His findings, though interesting, were taken by researchers with a pinch of

[4]Gravity as literately defined in the spirit of Newton's law is directly proportional to the mass of objects (say country i and j) and inversely proportional to the distance between them. Presented mathematically and in economic terms as; $G_{ij} = \frac{GDP_i GDP_j}{Dist_{ij}}$. The specification in Tinbergen (1962) is slightly different, and given below as;

$$G_{ij} = \alpha GDP_i^{\alpha_1} GDP_j^{\alpha_2} Dist_{ij}^{\alpha_3}$$

Thus, G are the bilateral trade flows, GDP represents the market size, Dist is the bilateral geographical distance between countries and α are constant parameters.

salt, leading to the revival of the currency union effect literature. Other panel studies (Rose and Glick, 2002; Rose and van Wincoop, 2001 among others) were further developments on the subject and a year after the publication of Rose (2000), a number of authors [5] identified some theoretical and empirical flaws in his work.

Baldwin (2006) raised three main critiques of the work by Rose (2000): omitted variables, reverse causality and model misspecification. It is worth mentioning that the identification of the currency union's effect in Rose (2000) rests on the exploitation of cross-country heterogeneity. Persson (2001) questioned the validity of Rose's country selection and proposed the use of a "matching strategy" for the sample selection.

By reviewing the euro's effect literature, Baldwin (2006) re-classified errors in the empirical estimation of the gravity model into gold, silver and bronze medal errors. These errors relate to the wrongful measurement of variables and specification of the gravity model. The gold medal error refers to the omission of relative prices (*multilateral resistance term*) in the empirical estimation, while the silver medal error concerns the definition of the dependent variable which, preferably, should be represented by bilateral exports. The bronze medal error relates to the conversion of nominal variables into real variables which turn to over/underestimate variables. That notwithstanding, there still exist contrasting empirical measurements and specifications of the gravity model even in recent contributions.

By building on the Rose (2000)'s contribution, Micco, Stein, and Ordenez (2003) were the first to study the euro's effect on trade. Moreover,

[5] see Persson (2001) and Tenreyro (2001)

their empirical model was an improvement[6] on earlier contributions, given the updated empirical and theoretical developments in Persson (2001), Tenreyro (2001) and Rose and Van Wincoop (2001). By studying 22 developed countries (including 15 European countries) for the period 1992 to 2002, they found that euro's adoption was associated to an increase in bilateral trade by 8 to 16 percent. Furthermore, they also reported no evidence of trade diversion. Others,[7] such as Barr et. al, (2003), Flam and Norstrom (2003) and Berger and Nitsch (2008), using similar estimation methods have reported somewhat similar results.

Prior to their membership in the EMU, all "new" EMU countries, considered in "euro effect" studies, were used as a control sample. However, some studies anticipated the EMU integration of some Central and Eastern European Countries (henceforth, CEECs), by considering countries such as Slovenia, Latvia, Estonia etc., as EMU countries prior to their membership. Maliszewska (2004) and Belke and Spies (2008) are a few known ex-ante analyses of the euro's effect on a selected group of "new" EMU countries.

By estimating both OLS and panel (FE) models, Maliszewska (2004) reported a euro effect in the range of 6-26 percent on trade. She assumed that any CEEC joining the euro will have a similar trade effect. Based on this assumption, she made a forecast of the euro's effect for the CEECs yet to join the EMU. Her conclusion from the forecast was that less open economies like Latvia and Lithuania will have a significant increase in trade compared to economies like Estonia and Slovakia who were relatively more opened.

[6]For example, they avoided the gold medal mistake by including a measure of relative prices (exchange rates) in their empirical model.

[7]See Rose (2017) which list a number of recent contributions.

Interestingly, the conclusion in Belke and Spies (2008) contrasts with the above findings. Thus, using a Hausman-Taylor approach on a sample of CEECs and OECD countries for the period 1992-2004, they concluded that except for Poland, Latvia and Lithuania, all other CEECs that had joined the EMU would have experienced an increase in trade.

The need for expanding empirical investigations on the "euro effect" by including the analysis of the "new" EMU members became more apparent after Slovenia and other CEECs joined the EMU in 2007. Cieślik, Michałek and Mycielski (2014) is one of the few ex-post euro studies of the "euro effect" on the "new" EMU members. In their study, they use a data set similar to that in Rose (2000) for the period 1990-2010. Using a panel (FE) estimator, they concluded that the elimination of exchange rate volatility by joining the Exchange Rate Mechanism (ERM II) resulted in trade expansion for the "new" EMU members. However, their EMU accession did not have any positive effect on trade.

The conclusion above is consistent with their earlier studies (Cieślik et al., 2012) which considered only Slovenia and Slovakia as the "new" EMU countries. More recently, Mika and Zymek (2017) by adopting both OLS and PPML estimators on a sample of EU and 7 developed countries for the period 1992-2002, found no evidence of a positive euro effect on trade for the "old" EMU countries. The same evidence is corroborated when they expand the sample to include 153 countries for the period 1992-2013. Finally, they found no significant effect for the "new" EMU members either.

Our work differs from existing ones in the following: (i) the estimator used (ii) includes all EMU and EU member countries and (iii) focus on export concentration in the euro area. More importantly, this work is related to studies by Mika and Zymek (2017) and Larch et al., (2017) in terms of the estimation methodology used. However, we consider a larger sample of "new" EMU members, investigating a longer post-euro time span in our estimation. In addition, and different from Zymek et al., (2017), we estimate a euro's effect on bilateral exports among the "old" EMU countries, among the "new" EMU countries and between the "old" and "new" EMU countries.

The findings of this work add to the recent policy debate about trade in the euro area and the benefits of adopting the euro by countries in transition. In the light of increasing globalization and world trade, intra-euro area trade flows have risen significantly above their average in the 1990s. As shown in Figure 1 (see appendix), euro area trade peaked in 2008 at about 4,672 billion US dollars. Since then trade in the euro area has fluctuated in the last decade partly because of the global financial crisis in 2007-2008 and the European debt crisis. Thus, the value of the intra-euro area trade is yet to reach its peak in 2008. Interestingly, since 2002 the gap between intra and extra-euro area trade seems to have widened, which implies the continuous growth in trade between EMU and non-EMU members despite the euro initiative.

Moreover, focusing on the "new" EMU members' trade in the euro area, Figure 2 (see appendix) shows an upward trend in the share of intra-euro trade by the "new" EMU members except for Slovenia. As at 2017, Lithuania's share of intra-euro trade rose from 1.5 to 4.5 percent, while that of Slovenia remained fairly constant between 0.5 to 0.9 percent. Moreover, Slovakia's share stood at 0.9 to 2.3 percent, Estonia at 1 to 3.3 percent, Cyprus 1.1 to 3.4 percent, Latvia 1.1 to 3.8 percent and Malta 1.3 to 3.9 percent.

Clearly, the adoption of the euro by these "new" EMU members have played a significant role in their trade in the euro area.

3 Data and empirical methodology

Bergstrand (1989) formulated a demand-side model that deviated from the conventional homogeneous endowments (factors) assumption, thus accounting for the differences in factor endowment. The resulting empirical suggestion is to include GDP per capita in the gravity model specification. Furthermore, Anderson and Van Wincoop (2001), an update on Anderson (1979), introduced the concept of *multilateral resistance term* and suggested the need to relax the homogeneous price assumption due to border effect. This led to the inclusion of relative price variables in the gravity model specification. In order to account for this effect, researchers include time-varying importer and exporter fixed effects in the gravity specification.

Our baseline analysis mainly rests on a sample of OECD countries. This is an attempt to focus on a fairly homogeneous group of countries. That notwithstanding, we recognize that OECD countries are differentiated in several factors. Moreover, we also acknowledge the differences between the "old" and "new" EMU countries. To date, there still exist some differences in the institutional setup and economic structure among member states which lead to the lags in the implementation of euro-wide policies among member states.

The literature shows that the choice of the sample of countries under analysis matters for the identification of the euro's effect on trade. In particular, Rose (2017) argues in favour of using larger samples. However, the inclusion of many smaller countries tends to exacerbate the difference in the estimated effects between estimators (Larch, et al., 2017). Hence, while we decided to focus on a smaller sample[8] of OECD countries, we also show the robustness of our findings by extending the sample to include a larger set of countries. More interesting, by exploiting our baseline sample, we arrive at a conclusion similar to those in Larch et al., (2017) and Mika and Zymek (2017) who used a relatively large sample.

After the publication of Santos Silva and Tenreyro (2006), the Pseudo-Poisson Maximum Likelihood (PPML) estimator has been embraced in the gravity model literature. Indeed, it is consistent in the presence of heteroskedasticity, and it offers a natural treatment for missing bilateral trade flows for which alternative treatments in the literature are found to generate inconsistent estimates of parameters. Finally, with respect to other estimators (like Least Square Dummy Variable (LSDV)), the PPML report non-bias estimates (in terms of magnitude) of dyadic dummies. We avoid Baldwin's gold medal error by including exporter-year and importer-year fixed effects to control for multilateral resistance, silver medal error by using bilateral export trade as the dependent variable and bronze medal error by estimating our gravity model in nominal terms. Hence, our PPML gravity specification is the following:

$$X_{ijt} = exp\Big\{\beta_0 + \beta_1 FTA_{ijt} + \beta_2 EU_{ijt} + \beta_3 EMU_{ijt} + \alpha_{it} + \delta_{jt} + \phi_{ij}\Big\} \times \epsilon_{ijt} \quad (1)$$

[8]see Figure 1 on page 21 of Rose (2017). The literature reflects significant number of small sample studies.

The dependent variable is the bilateral exports between country i and j at time t. Free Trade Agreements (henceforth, FTA) is the trade policy dummy indicating whether both countries are/were members of some free trade agreements. EU and EMU are the institutional dummies indicating whether both countries are members of the European Union and the European Monetary Union respectively. It is important to emphasize that EMU is the dummy of interest which captures the euro's effect on trade.

EMU is further disaggregated into EMU_{old}, EMU_{new} and EMU_{oldnew}. EMU_{old} takes the value 1 for the pair of "old" EMU countries and 0 otherwise, while EMU_{new} takes value 1 for the pair of "new" EMU countries and 0 otherwise, and EMU_{oldnew} takes value 1 for the pair of "old" and "new" EMU countries and 0 otherwise. α_{it} and δ_{jt} are the time-varying exporter and importer fixed effects respectively and ϕ_{ij} captures country-pair fixed effects. Finally, ϵ_{ijt} is the error term.

We also report estimates of an alternative specification where we use countries' GDP and bilateral exchange rates (EX) as controls for multilateral resistance, instead of including exporter-year and importer-year fixed effects, but we include country-pair fixed effects as controls for endogeneity. While we expect the EU dummy to be positive, EMU could be negative or positive reflecting the inconclusiveness of the euro's effect on trade in the literature. However, when disaggregating the total EMU effect, we expect a larger and positive euro's effect on the "new" EMU members. While the theoretical literature on trade suggests a positive FTA on trade, there exists a large empirical literature that concludes on the ambiguous effects of FTA on trade. Given this inconclusiveness, we are receptive to the outcome of the FTA dummy.

Moreover, regardless of a positive, negative or zero euro's effect on trade, we estimate trade diversion effect by means of the following specification:

$$X_{ijt} = exp\Big\{\beta_0 + \beta_1 FTA_{ijt} + \beta_2 EU_{ijt} + \beta_3 EMU_{ijt} + \beta_4 DV_{ijt} + \alpha_{it} + \delta_{jt} + \phi_{ij}\Big\} \times \epsilon_{ijt} \quad (2)$$

In equation (2) all variables follow their definition given in equation (1). DV is a dummy which takes the value 1 for the pair of EMU and non-EMU countries and 0 otherwise. A positive coefficient of the DV dummy implies no evidence of trade diversion while a negative coefficient indicates otherwise. An analysis of trade diversion in the EMU was first done by Micco et. al, (2003). In their work, they found no evidence of trade diversion. We expect similar results as trade (both pre and post-EMU integration) between EMU and non-EMU members have not changed significantly (both EU and non-EU alike), looking at the global pattern of trade. And more so, EU-China trade flows have grown steadily in recent years, showing the EU's sustained interest in external markets.

3.1 Data

Our study is focused on all members of the EU, as well as further OECD and non-OECD countries. The sample includes 38 countries which are: Austria, Belgium, Britain, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Italy, Ireland, Latvia, Hungary, Romania, Bulgaria, Croatia, Iceland, Poland, Luxembourg, Lithuania, Malta, Netherlands, Norway, Portugal, Spain, Slovakia Republic, Slovenia, Sweden, Switzerland, Australia, Canada, New Zealand, Japan, China, India, US. The estimates cover the period from 1988 to 2015. Hence, our analysis is implemented on a balanced panel with a total of 39,368 observations (given by $38 \times 37 \times 28$).

Bilateral trade data are sourced from the International Monetary Fund's (IMF) *Direction of Trade Statistics* (DOTS), while data on GDP are from the World Bank's *World Development Indicators* (WDI). Bilateral exporter and importer exchange rates (period averages) data are from the OECD.stat database. For Bulgaria, Cyprus, Croatia, Malta and Romania, we used exchange rates data from the WDI. Finally, trade policy (free-trade agreement) data are from the Mario Larch's Regional Trade Agreements Database in Egger and Larch (2008).

Both EU and EMU dummies are created with particular reference to country's period of membership in the EU and EMU. In this work, countries who were members of the EMU by 2001 are classified as "old" EMU members, while those who gained membership subsequent to 2001 are deemed "new" EMU countries. It is worth noting that among the non-EMU economies we included in the analysis China and India. This reflects their prominent role in recent international trade flows.

4 Empirical Results and Discussion

4.1 Bilateral export in the euro area

Table 1 presents the results of the estimation of equation (1) by adopting the PPML estimator. The models are estimated on the whole sample of 38 countries for the period 1988-2015. We report estimates using bilateral exports (dependent variable) that include both zero and non-zero trade flows. We estimate two baseline specifications. While in Model 1, we treat both "old" and "new" EMU groups as homogeneous, and we estimate a single effect for the whole set of EMU members, in Model 2 we split them between "old" and "new" EMU members and we estimate heterogeneous effects for three different groups of country pairs: "old-old" EMU members, "new-old" EMU members, "new-new" EMU members.

Our results are consistent with our expectations in terms of sign and magnitude. The trade benefits of joining the EMU is small, negative and statistically insignificant with reference to our baseline model [column 3]. When disaggregating the total "euro-effect"[column 4], our results indicate that the euro has been highly beneficial for trade flows taking place within the group of "new" EMU members. As indicated by the EMU_{new} dummy, the reported "euro effect" is as high as 49 percent[9] compared to that of the "old" EMU countries (indicated by EMU_{old}), which is negative and statistically insignificant. Interestingly, the "euro effect" on the trade between the "new" and "old" EMU countries (indicated by EMU_{oldnew}), though positive,

[9]This value is computed by; $[(exp^{\beta} - 1) \times 100]$, where β is the estimated coefficient of the EMU_{new} dummy.

is statistically insignificant.

Our results from the alternative baseline model show a large, positive and statistically significant euro's effect on trade [column 1]. Furthermore, they also show a similar euro's effect on the "old" EMU countries. It is indeed evident that an inadequate specification of the multilateral resistance term in the structural gravity model can bias the estimates of the euro's effect. Thus, time-varying exporter and importer fixed effects are important to account for changes in multilateral resistance (Feenstra, 2004; Baldwin and Taglioni, 2007).

The larger "euro effect" on the "new" EMU countries needs further clarification. These countries, prior to their EU integration, were less open to the international market with respect to the "old" EMU members. Thus, their EU membership gave them unlimited access to the larger EU market, providing a possibility for these countries to improve their market institutions. Moreover, their further integration in Europe by joining the EMU gave them further trade advantages in terms of price transparency, mitigation of external price volatility and other frictions related to cross-border trade.

Our results also suggest that the creation of the European single market (EU) had a positive and statistically significant effect on trade. A result consistent with the argument documented in Berger and Nitsch (2008). Importantly, EU membership comes with the removal of obstacles to the free movement of goods, capital and labour, in the spirit of transparent and falling prices through competition. The EMU provides members with all the EU benefits together with sharing a common currency and monetary policy with other members. Thus, one has to disentangle the two to avoid plausible over-

Table 1: PPML- Baseline Estimates

	WORLD (38) SAMPLE- BASELINE Dependent Variable: Bilateral Exports			
VARIABLES	**Model [1]**	**Model [2]**	**Model [3]**	**Model [4]**
lnGDPeGDPm	0.744***	0.748***		
	(0.077)	(0.076)		
lnEXe	0.384*	0.381*		
	(0.202)	(0.201)		
lnEXm	-0.077	-0.078		
	(0.129)	(0.129)		
FTA	0.014	-0.001	0.065	0.069
	(0.093)	(0.090)	(0.051)	(0.051)
EU	0.218	0.232	0.137**	0.123**
	(0.170)	(0.168)	(0.061)	(0.059)
EMU	0.415***		-0.031	
	(0.105)		(0.060)	
EMU_{old}		0.459***		-0.062
		(0.115)		(0.067)
EMU_{new}		0.353***		0.397**
		(0.118)		(0.156)
EMU_{oldnew}		-0.012		0.114
		(0.233)		(0.072)
Exporter_Year FE	NO	NO	YES	YES
Importer_Year FE	NO	NO	YES	YES
Country-pair FE	YES	YES	YES	YES
Year FE	YES	YES	NO	NO
Observations	35,068	35,068	36,026	36,026
R^2			0.942	0.943

$***$,$**$,$*$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable (bilateral exports) include zero and non-zero trade flows.

estimation of the EMU effect. We also find a positive but insignificant effect of free trade agreements on trade. In recent literature, Larch et al.,(2017) and Zymek et al., (2017) have found a positive, significant but small FTA effect on trade.

4.2 Export Concentration in the Euro Area

Recent literature has shown a positive welfare impact of the adoption of the euro. This is evident by the fall in prices across the euro area through tougher competition associated with enhanced transparency and lower transaction costs (Fontagné et. al, 2009) and the increase in extensive and intensive margins of trade (de Nardis et. al, 2008; Baldwin et. al 2008; Berthou and Fontagné, 2008). Thus, the introduction of the euro may have increased the availability of differentiated varieties of both final and intermediate products. Moreover, the single currency may have helped new exporters to enter euro-area markets. It may also have helped existing exporters to increase the number of products exported and the number of destinations they export to (Fontagné et al., 2009).

An analysis at the aggregate level of exports mask heterogeneous effects across sectors and products. Stated differently, an evidence of a no significant trade effect (as shown in Table 1) of the euro adoption at country level may not necessarily imply a no shift in the number of tradable products and in the export share they account for. For example, a reduction in the average export of richer (expensive) product variety could be compensated for by an increase in the average export of existing and new less rich ones. Thus, it is plausible for countries to experience no significant change in their aggregate bilateral trade flows, but rather a dramatic change in the composition and concentration of their trade flows.

We use a similar estimation approach as done in equation (1) to estimate the euro impact on the extent of export concentration. We compute an index of bilateral export concentration (Herfindahl-Hirschman Index, HHI) as:

$$HHI_{ijt} = \sum_{p=1}^{N} S_{pijt}^2 \quad (3)$$

where S_{pijt} is the share of the total trade of an export product p from country i to country j at time t. Thus, HHI_{ijt} measures the level of export concentration in the bilateral export of countries i and j at time t. Using HHI_{ijt} as the dependent variable, we re-estimate equation (1) given below as:

$$HHI_{ijt} = exp\left\{\beta_0 + \beta_1 FTA_{ijt} + \beta_2 EU_{ijt} + \beta_3 EMU_{ijt} + \alpha_{it} + \delta_{jt} + \phi_{ij}\right\} \times \epsilon_{ijt} \quad (4)$$

All variables in equation (4) follow their respective definition as given in the previous equations. Moreover, in equation (4) coefficient β_3 represents the estimate of the "euro effect" on export concentration. A negative coefficient shows a fall in export concentration while a positive coefficient indicates otherwise. In other words, a negative coefficient implies an increase in the number of tradable commodities or a more balanced distribution of exports across products/industries as a results of the euro introduction, while a positive coefficient indicates a fall in the number of traded goods or a more unbalanced distribution of exports across products/industries. We use Harmonized System (HS) 2-digit trade data[10] from COMTRADE to compute the Herfindahl Index. Using this index, we estimate the euro's effect on export concentration both at country-pair and country-industry-pair levels.

Table 2 presents the estimates of export concentration in the euro area

[10]We use a further disaggregated (HS) 6-digit data from BACI for the period 1995 to 2011 to study the level of bilateral export concentration at industry-level. The results seem mixed at the industry-level, however, we see a significant fall in bilateral export concentration for a some industries in the trade among the "old", "new" and between the "old" and "new" EMU countries.

based on export flows at 2digit HS level. Our preferred specification covers the period 1988 to 2015, however, we also report estimates for the period 1993 to 2015. This period definition is in reference to Baldwin (2006) which will be discussed extensively in the next section. From Table 2, our aggregate results indicate no evidence of a significant impact of euro on bilateral export concentration (using HS 2-digit data) and this is confirmed in both 1988-2015 and 1993-2015. The EMU dummy though positive is statistically insignificant. Increased competition across the euro area may alter the production of commodities and the composition of exchanged products by member countries. The evidence of no significant change in the aggregate bilateral export concentration might be the result of the net changes in exchanged commodities produced by member countries.

We further estimate disaggregated effects by focusing on the trade among the "old", "new" and between the "old" and "new" EMU member countries. Our results indicate heterogeneous effect in both "old" and "new" country groups. Consistent with previous literature (see Berthou and Fontagné, 2008; de Nardis et. al, 2008; Baldwin et. al 2008), our results indicate a reduction in the export concentration of about 5 percent in the group of "old" EMU countries. In contrast, our results also suggest an increase in export concentration in the trade between "old" and "new" EMU countries. Lastly, the reported coefficient for the group of "new" EMU countries is positive but statistically insignificant in both periods.

The evidence of a fall in export concentration in the bilateral trade of the "old" EMU countries is intuitive. These countries have similar economic development and production techniques and are better-off diversifying pro-

Table 2: Estimates of Export Concentration in the Euro Area

	WORLD (38) SAMPLE Dependent Variable: HH Index			
	1988-2015		1993-2015	
VARIABLES	**Model**	**Model**	**Model**	**Model**
	[1]	**[2]**	**[3]**	**[4]**
FTA	-0.081***	-0.081***	-0.079***	-0.078***
	(0.019)	(0.019)	(0.020)	(0.020)
EU	-0.086***	-0.096***	-0.077***	-0.087***
	(0.023)	(0.023)	(0.024)	(0.025)
EMU	0.020		0.029	
	(0.020)		(0.021)	
EMU_{old}		-0.046*		-0.047*
		(0.024)		(0.026)
EMU_{new}		0.061		0.072
		(0.047)		(0.046)
EMU_{oldnew}		0.056*		0.064**
		(0.029)		(0.029)
Exporter_Year FE	YES	YES	YES	YES
Importer_Year FE	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES
Observations	33,126	33,126	30,925	30,925
R^2	0.734	0.734	0.732	0.732

$***$,$**$,$*$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets.

duction to avoid excessive competition. Since there are no restrictions to trade in the euro area, members' production techniques (innovations) and natural endowments play an important role in the concentration of trade in the euro area. Also, external trade relations with non-EMU members is another important factor in the structure of trade concentration in the eurozone. For the "old" EMU members their role in international trade flows drives their trade in the euro area which we find to be less concentrated. On the other hand, the "new" EMU members rely heavily on trade within the eurozone which potentially limits their number of tradable commodities and export destinations.

Finally, we estimate the euro's effect effect on export concentration using product level data. In table 3, the herfindahl index is computed at (HS) 2-digits level and is based on export data at 6 digit (HS) level. The results are consistent with our baseline findings in table 2. Thus, we find industry-level evidence of a decrease in export concentration in trade among the "old" EMU members but an increase in export concentration in trade between "old" and "new" EMU members.

Table 3: Estimate of Export Concentration (sector level)

	WORLD (38) SAMPLE			
	Dependent Variable: HH Index			
	1988-2015		**1988-2015**	
	Model	**Model**	**Model**	**Model**
VARIABLE	**[1]**	**[2]**	**[3]**	**[4]**
FTA	-0.0174***	-0.0170***	-0.0166***	-0.0162***
	(0.001)	(0.001)	(0.001)	(0.001)
EU	-0.0182***	-0.0217***	-0.0184***	-0.0219***
	(0.002)	(0.002)	(0.002)	(0.002)
EMU	-0.001		-0.001	
	(0.001)		(0.001)	
EMU_{old}		-0.013***		-0.014***
		(0.001)		(0.001)
EMU_{new}		0.006		0.003
		(0.007)		(0.007)
EMU_{oldnew}		0.013***		0.014***
		(0.002)		(0.002)
Exporter_year FE	YES	YES	YES	YES
Importer_year FE	YES	YES	YES	YES
Industry_year FE	YES	YES	YES	YES
Exporter_importer FE	YES	YES	NO	NO
Exporter_importer_Industry FE	NO	NO	YES	YES
Observations	408,319	408,319	407929	407929
R-squared	0.731	0.733	0.738	0.74

* * *,**,* represent 1%, 5% and 10% significant level respectively, standard errors are in brackets.

5 Sensitivity Analysis

As discussed in Rose (2017), a number of factors can bias the estimation of the euro's effect on trade. We test the sensitivity of our results by focusing on three of these factors that are likely to affect our results. The analysis is categorized under three subsections: (5.1) the number of countries under analysis; (5.2) the nature of countries included in the estimation; Related to this analysis, we also estimate whether there exists any evidence of trade diversion since a currency union can divert trade from high-cost producers (non-union member) to low-cost producers (union member) and vice versa; (5.3) the time span covered by the analysis.

5.1 The number of countries under analysis

Table 3 presents the results obtained by restricting the sample to the 28 EU countries for the same period as in Table 1. We use this approach since there exists a number of large sample evidence in the literature. For easy comparison, we will refer to our main sample as the baseline sample and the sub-sample of 28 EU countries (used for the results in Table 3) as the EU sample. From Table 3, the estimated euro's effect on trade though positive is statistically insignificant as that reported in Table 1. Also, the euro's effect on trade for the "new" EMU members is positive and significant but of a slightly large magnitude. We, however, find subtle changes in the estimate of trade between the "new" and "old" and among the "old" EMU countries. Thus, the results show a statistically significant (10 percent) negative effect on trade among the "old" EMU countries.

Table 4: PPML- EU (28) Estimates

	EU (28) SAMPLE Dependent Variable: Bilateral Exports			
VARIABLES	**Model [1]**	**Model [2]**	**Model [3]**	**Model [4]**
lnGDPeGDPm	0.398	0.425		
	(0.291)	(0.288)		
lnEXe	0.156**	0.157**		
	(0.078)	(0.078)		
lnEXm	0.124**	0.126**		
	(0.060)	(0.059)		
FTA	0.002	-0.014	-0.086	-0.053
	(0.041)	(0.037)	(0.077)	(0.077)
EU	0.236***	0.247***	0.119	0.103
	(0.071)	(0.070)	(0.090)	(0.088)
EMU	0.253***		0.006	
	(0.085)		(0.034)	
EMU_{old}		0.314***		-0.098*
		(0.100)		(0.057)
EMU_{new}		0.383**		0.473***
		(0.161)		(0.131)
EMU_{oldnew}		-0.043		0.160***
		(0.223)		(0.061)
Exporter_Year FE	NO	NO	YES	YES
Importer_Year FE	NO	NO	YES	YES
Country-pair FE	YES	YES	YES	YES
Year FE	YES	YES	NO	NO
Observations	18,006	18,006	18,794	18,794
R^2			0.986	0.986

$***$,$**$,$*$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable (bilateral exports) include zero and non-zero trade flows.

Our results seem to contrast the argument that small observations used in estimating the euro's effect are likely to cause underestimation. Thus, our point estimate of the EMU dummy in both the baseline and EU sample falls in the range of those documented in Larch et al., (2017) which used a sample of 200 countries for the period 1948-2013. Other contributions which exploit larger sample of countries (Zymek et al., 2017 and Cie'slik et al., 2012b) have concluded on a statistical insignificant euro's effect on trade.

5.2 The nature of countries included in the estimation

In this analysis, we only considered countries of relatively homogeneous economic size and development. For easy comparison, we focus on OECD countries. There are 30 OECD countries in the sample. Hence, estimating a model of only OECD countries motivate our quest in three ways: (i) it represents a further robustness check on the "size of the sample" argument; (ii) we are able to estimate the euro's effect assuming that the EMU is composed of only OECD-EMU countries; (iii) we only focus on countries with comparable economic size. We report in Table 4 results from the estimation of equation (2) which includes the trade diversion dummy.

In Table 4, our results show a negative and statistically significant euro's effect on trade. However, the negative effect disappears when we add to the specification, the trade diversion dummy. The coefficient of the trade diversion dummy is positive and significant. This hypothetically indicates that if the euro is to be shared by OECD-EMU countries, then their trade with other non-OECD-EMU members is undoubtedly crucial. Importantly, in the specifications where we control for trade diversion (Model 2 using OECD 30 sample), our results are quite consistent with our baseline findings in table 1. Using the OECD sample, we excluded the analysis of the disaggregated (country groups) effect because a few of the "new" EMU members were also OECD members (Slovakia in 2000, both Slovenia and Estonia in 2010).

Table 5: PPML- OECD (30) Estimates

	Dependent Variable: Bilateral Exports					
	EXCLUDE ZERO OECD (30)		**INCLUDE ZERO OECD (30)**		**INCLUDE ZERO BASELINE**	
VARIABLES	**Model [1]**	**Model [2]**	**Model [3]**	**Model [4]**	**Model [5]**	**Model [6]**
FTA	0.005	0.012	-0.023	-0.014	0.066	0.067
	(0.059)	(0.060)	(0.061)	(0.061)	(0.051)	(0.051)
EU	0.097	0.104	0.070	0.078	0.138**	0.114**
	(0.069)	(0.069)	(0.072)	(0.072)	(0.061)	(0.058)
EMU	-0.162***	0.027	-0.135**	0.109	0.013	
	(0.061)	(0.088)	(0.062)	(0.089)	(0.114)	
EMU_{old}						-0.271*
						(0.157)
EMU_{new}						0.216
						(0.181)
EMU_{oldnew}						-0.018
						(0.079)
DV		0.108*		0.140**	0.024	-0.111
		(0.062)		(0.063)	(0.079)	(0.087)
Exporter_Year FE	YES	YES	YES	YES	YES	YES
Importer_Year FE	YES	YES	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES	YES	YES
Year FE	NO	NO	NO	NO	NO	NO
Observations	21,985	21,985	22,203	22,203	36,026	36,026
R^2	0.943	0.943	0.943	0.943	0.942	0.943

∗∗∗,∗∗,∗ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets.

Finally, the results of estimating equations (2) using the baseline sample is reported in the last two columns of table 4. While the results support our baseline findings, the statistically significant diversion effect disappears showing both positive and negative coefficients. Thus, collaborating existing results, there exists no evidence of trade diversion from non-EMU to EMU members despite the introduction of the euro. This finding is very much in line with that reported in Micco et al., (2003). The US, Japan, and more recently China, are important external markets for most EMU countries.

Do the results from the OECD sample invalidate our previous findings? Looking at Larch et al.,(2017), our answer is certainly "*no*". Using a sample of over 800,000 observations, they documented (elasticities) -0.203, -0.117 and -0.067 euro's effect on trade using the OECD sample in their data for the period 1948-2005, 1985-2005 and 1995-2005 respectively. There is not much difference in their results and those reported in Table 5. It is important to add that since Malta, Latvia, Lithuania and Cyprus were not yet members of the OECD[11] in 2015, the estimated EMU coefficients in table 4 (OECD 30 sample) exclude these countries.

5.3 The time span covered by the analysis

As argued in Baldwin (2006), the institutional changes in Europe in 1992 can bias the estimation of the euro's effect if not properly controlled for in the empirical specification. One of these institutional changes was the removal of EU internal customs that led to the change in the recording system of trade flows in most EU countries. To avoid this problem, we re-estimate the euro's effect for the period 1993-2015. Table 5 presents the results using the Baseline, EU and OECD samples for the period 1993-2015. Clearly, the results in Table 6 are quite consistent with those presented in previous tables. More specifically, we correctly estimated the statistical insignificance of the euro's effect in [Model 1] and [Model 2] using the EU (28) and OECD (30) samples respectively. Moreover, EMU_{new} is also correctly estimated.

Finally, as done in both Larch et al., (2017) and Zymek et al., (2017),

[11] Latvia and Lithuania obtained OECD membership in 2016 and 2018 respectively.

Table 6: PPML- Basline, EU (28) and OECD (30) Estimates

	PERIOD: 1993-2015 **Dependent Variable:** $X_{ijt} >= 0$					
	BASELINE		**EU (28) SAMPLE**		**OECD (30) SAMPLE**	
	Model [1]	**Model [2]**	**Model [3]**	**Model [4]**	**Model [5]**	**Model [6]**
FTA	0.033	0.040	-0.129	-0.091	-0.024	-0.014
	(0.053)	(0.053)	(0.091)	(0.091)	(0.075)	(0.076)
EU	0.088	0.044	0.054	0.014	0.069	0.071
	(0.073)	(0.070)	(0.125)	(0.120)	(0.098)	(0.099)
EMU	-0.158**		0.007		-0.201**	0.071
	(0.074)		(0.038)		(0.084)	(0.086)
EMU_{old}		-0.226***		-0.131*		
		(0.086)		(0.067)		
EMU_{new}		0.389**		0.475***		
		(0.156)		(0.130)		
EMU_{oldnew}		0.102		0.167***		
		(0.070)		(0.060)		
DV						0.161**
						(0.076)
Exporter_Year FE	YES	YES	YES	YES	YES	YES
Importer_Year FE	YES	YES	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES	YES	YES
Observations	31,754	31,754	16,964	16,964	19,554	19,554
R^2	0.949	0.949	0.986	0.986	0.944	0.944

∗ ∗ ∗,∗∗,∗ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets.

we estimate our specification using a dataset similar to that in Rose and Glick (2015). The limitation of using these data is that since the sample ends in 2013, estimates of the EMU effect are likely to exclude the effect of Latvia and Lithuania. That notwithstanding, the estimates as shown in Table B indicate the statistical insignificance of the euro's effect on bilateral exports, but a relatively large EMU_{new} effect as reported in the baseline results. Moreover, as done in Table 4, restricting the sample to the period 1993-2015, the results are again consistent with our baseline results. Using a Panel Fixed Effect(FE) estimator, we again found a larger euro's effect on the "new" EMU members. Furthermore, the evidence of no trade diversion is also found to be consistent. These results are not reported but are available upon request.

It is important to state that most of the earlier contributions to the literature (Micco et al., 2003; Berger and Nitsch, 2008; Flam and Norstrom, 2003 among others) prior to (SST, 2006) employed the use of the panel fixed effect estimator. This estimator is based on the *log-linearization* of the gravity model which is sometimes a challenge, especially when there are a lot of zeros or missing bilateral trade flows in the sample. For this reason, this estimator only works on the necessary condition that $X_{ijt}>0$. Moreover, as argued in SST, the FE estimator tend to be unbiased, but inconsistent in the presence of heteroskedasticity.

6 Conclusion

In this paper, we set out to study the euro's effect on trade for both the "old" and "new" EMU members for the period 1988-2015. We estimated a theory-consistent gravity model controlling for both time and country heterogeneity effects. We used the Pseudo Poisson Maximum Likelihood (PPML) estimator, and we conducted a number of robustness checks to test the sensitivity of our results. We found that the euro's effect is statistically insignificant on bilateral exports. Moreover, disaggregating the total euro's effect to that of "new" and "old" EMU members, we found a statistically significant euro's effect of between 42-60 percent of bilateral export on the "new" EMU members. For the "old" EMU members, the euro's effect is for most estimates negative and statistically insignificant.

Our results on the "new" EMU countries contrast with the conclusions by Zymek et al., (2017) and Cieślik et al., (2012b, 2014). However, our baseline findings on the aggregate euro's effect on trade is consistent with (Zymek et al., 2017; Cieślik et al., 2012b, 2014; Larch et al., 2017). We then add to the list of contributions that contrast the results in Glick and Rose (2016). Consistent with the findings in Micco et. al, (2003), we found no evidence of trade diversion between EMU and non-EMU countries.

We also extended the analysis to provide evidence of the impact of the euro on export concentration using the Herfindahl-Hirschman Index (HHI). Our results indicate a reduction in bilateral export concentration in the "old" EMU countries. This finding is consistent with the literature focusing on the "old" EMU countries. We find no evidence of bilateral export concentration at the aggregate EMU level. Similar result is found in the trade among the "new" EMU countries. What we find puzzling is the evidence of an increase in bilateral export concentration of trade between the "new" and "old" EMU countries. As a result, more inquiry on the subject is required .

Our study suggests that the adoption of the euro has been beneficial for trade among "new" EMU countries. However, further analysis reveals an increase in export concentration in trade among "new" EMU countries. These findings are key to the recent policy debate about the trade relevance of the euro adoption for new entrants. In terms of trade, much of what is expected to happen to new entrants after the adoption of the euro depends on the extent of factors such as trade openness, factor mobility, capital market development and similarities of institutions and other macroeconomic factors between the new entrants and other EMU members. Hence, the euro is likely to be beneficial to new entrants if the above factors are well adhered to. Actually, these are important factors that ensure economic re-balancing in a monetary union given any shock.

In order to extend our conclusions to new EMU entrants, some caution should be taken. Thus, as far as other CEECs in transit to the EU are concerned, there is the need to converge and synchronize their economies to the EMU average. For the "new" EMU members, the Exchange Rate Mechanism (ERM II) was a good pathway to the convergence of their economies to the "old" EMU members. Currently, countries like Poland, Hungary, Czech Republic, Croatia among others, are yet to fully exploit this convergence avenue. Hence, the large positive euro's effect on trade for the "new" EMU members should not be over-stretched in the case of other CEECs in transit to the EMU. Thus the benefit of increasing trade should be assessed against the cost of an increase in bilateral export concentration.

References

Anderson, J. E., 1979. A theoretical foundation for the gravity equation. *The American Economic Review*, 69(1): 106-116.

Anderson, J. E. and Van Wincoop, E., 2001. "Borders, Trade and Welfare," NBER WP 8515, October.

Baldwin, R. E., 2006. "The Euro's Trade Effects". *ECB* Working Paper, No. 594.

Baldwin, R. E. and Taglioni, D., 2007. "Trade Effects of the Euro: A Comparison of Estimators," Journal of Economic Integration, 22(4), 780–818.

Baldwin R., Di Nino, V., Fontagne, L., De Santis, R.A. Taglioni, D., 2008. "Study on the Impact of the Euro on Trade and Foreign Direct Investment", European Economy Economic Papers no.321, May.

Barr, D., Breedon, F. and Miles, D., 2003. Life on the outside: Economic conditions and prospects outside Euroland. *Economic Policy*, 18(37): 573-613.

Belke, A. and Spies, J., 2008. Enlarging the EMU to the east: what effects on trade? *Empirica*, 35(4): 369-389.

Berger, H. and Nitsch, V., 2008. Zooming out: The trade effect of the euro in historical perspective. *Journal of International Money and Finance*, 27(8): 1244-1260.

Bergstrand, J. H., 1990. The Heckscher-Ohlin-Samuelson model, the Linder hypothesis and the determinants of bilateral intra-industry trade. *The Economic Journal*, 100(403): 1216-1229.

Berthou, A. and Fontagne, L., 2008a. 'The euro and the intensive and extensive margins of trade: Evidence from French firm level data', CEPII Working Paper 2008-06, May.

Blonigen, B.A. and Wang, M., 2004. Inappropriate pooling of wealthy and poor countries in empirical FDI studies (No. w10378). National Bureau of Economic Research.

Cieślik, A., Michałek, J. J. and Mycielski, J., 2012. Measuring the trade effects of the euro in Central and Eastern Europe. *The Journal of International Trade and Economic Development*, 21(1): 25-49.

Cieślik, A., Michałek, J. J. and Mycielski, J., 2014. Trade effects of the euro adoption by the EU new member states. *Bank i Kredyt*, 45(4): 331-348.

De Nardis, S., Pappalardo, C. and Vicarelli, C., 2008. The Euro adoption's impact on extensive and intensive margins of trade: the Italian case. Istituto di Studi e Analisis Economica Working Paper, (101).

Feenstra, R. C., 2004. Advanced International Trade: Theory and Evidence. Princeton University Press, Princeton, NJ.

Flam, H. and Nordstrom, H., 2003. Trade Volume Effects of the Euro: Aggregate and Sector Estimates", *Institute for International Economic Studies*, mimeo.

Fontagné, L., Mayer, T. and Ottaviano, G.I., 2009. Of markets, products and prices: The effects of the euro on European firms. Intereconomics, 44(3), pp.149-158.

Frankel, J., Romer, D., 1999. Does trade cause growth? American Economic Review 89, p.p 379–399.

Glick, R. and Rose, A. K., 2002. Does a currency union affect trade? The time-series evidence. *European Economic Review*, 46(6): 1125-1151.

Glick, R. and Rose, A.K., 2016. Currency unions and trade: a post-EMU reassessment. European Economic Review, 87, pp.78-91.

Head, K. and Thierry M., 2014. "Gravity Equations: Workhorse, Toolkit, and Cookbook" chapter 3 in Gopinath, G., E. Helpman and K. Rogoff (eds), vol. 4 of *the Handbook of International Economics* (Elsevier, Amsterdam), 131–95.

Larch, M., Wanner, J., Yotov, Y. and Zylkin, T., 2017. The Currency Union Effect: A PPML Re-assessment with High-Dimensional Fixed Effects.

Maliszewska, M.A., 2004. New member states trading potential following EMU accession: A gravity approach, Studies and Analyses, 286, CASE – Center for Social and Economic Research.

Micco, A., Stein, E. and Ordoñez, G., 2003. The currency union effect on trade: early evidence from EMU. *Economic policy*, 18(37): 315-356.

Mika, A. and Zymek, R., 2017. Friends without benefits? New EMU members and the 'euro effect'on trade.

Persson, T., 2001. Currency unions and trade: how large is the treatment effect? *Economic Policy*, 16(33): 434-448.

Rose, A. K., 2000. One money, one market: the effect of common currencies on trade. *Economic policy*, 15(30): 08-45.

Rose, A. K., 2017. Why do Estimates of the EMU Effect on Trade Vary So Much? *Open Economies Review*, 28(1): 1-18.

Rose, A. K. and Van Wincoop, E., 2001. National money as a barrier to international trade: The real case for currency union. *The American Economic Review*, 91(2): 386-390.

Tenreyro, S., 2001. On the causes and consequences of currency unions. *Harvard University*, unpublished.

Appendix

Table A: Summary Statistics

Variables		**Mean**	**Std. Dev.**	**Min**	**Max**	**Obs**
Log(Bil.Expts)	overall	19.001	3.046707	2.108425	27.58471	N = 35581
	between		2.880675	7.108208	26.04075	n = 1406
	within		1.010617	7.661089	35.51792	T-bar = 25.3
Log(GDPem)	overall	51.9969	2.72025	43.60304	60.55304	N = 36366
	between		2.530248	45.38641	59.11085	n = 1406
	within		0.9953118	49.06829	55.0281	T-bar = 25.9
Log(EX)	overall	0.6911508	1.733699	-7.094085	5.657703	N = 37777
	between		1.595571	-1.059861	5.084888	n = 1406
	within		0.6503173	-5.343073	2.683069	T-bar = 26.9
FTA	overall	0.2575696	0.4373012	0	1	N = 39368
	between		0.307304	0	1	n = 1406
	within		0.3112256	-0.7067161	1.221855	T = 28
EU	overall	0.2808626	0.4494262	0	1	N = 39368
	between		0.3233576	0	1	n = 1406
	within		0.3122428	-0.4691374	1.17372	T = 28
EMU	overall	0.0843833	0.2779653	0	1	N = 39368
	between		0.1826132	0	0.6071429	n = 1406
	within		0.2096187	-0.5227596	1.048669	T = 28
DV	overall	0.2335907	0.4231201	0	1	N = 39368
	between		0.269745	0	0.6071429	n = 1406
	within		0.3260647	-0.3735521	1.197876	T = 28

Figure 1: Euro Area Trade in Goods (in billions US)

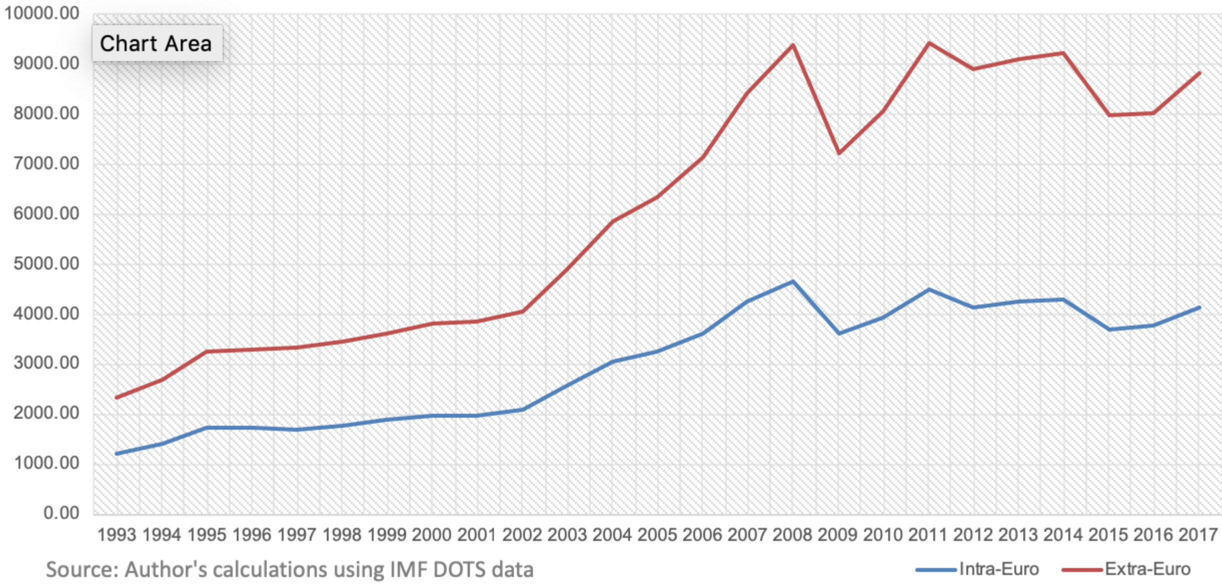

Figure 2: Percentage Share of Intra-Euro Goods Trade- New EMU members

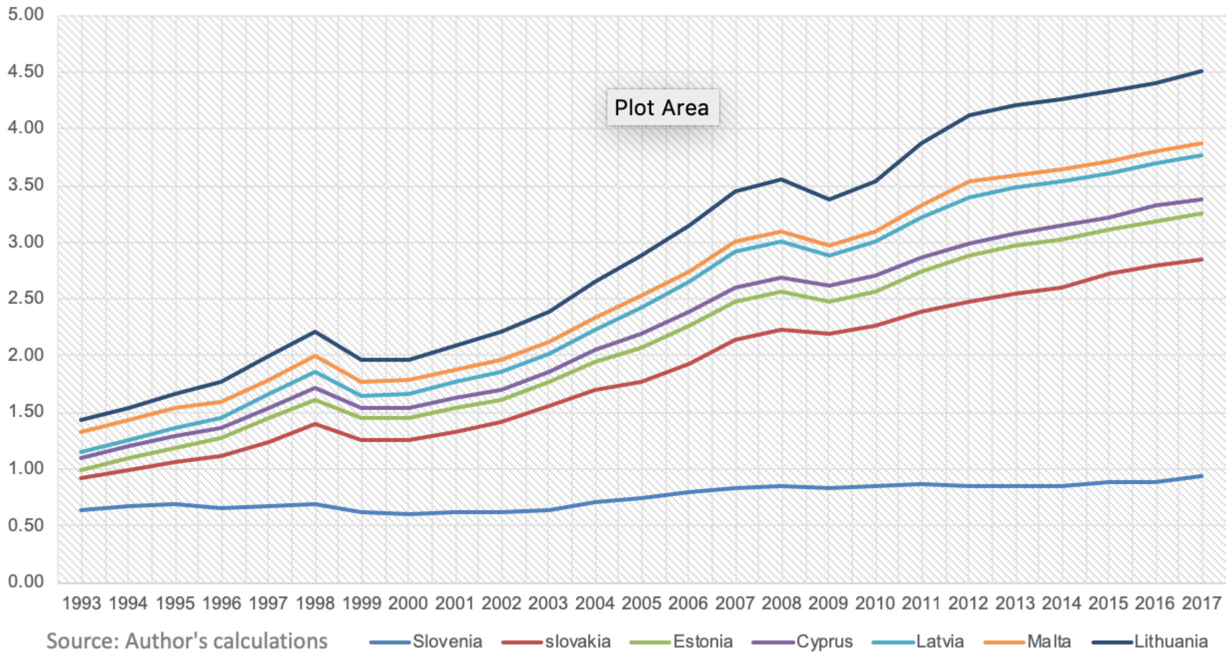

Table B: PPML Estimates- Larger Sample

	ROSE-LIKE SAMPLE (206 COUNTRIES)			
	Dependent Variable: Bilateral Export Trade			
	1988-2013		**1993-2013**	
VARIABLES	**Model [1]**	**Model [2]**	**Model [3]**	**Model [4]**
RTA	-0.100***	-0.100***	-0.079***	-0.079***
	(0.012)	(0.012)	(0.012)	(0.012)
EU	0.337***	0.336***	0.274***	0.272***
	(0.015)	(0.015)	(0.016)	(0.016)
EMU	-0.002		0.010	
	(0.010)		(0.011)	
EMU_{old}		-0.005		0.005
		(0.010)		(0.012)
EMU_{new}		0.365***		0.371***
		(0.083)		(0.082)
EMU_{oldnew}		0.022		0.036
		(0.026)		(0.026)
Exporter_Year FE	YES	YES	YES	YES
Importer_Year FE	YES	YES	YES	YES
Country-pair FE	YES	YES	YES	YES
Observations	526,360	526,360	454,945	454,945
R^2	0.993	0.993	0.994	0.994

$***$, $**$, $*$ represent 1%, 5% and 10% significant level respectively, standard errors in brackets. The dependent variable (bilateral exports) include zero and non-zero trade flows.

Table C: Industry Classification

INDUSTRIES;	**SECTIONS**	**2-DIGIT**
Live Animals and Animal Products	1	01 to 05
Vegetable Products	2	06 to 14
Animal or Vegetable Fat and oil and waxes	3	15
Prepare foodstuffs, tobacco, beverages and Vinegar	4	16 to 24
Minearal Products	5	25 to 27
Products of chemical and allied industries	6	28 to 38
Plastics and Rubber products	7	39 to 40
Raw hides, leather, animal gut and silk-worm gut	8	41 to 43
Wood, charcoal, basketware and wickerwork	9	44 to 46
Pulp of wood, other fibrous cellulosic material and paperboard	10	47 to 49
Textiles and Textile articles	11	50 to 63
Footwear, prepared feathers, artificial flowers and art. human hair	12	64 to 67
Stone, plaster,cement and ceramic product, glass and glassware	13	68 to 70
Natural or pearls, precious stones and metals, jewellery	14	71
Vehicles, aircraft, vessels and associated transport equipment	17	86 to 89
Optical , musical and medical instruments, clocks and watches	18	90 to 92
Arms and Ammunition	19	93
Miscellaneous manufactured articles	20	94 to 96
Works of art, collectors' pieces and antiques	21	97 to 99

The impact of FDI on output growth volatility: a country-sector analysis

Isaac Mensah*

Abstract

While existing literature points to a positive impact of FDI on host countries' growth, little is known about how inward FDI contributes to economic volatility in the host country. In this paper, we investigate the FDI-volatility nexus focusing on manufacturing sectors of OECD countries over the period 1990 to 2015. We document a positive and statistically significant relationship between inward FDI stock and sectoral output volatility. We also show that the impact of inward FDI stock in downstream activities on volatility is larger compared to that of inward FDI stock in upstream activities which is not significant. Additionally, we find that the positive relationship between FDI and volatility is stronger in high capital-intensive industries. These results are robust to the use of a measure of FDI targeting practices.

JEL classifications: E32, F15, F36, O16

Keywords: inward FDI, Volatility, FDI targeting, spillover

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1 Introduction

Most countries around the globe compete fiercely to attract foreign direct investment (FDI). While existing literature points to a positive impact of FDI on host countries' growth, little is known about how inward FDI contributes to economic volatility in the host country. Understanding the FDI-volatility nexus is relevant especially for policy making as economic volatility generally discourage investments, at least, in the case of risk-averse investors. Moreover, cross-country studies point at the existence of a robust correlation between volatility and growth, which seems to reflect the negative[1] impact of the former on the latter (Ramey and Ramey, 1995; Hnatkovska and Loayza, 2004; Norrbin and Yigit, 2005; Lin and Kim, 2014).

Existing literature has studied the the role of trade openness, financial openness, geographic and institutional factors, product characteristics for output volatility at both country and sectoral levels. At the country level, trade openness, financial integration and geographical and institutional characteristics (see Malik et al., 2009; Balavac et al. 2016; Easterly et al., 2001) have been largely explored. Also, production complexity (Koren and Tenreyro, 2007; di Giovanni and Levchenko, 2011) and product specialization have been found to play a significant role on sectoral volatility. Scant attention has been, instead, devoted to the role of FDI.

There are several different channels by which FDI may affect output volatility. The net effect, however, largely depends on MNE's business activ-

[1]This is the empirical evidence of most recent contributions. Historically, there exist important theoretical and empirical works such as Black (1987); Schumpeter (1939); Mirman (1971); Caporale et al., (1998) which document the positive impact of volatility on growth.

ities in the host country, their operational relationship with domestic firms (backward and forward linkages) and the economy of the host country in question. More specifically, MNEs may be less risk averse and invest in more risky projects (Kalemli-Ozcan et al., 2014), thus presenting a higher output volatility risk which can also be transferred to their local suppliers and customers. More so, the risk of transmission is even profound if MNEs have a relatively large industrial or economy-wide market share.

Furthermore, in the light of higher market competition, MNEs can displace domestic competitors (Backer and Sleuwaegen, 2003), thereby ensuing volatility tendencies due to the higher uncertainty faced by the domestic firms exposed to competitive pressure by MNEs. On the other hand, FDI inflows can help improve the competitiveness of domestic firms through production technology transfer and knowledge spillover effects, which can stimulate the creation of new product lines (Gorodnichenko et. al, 2010) and upgrade existing products in host economies (Swenson and Chen, 2014).

Given the different channels by which FDI affects volatility, the question of whether or not the impact is positive is an empirical issue. Hence, in this paper, we study the impact of inward FDI stock on output volatility. More specifically, we analyze the FDI-output volatility nexus by focusing on the manufacturing sector of OECD countries. If output growth across industries is imperfectly correlated and if these correlations change over time, then aggregate sector-level volatility may develop differently. However, this paper does not study the correlation of growth or the co-movement [2] of growth across industries but shed light on heterogeneous volatility paths

[2]See Comin and Philippon, 2005 and Imbs, 2007.

across sectors which receive a heterogeneous amount of FDI.

Following existing literature (Ramey and Ramey, 1995; Acemoglu et al., 2003; Kalemli-Ozcan et al., 2014, among others), we measure volatility as the standard deviation of industry-level real output growth. Additionally, and as a robustness check, we prove the robustness of our findings to an alternative indicator which is the square of the residual of a growth regression that has been adopted in further studies by (Kalemli-Ozcan et al., 2014, Alfaro and Charlton, 2013).

Our results are based on industry-level data collected from the OECD.stat database and UNIDO INDSTAT database. Also, data on control variables are sourced from the World Bank's World Development Indicators (WDI), IMF's IFS among others. We focus on thirteen manufacturing industries for 34 OECD countries during the period 1990-2015. We prove the robustness of our findings by using data on FDI targeting practices collected in the 2005 Investment Promotion Agency (IPA) Survey commissioned by the World Bank's Research Department together with other international institutions (Harding and Javorcik, 2011). The survey covered over 100 countries and allows us to extend the sample of countries in our analysis.

Figure 1 (see appendix) presents the binscatter plot of the relationship between output volatility, inward FDI stock and output growth. It shows a positive correlation between each pair of output volatility, inward FDI stock and output growth. However, the graphical analysis shows a stronger correlation between output growth and inward FDI stock and output volatility and output growth than output volatility and inward FDI stock.

Anticipating our results, we find a positive and statistically significant correlation between inward FDI stock and sector-level output volatility. By exploring industry-level heterogeneity, we detect a strong impact of inward FDI stock on volatility in high capital intensive industries. Moreover, the results also show that the inward FDI stock in downstream activities seems to have a significant effect on volatility with respect to inward FDI in upstream activities that turns to be non-significant. Furthermore, by taking into account the different growth experienced by sectors, we find that the impact of inward FDI on volatility is larger in magnitude in high growth sectors than in low growth sectors.

The use of a reduced-form model exploiting FDI targeting data suggests that FDI promotion practices increase output volatility. By focusing on countries that targeted at least an industry in the period of our analysis, we estimate a cross-sectional model and we find that output volatility is larger in the post-targeting period, thus providing further evidence in line with a positive relation between FDI and volatility. Our results are robust to the use of alternative measures of volatility and FDI targeting practices data.

The rest of the paper is organized as follows. Section 2 reviews the existing literature, Section 3 offers a discussion of the empirical methodology and data we use, Section 4 presents and discusses our results, Section 5 concludes.

2 Literature Review

Our research relates to large literature on the relationship between FDI and output growth. Recent contributions seem to point at a positive relationship between FDI and output growth. Both Campos and Kinoshita (2002) and

Moudatsou (2003) find a positive effect of FDI on economic growth. The former focus on Central and Eastern European Countries (henceforth, CEEC) and former Soviet Union transition economies, while the latter explores EU countries. Moreover, Alfaro and Charlton (2013) find that the quality of FDI has a larger effect on growth. With reference to UNCTAD's World Investment Report 2006, they describe "quality FDI" as the kind that would significantly increase employment, enhance skills and boost the competitiveness of local enterprises.

Blonigen et al. (2004) have shown that regarding the benefits of FDI, whether FDI crowds out or crowds in investment depends on countries' level of development. FDI is much less likely to crowd out (and then likely to crowd in) domestic investment for Least Developing Countries (LDCs) than Developing Countries (DCs). Thus, countries' level of development is crucial to the benefits and spillover effects of capital flows and the adverse impact of economic fluctuations. Balasubramanyam (1998) shows that the economic characteristics (such as sizeable domestic markets, infrastructure facilities, resource endowments etc.) of the host country determine the technology imported by MNEs. Borensztein et al. (1998) also point at FDI to being positively associated with growth only in countries with sufficiently high levels of human capital. Furthermore, Alfaro and Charlton (2013) find similar results at the industry level.

At the country level, the literature has shown that output volatility affects countries disproportionately, and more specifically, developing countries seem to suffer more from output volatility than developed countries (Jansen et al., 2009). A plausible explanation is that these economies specialize in few tradable products and sectors and lag behind in the adaptation of cutting-edge technologies (Tenreyro and Koren, 2007; Krishna and Levchenko, 2013; and Tenreyro and Koren, 2013). Other factors connected to the structural vulnerability of developing countries regard their lack of proper financial, monetary and fiscal discipline which could serve as tools for mitigating the effect and intensity of economic shocks.

The shocks that most developing countries face are either internally generated or arguably the spillover effects of some external circumstances (Reinhart and Rogoff, 2009). A plunge in commodity prices over a long period of time affects foreign earnings of most developing countries, which could potentially precipitate domestic shock through production, investment and consumption uncertainty. While different existing contributions (Bejan, 2006; Abubaker, 2015; Balavac et al., 2016 and Di Giovanni et al., 2009) focus on international trade as a determinant of output volatility, we study the impact of foreign direct investment.

The literature on the role of FDI flows on output volatility is relatively scant. A strand of literature rests on the stylized fact that, among the components of capital flows, FDI flows are relatively stable and could, therefore, deliver higher stability. In this respect, Federico et al. (2013) show that output volatility depends not only on the volatility of FDI and portfolio and other investments, but also on the correlation among them and the share of FDI in total capital flows. They find that foreign investments decrease output volatility when the FDI share in total foreign capital flow is low.

A different approach in the analysis of the FDI-volatility nexus is followed by Kalemli-Ozcan et al. (2014). They study the relationship between output volatility and foreign ownership by using a firm-level panel data set for European countries. In their firm-level analysis, they find a positive relationship between foreign ownership and firm-level volatility. They conclude that the risky behaviour of foreign firms comes from their ability to diversify risk internationally. At the aggregate regional level, they show that micro-level (firm) patterns of volatility carry-over to the macro-level (regional).

In particular, the evidence of consistency in the micro-level and macro-level patterns of volatility, as shown by Kalemli-Ozcan et al. (2014), originates from the "granular" (see, Gabaix, 2011) firm size structure of the countries they analyse. However, Imbs (2007) document a negative aggregate growth and volatility relationship, but a positive sectoral growth and volatility. Furthermore, Comin et al. (2005) find that there exists a negative relationship between firm-level and aggregate volatility. These contributions have shown that sector-level patterns of volatility could drive aggregate volatility, even if this is not always the case since co-movement of sector-level and country level volatility could develop differently.

Our work follows that of Federico et al. (2013) and Kalemli-Ozcan et al. (2014) in the scant FDI-output volatility literature. We distinguish our work from the one by Federico et al. (2013) by implementing an industry-country level analysis. While the effect highlighted in the Kalemli-Ozcan et al. (2014)'s paper captures the direct impact of firms' foreign ownership on their volatility, our analysis is able to capture a sector-level FDI-volatility nexus engendered by the impact of MNEs' presence on domestic actors, thus encompassing the different channels presented above. Moreover, we also focus on a larger sample of countries with respect to the work by Kalemli-Ozcan et al.(2014), especially when we extend the analysis to FDI targeting.

3 Empirical Methodology and Data

We start off the empirical analysis by first exploring the link between industry-level inward FDI stock and output growth volatility. Output growth rate is computed as the log difference of real output. We report estimates using two alternative measures of volatility. The first relying on the standard deviation of real output growth rates, while the second follows from the square of the residuals of a growth regression.

Due to the lack of sectoral price index for a large number of countries, we deflate sector level output by using the country level GDP deflator. It follows that our measure of volatility may reflect in part volatility in relative prices. However, our focus on the manufacturing sector mitigates this drawback, as price volatility is much less severe issue for manufacturing than for agricultural commodities or agricultural sector. Moreover, our analysis focuses on developed countries (OECD countries), which are less likely to experience frequent price changes. Also, we focus on a sample period that did not record large changes in prices (at least not for the majority of countries we analyze).

We measure volatility[3] in a time window of five years which is found to be

[3]We compute volatility in the following ways:

A. $Vol_{cit} = \sqrt{\frac{1}{5}\sum_{t=1}^{5}(y_{cit} - \bar{y}_{ci})^2}$

B. $y_{cit} = y_{cit-1} + \alpha_t + \delta_{ci} + \varepsilon_{cit}, Vol_{cit} = \hat{\varepsilon}^2$. Where y_{cit} is the country-industry growth rate at time t, $\bar{y}_{ci}$ is a five-year average of growth rate, α_t, δ_{ci} and ε_{cit} are the time fixed effect, country-industry fixed effect and residuals respectively. Before computing the standard deviation in (A) we exclude those country-industry pairs with growth rates above the top 1 percent and below 99 percent of the output growth rate distribution. Likewise, the typical length of a business cycle (Madsen 2002; Beck and Levine, 2001). Similarly, Blanchard and Simon (2001) and Abubaker (2015) both use a time window of 20 quarters. We specify a panel fixed-effect model given below as:

$$lnVol_{cit} = \beta_0 + \beta_1 shFDI_{cit-1} + \beta_2 lnOutput_{cit-1} + \beta_3 TrdOpenness_{cit-1} + \beta_4 FinOpenness_{ct-1} + \beta_5 lnSch\_enrol_{ct-1} + \beta_6 lnSalaries\_Wages_{cit-1} + \beta_7 lnGFCF_{cit-1} + \beta_8 shPfl\_Invst_{ct-1} + \alpha_t + \delta_{ci} + \varepsilon_{cit}. \quad (1)$$

The dependent variable is the volatility of output growth rate of country c in industry i at time t. Vol is the standard deviation in a 5-year time window covering the period 1990-2015. This gives a total of five non overlapping time windows: 1991-1995, 1996-2000, 2001-2005, 2006-2010, 2011-2015. A similar model is estimated by using as dependent variable an alternative measure of volatility computed as the square of the residual of an AR(1) growth regression in each year. The variable of interest, $shFDI_{cit-1}$, is a year lag of the share of inward FDI stock of country c in industry i at time t ($\frac{FDIstock\_in\_value}{Output\_value}$). We control for other plausible determinants of volatility namely the Output level (Output), trade openness (TrdOpenness) , financial openness (FinOpenness), secondary school enrollment (Schenrol), wages and salaries (Salaries_Wages), gross fixed capital formation (GFCF) and portfolio investments (shPfl_Invst).

More important, portfolio investment, which is computed as a share of GDP, controls for all other foreign capital flows below 10 percent of owners' equity. All controls follow the industry-country-year dimension, except (Sch_enrol), (FinOpenness) and (shPfl_Invst) which are country-level vari-

we follow similar treatment before estimating the growth model in (B).

ables. α_t is the time fixed-effect, δ_{ci} is the country-industry fixed-effect and finally, ε_{cit} is the error term which is assumed to be uncorrelated with the controls and the variable of interest.

The theoretical narrative for the correlation between FDI and volatility holds in both positive and negative directions. Just as inward FDI can stimulate competition and consequentially eliminate inefficient firms leading to long-run stability, it can also stifle credit and crowd out domestic firms leading to domestic demand instability. Both explanations though likely to have different long-run effect seem to indicate a similar short-run effect of FDI impact on volatility. Given this intuition, we expect the impact of FDI to be positive. This is also consistent with the idea that the manufacturing industries face high demand and supply risk following domestic or external shocks.

Our analyses are implemented on a sample of OECD countries. Data on industrial variables are collected from UNIDO INDSTAT database which provides industrial data for a large set of countries. For inward FDI stock, we use data from the OECD FDI database. The data cover thirteen (13) manufacturing industries following the International Standard Industrial Classification (ISIC revision 3- 2 digit) for the period 1990-2015. Trade openness is computed using industry-level import and export trade data from WITS-COMTRADE database. We exploit industry-specific characteristics retrieved from the NBER manufacturing industry database. Also, we use the OECD input-output table (IO) to compute the industry-level share of output and intermediate input supplies.

Data on other country-level variables (financial openness, secondary school enrollment and portfolio investments) are obtained from diverse sources. Secondary school enrollment data are from the World Development Indicators (WDI) of the World Bank, while financial openness and portfolio investment data are sourced from Chinn-Ito Index (KAOPEN) and the International Financial Statistics (IFS) of the IMF respectively.

4 Results

4.1 The FDI-volatility nexus

Table 1 reports our findings on the impact of inward FDI stock on output growth volatility obtained from the estimation of equation 1. From model [1] to [7], volatility is computed following the 5-year standard deviation measure, while the residual measure is used in model [8] to [13]. Moreover, in model [1] to [7], the lagged variables refer to the last year of the previous time window, while in model [8] to [13] lagged variables refer to the previous year .

The estimates show a positive and statistically significant correlation between output growth volatility and a year lag of inward FDI stock. This finding is confirmed when using both measures of volatility and controlling for other determinants of output growth volatility. With reference to model [1] to [7], the estimated effect[4] is between 38-65 percent and statistically significant at 1 percent level. Models [8] to [13] seem to report a still positive impact of inward FDI on volatility but a lower magnitude. This difference can be attributed to the fact that the standard deviation measure exploits a longer year-on-year variation compared to the residual measure.

[4] This is computed as: $100 \times (exp^{\beta_1} - 1)$

Table 1: Estimates- Impact of inward FDI stock on output growth volatility

	Dependent Variable: ln[SD_output_growth]						
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
L.shFDI	0.353***	0.352***	0.487***	0.501***	0.404***	0.316***	0.325***
	(0.118)	(0.117)	(0.086)	(0.088)	(0.090)	(0.085)	(0.088)
L.lnOutput		-0.005	0.044	0.067	0.288*	0.214	
		(0.086)	(0.111)	(0.119)	(0.162)	(0.178)	
L.TrdOpenness			0.125**	0.132**	0.154***	0.101*	0.079
			(0.060)	(0.061)	(0.059)	(0.057)	(0.052)
L.FinOpenness				-0.066	-0.122*		
				(0.049)	(0.066)		
L.lnsch_enrol					0.205	0.318	0.197
					(0.331)	(0.327)	(0.351)
L.lnwage_salaries					-0.084	-0.135	0.013
					(0.136)	(0.157)	(0.100)
L.lnGFCF					-0.068	-0.035	-0.036
					(0.070)	(0.073)	(0.076)
L.shPfl_invst						0.277**	0.289***
						(0.111)	(0.111)
A_out_grwth							-0.314
							(0.570)
Year FE	YES	YES	YES	YES	YES	YES	YES
Country_Industry FE	YES	YES	YES	YES	YES	YES	YES
Observations	769	769	726	726	637	581	581
R^2	0.358	0.358	0.422	0.425	0.483	0.492	0.488
	Volatility: Residual Method						
	Model 8	**Model 9**	**Model 10**	**Model 11**	**Model 12**	**Model 13**	
L.shFDI	0.0149***	0.0146***	0.0173***	0.0181***	0.0224***	0.0205***	
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	
L.lnOutput		-0.111	-0.208	-0.168	0.673***	0.664**	
		(0.130)	(0.139)	(0.141)	(0.241)	(0.299)	
L.TrdOpenness			-0.001***	-0.001***	-0.012**	-0.012**	
			(0.003)	(0.003)	(0.006)	(0.006)	
L.FinOpenness				-0.173*	0.063		
				(0.092)	(0.111)		
L.lnsch_enrol					-0.863	-0.847	
					(0.813)	(0.844)	
L.lnwage_salaries					-0.883***	-0.896***	
					(0.277)	(0.320)	
L.lnGFCF					-0.082	-0.082	
					(0.142)	(0.152)	
L.shPfl_invst						-0.335	
						(0.300)	
Year FE	YES	YES	YES	YES	YES	YES	
Country_Industry FE	YES	YES	YES	YES	YES	YES	
Observations	4,029	4,029	3,935	3,934	3,032	2,784	
R^2	0.058	0.059	0.063	0.064	0.051	0.049	

$***$,$**$,$*$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable in model [1] to [7] follows the standard deviation method, while in model [8] to [13] we apply the residual method.

Importantly, in the specifications where we use the standard deviation measure of volatility, we include the average sectoral output growth (A_out_grwth) which controls for heterogeneous growth across sectors which may affect the results. Additionally, as the evidence of a positive FDI-volatility nexus could be driven by peculiar characteristics of some sub-sample groups, we estimate the model by splitting the sample into high and low growth sectors. A sector is classified as high growth if the output growth of the sector exceeds the average sector growth defined at the country level. To capture the changing nature of sectors' productivity, the classification is based on a time window of 5 years.

The results (see table A4 and A5 in the appendix) show a positive relationship between FDI and output volatility in both high and low growth sectors. They, however, indicate that high growth sectors have larger (in magnitude) volatility than low growth sectors. Furthermore, we split the sample into high and low sectors according to sectors' pre-sample share of value-added. We use the value-added shares in 1990. While the results (see table A6 in the appendix) are consistent with our baseline findings, we, however, do not find any significant difference of the impact of FDI on volatility in sectors with either high or low initial share of value-added.

We also report in Table 2 the contemporaneous impact of average inward FDI on output volatility (using the standard deviation measure). In this estimation, we take the average of the variables of each time window by excluding from the computation those time windows which present at least one missing data point. This strategy ensures consistency in computing the averages across countries-industry-year. Consistent with our previous findings, the results indicate that contemporaneous average inward FDI stock increases output growth volatility. The results also indicate that the contemporaneous impact of inward FDI seems larger than the lag effect of inward FDI. This seems quite intuitive since generally the impact of economic shocks is profound during its early period but dissipates over time.

As shown in previous results, the estimated partial elasticities of $shFDI$ are statistically significant at 1 percent level after controlling for trade openness, financial openness and portfolio investment. Also consistent with findings in the literature, the positive impact of trade openness on volatility is correctly identified as shown in Model [5] and [6]. The results, however, indicate that financial openness[5] has no significant effect on volatility, while portfolio investment is significant at 5 percent level as shown in Model [6].

Table 2: Contemporaneous average effect of inward FDI stock

	Dependent Variable: ln[SD_output_growth]					
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
$shFDI$	0.669***	0.688***	0.607***	0.592***	0.761***	0.764***
	(0.136)	(0.137)	(0.167)	(0.170)	(0.178)	(0.179)
$lnOutput$		0.0825	0.0874	0.171	0.804*	1.581***
		(0.115)	(0.121)	(0.139)	(0.477)	(0.382)
$TrdOpenness$			0.066	0.0668	0.347***	0.388***
			(0.079)	(0.077)	(0.106)	(0.137)
$FinOpenness$				-0.197	-0.304	
				(0.128)	(0.189)	
$lnsch\_enrol$					3.794***	4.369***
					(1.337)	(1.378)
$lnwage\_salaries$					-0.00298	-0.684*
					(0.568)	(0.378)
$lnGFCF$					-0.466***	-0.464***
					(0.155)	(0.157)
$shPfl\_invst$						0.594**
						(0.257)
Year FE	YES	YES	YES	YES	YES	YES
Country_Industry FE	YES	YES	YES	YES	YES	YES
Observations	498	498	465	465	331	305
R^2	0.337	0.338	0.417	0.426	0.576	0.628

$***$,$**$,$*$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable is the standard deviation of output growth.

[5]This measure is likely to be associated to greater flows of FDI and portfolio investments.

4.2 FDI-Volatility nexus in capital intensive industries

In most developed countries, production is highly mechanized and essentially capital intensive. While huge capital requirement in high capital-intensive industries poses an inherent entry barrier for domestic firms, MNEs are more likely to enter high capital intensive industries as they have at their disposal higher financial resources and are less likely to be credit constrained. Hence, except for government investments, MNEs are the natural players in high capital intensive industries. In this section, we analyze the impact of inward FDI stock on volatility in high capital intensive industries using NBER manufacturing industry data. We measure capital intensity as the ratio of industry-level stock of capital and value-added. We then estimate the model:

$$lnVol_{cit} = \beta_0+\beta_1 shFDI_{cit-1}+\beta_2 shFDI_{cit-1}*CapInt_{cit-1}+\beta_3 CapInt_{cit-1}+ Z'_{cit-1}\Theta + X'_{ct-1}\Phi + \alpha_t + \delta_{ci} + \varepsilon_{cit} \quad (2)$$

Equation (2) follows the definitions given in equation (1), and we use the residual measure of volatility in the estimation. $CapInt$ is the measure of capital intensity, while Z'_{cit} and X'_{ct} are the vectors of country-industry-year and country-year controls respectively. Since the share of inward FDI stock and the measure of capital intensity are both continuous variables, we estimate the FDI effect on output volatility along sectors' capital intensity distribution.

Table 3 presents the results of the impact of inward FDI stock on output volatility in capital-intensive industries. The results seem to suggest a negative relationship between volatility and capital-intensive industries as

Table 3: Estimates- Impact of inward FDI on Volatility in Capital Intensive industries

	Dependent Variable: ln[Volatility_output_growth]					
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
L.shFDI	-0.021	-0.021	-0.033	-0.033	-0.032	-0.020
	(0.019)	(0.019)	(0.020)	(0.021)	(0.021)	(0.022)
$L.shFDI \times L.CapInt$	0.037*	0.036*	0.051**	0.052**	0.054**	0.041
	(0.021)	(0.021)	(0.023)	(0.023)	(0.024)	(0.026)
L.CapInt	-0.312	-0.357	-0.452**	-0.443**	-0.294	-0.341
	(0.211)	(0.217)	(0.220)	(0.218)	(0.263)	(0.327)
L.lnOutput		-0.176	-0.310**	-0.275*	0.617**	0.432
		(0.141)	(0.139)	(0.140)	(0.243)	(0.317)
L.TrdOpenness			-0.014***	-0.013***	-0.013**	-0.015***
			(0.003)	(0.003)	(0.006)	(0.005)
L.FinOpenness				-0.138	0.064	
				(0.095)	(0.113)	
L.lnsch_enrol					-0.866	-0.530
					(0.806)	(0.818)
L.lnwage_salaries					-0.857***	-0.699**
					(0.279)	(0.320)
L.lnGFCF					-0.074	0.036
					(0.144)	(0.160)
L.shPfl_invst						0.213*
						(0.114)
Year FE	YES	YES	YES	YES	YES	YES
Country_Industry FE	YES	YES	YES	YES	YES	YES
Observations	3,793	3,793	3,699	3,698	3,032	2,776
R^2	0.042	0.043	0.049	0.05	0.052	0.049
	FDI Effect along the capital intensity distribution					
10^{th} *Percentile*	0.005	0.005	0.004	0.004	0.007	0.010*
	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
25^{th} *Percentile*	0.008*	0.008*	0.008	0.008*	0.011**	0.013***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
50^{th} *Percentile*	0.013***	0.013***	0.015***	0.016***	0.019***	0.019***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
75^{th} *Percentile*	0.019***	0.018***	0.022***	0.023***	0.026***	0.025***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.008)
90^{th} *Percentile*	0.025***	0.024***	0.031***	0.032***	0.035***	0.031***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.011)

$***$,$**$,$*$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable follows the residual method of computing volatility.

shown by the main effect variable *CapInt*. That notwithstanding, inward FDI significantly flip the negative effect, indicating a positive relationship as reported in model [1] to [5] by the interaction term of inward FDI and capital intensity measure. By resting on these results, the effect of inward FDI on volatility differ across sectors with different level of capital intensity.

We estimate the FDI effect on volatility along the distribution of the capital-intensive measure by focusing on the 10th, 25th, 50th, 75th and 90th percentiles of the *CapInt* distribution. We consider industries to be relatively high capital intensity if their *CapInt* value equals or exceed the value of the 50th percentile. The mean and standard deviation of the *CapInt* distribution[7] is 1.009 and 0.379 respectively. However, the results are robust to dropping industries that are inherently high capital-intensive.

Using the 10th, 25th, 50th, 75th and 90th percentile value of *CapInt*, the results indicate that inward FDI stock impact positively on volatility in capital-intensive industries. This impact seems to be statistically significant and larger in magnitude in predominately high capital-intensive industries. For example, the estimated impact is approximately zero and insignificant (except in Model 6) for industries in the 10th percentile. Intuitively, in high capital intensive sectors, volatility may ensue from higher competition associated with the presence of MNEs. In general, the structure of capital-intensive industry permit the operation of a few number of firms, therefore new or existing MNEs might have to compete fiercely to maintain or extend their market shares hence the higher output growth volatility in high capital

[7]The outliers in the *CapInt* distribution are expected. The coke, refined petroleum products and nuclear fuel industries require huge capital and are extremely capital intensive than the food products and beverages industry both included in our sample.

intensive industries.

4.3 Volatility and FDI spillover

Since industries depend on each other due to their Input-Ouput (IO) relationships, the impact of inward FDI in the host industry is likely to spillover to other industries that are directly or indirectly connected in the supply chain. According to Javorcik (2004), spillovers from FDI take place when the entry or presence of MNEs increases the productivity of domestic firms and the MNEs do not fully internalize the value of these benefits.

Existing literature (Blalock, 2001; Schoors et al., 2001; Javorcik, 2004) point at the existence of some positive FDI spillover effect through backward linkages. Ideally, this positive effect is more likely to exist in upstream than in downstream activities. Thus, MNEs will be more willing to share cutting-edge production techniques with their local supplies than with their competitors. On the other hand, downstream activities are more likely to be volatile than upstream activities. The intuition is that firms providing finished products to customers mostly compete over market shares.

In this section, we analyze how the presence of inward FDI in downstream and upstream activities contributes to a sector's output volatility. We used the 1995 OECD input-output table to compute country level input-output shares between sectors. While our sample focuses on manufacturing industries in the OECD area, we normalize each manufacturing industry's input purchases on the total purchases and each industry's output on the total sales. We then estimate the following models:

$$lnVol_{cit} = \beta_0 + \beta_1 shFDI^{downstream}_{cit-1} + \beta_2 shFDI^{upstream}_{cit-1} + \beta_3 shFDI_{cit-1} + Z'_{cit-1}\Theta + X'_{ct-1}\Phi + \alpha_t + \delta_{ci} + \varepsilon_{cit} \quad (3)$$

Where downstream and upstream FDI are defined as fellows:

$shFDI^{downstream}_{cit} = \sum_j \mu_{cij} * shFDI_{cjt}, i \neq j, where \quad j \in M$, and M is the set of manufacturing sectors.

$shFDI^{upstream}_{cit} = \sum_j \nu_{cij} * shFDI_{cjt}, i \neq j$

The input-output shares (μ_{cij}, ν_{cij}) are computed excluding within industry transfers. μ_{cij} represents the share of sales (over total sales) of industry i to industry j in country c, while ν_{cij} are the share of purchases (over total purchases) of industry i from industry j in country c and $shFDI$ is computed as before.

In table 4, we report the results of the impact of inward FDI stock in downstream and upstream activities on a sector's volatility (we use the standard deviation measure). As shown in our baseline results, we find inward FDI stock in the sector under analysis to be positive and significant. Moreover, the effect of inward FDI in downstream activities is positive and significant in all reported models. However, FDI in upstream activities bear a positive coefficient, but it is significant just in model model 3 and 4. As expected, the reported partial elasticity of inward FDI in downstream activities on volatility seems larger with respect to that associated with upstream activities.

Firms in downstream sectors compete over market shares. They internalize the benefits of their production know-how and technology from other downstream firms. The outcome of the competitive pressure in downstream activities is the evidence of a significantly large (in magnitude) output growth volatility as shown by our results. Importantly, because of backward spillover effect, firms active in upstream activities may be more exposed to output growth volatility due to their relationships with firms in downstream sectors. Thus, their exposure to volatility originates from firms volatile activities in the downstream sectors. Consistent with our results, we find a positive FDI-volatility nexus in upstream sectors.

Table 4: Estimates- FDI spillover effect on volatility

	Dependent Variable: ln[Volatility_output_growth]							
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**
$L.shFDI^{downstream}$	1.174*	1.159*	2.530***	2.502***	1.946**	1.629*	1.629*	1.629*
	(0.649)	(0.638)	(0.852)	(0.829)	(0.777)	(0.901)	(0.901)	(0.902)
$L.shFDI^{upstream}$	0.907	0.902	1.610**	1.631**	0.992	1.203	1.203	1.204
	(0.810)	(0.809)	(0.777)	(0.762)	(0.656)	(0.774)	(0.774)	(0.771)
$L.shFDI$	0.280**	0.279**	0.351***	0.359***	0.333***	0.257**	0.257**	0.257**
	(0.113)	(0.111)	(0.110)	(0.112)	(0.109)	(0.108)	(0.108)	(0.110)
A_out_grwth								0.009
								(0.593)
$L.lnOutput$		-0.008	0.031	0.048	0.220	0.222	0.222	0.223
		(0.086)	(0.108)	(0.115)	(0.160)	(0.177)	(0.177)	(0.186)
$L.TrdOpenness$			0.118**	0.123**	0.145**	0.101*	0.101*	0.101*
			(0.058)	(0.059)	(0.058)	(0.058)	(0.058)	(0.058)
$L.FinOpenness$				-0.045	-0.095	-0.016	-0.016	-0.016
				(0.045)	(0.061)	(0.059)	(0.059)	(0.060)
$L.lnsch\_enrol$					0.235	0.362	0.362	0.362
					(0.320)	(0.326)	(0.326)	(0.328)
$L.lnwage\_salaries$					-0.060	-0.140	-0.140	-0.140
					(0.140)	(0.162)	(0.162)	(0.161)
$L.lnGFCF$					-0.049	-0.035	-0.035	-0.035
					(0.070)	(0.072)	(0.072)	(0.073)
$L.shPfl\_invst$						0.213*	0.213*	0.213*
						(0.119)	(0.119)	(0.120)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
Country_Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	765	765	722	722	635	581	581	581
R^2	0.367	0.367	0.447	0.448	0.497	0.496	0.496	0.496

$***$,$**$,$*$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable follows the standard deviation measure of computing volatility.

4.4 Volatility and FDI targeting

According to most investment promotion practitioners, the most effective way of attracting FDI is through prioritizing industries and targeting the industries with higher priority. This is very crucial as FDI flows could potentially restructure firms and ultimately industries in the host country. Wells and Wint (2000) define investment promotion as activities through which governments aim to attract FDI inflows. These activities are sometimes comprehensive, going from fiscal incentives like tax cut and tax holidays to administrative incentives such as investors servicing etc. FDI targeting has been shown to be positively correlated with FDI flows, with developing countries being the main beneficiaries (Harding and Javorcik, 2011).

On this basis, we use FDI targeting data in a sort of reduced form model in order to analyze the FDI-volatility relationship. The FDI targeting data we used are retrieved from a World Bank commissioned survey conducted in 2005. This data is extensively described in Harding and Javorcik (2011). It is important to stress that the survey provides time-varying industry-specific information about whether an industry was targeted or not over a defined period of time. The data cover 124 countries for the period 1989-2004.

We exploit the data in two ways. First, we take advantage of the large cross-section of countries by estimating a model which covers 95 countries (referred to as the world sample) over the sample period 1980-2010. The overlap in our sample period comes from the fact that the lagged variables follow a 5-year time window. Second, we limit the sample to only OECD countries as we have done in our baseline estimations. This allows us to understand if there exist significant differences between the average impact of FDI targeting on output volatility focusing on these two sample groups.

In table 5, we report the impact of FDI targeting on output volatility. The upper table shows the estimates using all the sample of countries, while the lower table shows that for the OECD sample. Moreover, we use the residual measure of volatility in the upper table, and the standard deviation measure in the lower table. The dummy $Targeted$ is our variable of interest and it takes value 1 if an industry was targeted by the host government usually through investment promotion agencies (IPAs) at a given period and 0 otherwise.

The results thus indicate that there exists a positive and statistically significant impact of FDI targeting on output volatility. Put differently, industries that were targeted experience higher volatility of output than industries that were not targeted. This finding is consistent irrespective of the measure of volatility or the country group used. Thus, the impact of FDI targeting on volatility in developed (OECD) countries does not differ significantly from the world average. Moreover, and as expected, the estimated effect is quite similar to that obtained by using inward FDI stock.

We verify this finding further by estimating an alternative model where we consider FDI targeting as a treatment variable. More specifically, we focus on just countries that start targeting an industry in one specific year. This allows us to easily define a pre- and post-targeting period, which will differ across countries but is the same across all sectors in a given country. In this flavour of difference-in-difference estimation, we analyze if the impact of FDI targeting on output growth volatility is significant in the post-targeting

Table 5: Estimates- FDI targeting on Volatility

	Dependent Variable: ln[Volatility_output_growth]					
			WORLD SAMPLE			
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
L.Targeted	0.528***	0.476***	0.323**	0.339**	0.369*	0.708***
	(0.132)	(0.133)	(0.138)	(0.142)	(0.206)	(0.222)
L.lnOutput		0.119***	0.145**	0.146**	0.192**	0.441***
		(0.025)	(0.067)	(0.066)	(0.082)	(0.148)
L.TrdOpenness			0.485***	0.483***	5.702**	4.405
			(0.082)	(0.081)	(2.608)	(5.539)
L.FinOpenness				-0.151**	-0.0889	-0.00829
				(0.059)	(0.070)	(0.101)
L.lnsch_enrol					0.394	-0.347
					(0.534)	(0.839)
L.lnwage_salaries					-0.270*	-0.871***
					(0.164)	(0.254)
L.lnGFCF					-0.0743	-0.0638
					(0.077)	(0.122)
L.shPfl_invst						-0.617*
						(0.372)
Year FE	YES	YES	YES	YES	YES	YES
Country_Industry FE	YES	YES	YES	YES	YES	YES
Observations	10,106	10,106	6,315	6,243	3,822	2,684
R^2	0.033	0.037	0.035	0.037	0.035	0.066
			OECD SAMPLE			
L.Targeted	0.477***	0.470***	0.551***	0.405***	0.729***	0.352*
	(0.123)	(0.126)	(0.128)	(0.145)	(0.159)	(0.200)
L.lnOutput		0.174*	0.196*	0.239*	0.0467	0.0421
		(0.092)	(0.109)	(0.140)	(0.116)	(0.152)
L.TrdOpenness			-9.619***	-21.81	-9.882***	5.445
			(2.796)	(58.760)	(3.424)	(73.430)
L.FinOpenness					-0.171***	-0.522***
					(0.064)	(0.114)
L.lnsch_enrol						1.795**
						(0.767)
L.lnwage_salaries				0.629***		0.499**
				(0.200)		(0.199)
L.lnGFCF				-0.281***		-0.168*
				(0.081)		(0.085)
Year FE	YES	YES	YES	YES	YES	YES
Country_Industry FE	YES	YES	YES	YES	YES	YES
Observations	656	656	586	465	544	429
R^2	0.169	0.179	0.112	0.167	0.158	0.296

$***, **, *$ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable in the upper table follows the residual method while we use the standard deviation method in the lower table period. Importantly, since we are able to identify one single targeting year for each country, we consider this year when computing the post and pre targeting period even for non targeted sectors. For example, in our sample, Austria targeted the food processing industry beginning 1997. Hence, we, therefore, impute 1997 to all non targeted industries as the year of targeting. We are thus able to identify the post and pre-targeting period for all sectors. We then estimate a cross-sectional model of the form given below as:

$$\Delta_{\tau+5,\tau-5} lnVol_{ci\tau} = \beta_0 + \beta_1 Targeted_{ci\tau} + \Phi X'_{ci} + \lambda_c + \gamma_{i\tau} + \epsilon_{ci\tau} \quad (4)$$

The dependent variable is the difference of a 5-year lead and lag of output growth volatility. The leads and lags are computed using the year of industry targeting as the reference. τ in equation (4) correspond to different calendar years across sectors as the targeting year ($t = 0$) is different across countries. For example, in our sample, Austria targeted some industries in 1997 while Canada began its targeting in 2003. Thus, despite the different time period, country-industry pairs are included only once in the estimation. The dummy $Targeted$ takes value 1 if the industry was targeted and 0 otherwise. X'_{ci} is a vector of country-industry controls, λ_c is the country FE, and $\gamma_{i\tau}$ is the industry-year FE.

Table 6 reports estimates of the cross-sectional effect of FDI targeting on output volatility. Volatility was computed using the 5-year standard deviation measure. The results in table 6 complement our baseline findings, in showing that output volatility is larger in the post-targeting period. The point estimate of the effect of FDI targeting on volatility in the post-targeting

Table 6: Cross-Sectional effect- Volatility and FDI targeting

	Dependent Variable: $Volatility_{Post} - Volatility_{Pre}$			
	[Model 1]	[Model 2]	[Model 3]	[Model 4]
Targeting	**0.418****	**0.421****	**0.600***	**0.690***
	(0.166)	**(0.174)**	**(0.342)**	**(0.349)**
Fixed Effects:				
Sector × Year	NO	NO	YES	YES
Country	NO	NO	YES	NO
Country-industy covariates	NO	YES	NO	YES
Observations	102	101	102	101
R^2	0.214	0.269	0.823	0.833

∗ ∗ ∗,∗∗,∗ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets.

period is similar to our baseline results. Moreover, the results of Model 3 and 4 show a similar effect than the contemporaneous effect of FDI on volatility reported in Table 2.

5 Conclusion

The aim of this paper was to analyze the relationship between industry-level output volatility and inward FDI stock focusing on the manufacturing sector. While existing literature on the subject is scant, Kalemli-Ozcan et al., (2014) provide some firm-level evidence on the FDI-volatility nexus. This paper tackles the sector-level dimension engendered by the impact of MNEs' presence on domestic actors, thus encompassing the different channels presented in the paper. We extend the analysis by exploring the existence of some heterogeneity according to the capital intensity of sectors and by shedding light on the impact of the inward FDI stock in downstream and upstream activities on a sector's output volatility.

Our results show a positive and statistically significant correlation between inward FDI stock and sector-level output volatility, and the estimated effect is between 38-65 percent. The results are robust to the use of an alternative measure of volatility and the inclusion of control variables. By exploiting industry-level heterogeneity, we find that inward FDI stock increases volatility in high capital intensive industries. Moreover, the results also show that inward FDI stock in downstream activities seems to have a significant effect on volatility with respect to inward FDI in upstream activities.

We conclude on a positive FDI-volatility nexus at the sector level, adding to the firm-level evidence in Kalemli-Ozcan et al., (2014). Further analysis using a measure of FDI targeting practices supports our baseline findings. An increasing number of governments want to attract FDI because the positive effects (growth and development, increasing innovation, human capital development) of FDI fit into the development agenda of policymakers. That notwithstanding, the risk of income inequality, profit repatriation and output volatility, the latter shown by our results, always revive the question about the dangers of inward FDI in the policy cycles.

Our results do not imply that policymakers should discourage or refrain from attracting FDI or practicing investment promotion. They rather highlight the strong connection between inward FDI stock and volatility. The results, however, highlight the vulnerability of some industries to inward FDI which in this case requires some degree of policy intervention. For example, for countries with sufficiently large high capital-intensive sectors, much is required in term of policy intervention as inward FDI increases volatility in these sectors.

In this regard, policymakers could priorities and monitor sectors that are likely to present higher volatility. Capital intensive and downstream sectors are relatively volatile as shown by our results. Moreover, our results show that high growth sectors face larger output volatility than low growth sectors. This is usually a concern in countries that depend on a few sectors and in cases where these sectors represent a significant domestic market share. A wider scope of prioritized sectors and a timely redistribution and promotion of investment in negligible sectors is key in managing inward FDI and volatility. Thus, higher diversification of the economic structure would smoothen the effects of higher volatility experienced by a specific sector.

An unexplored relationship is the likelihood of risk-averse investors choosing to invest in high volatile sectors. This is another important relationship between FDI and volatility which we leave for future research. Moreover, the identification of the nexus could be strengthened under the availability of a larger database for a wider time span, and covering a larger number of countries.

Reference

Abubaker, R., 2015. The asymmetric impact of trade openness on output volatility. Empirical Economics, 49(3), pp.881-887.

Acemoglu, D., Jhonson, S., Robinson, J. and Thaicharoen, Y., 2003. Macroeconomic symptoms: volatility, crises and growth institutional causes. J. Monetary Econ.50 (1), 49–123.

Alfaro, L. and Charlton, A., 2013. Growth and the quality of foreign direct investment. In The Industrial Policy Revolution I (pp. 162-204). Palgrave Macmillan, London.

Balasubramanyam, V. N., 1998. "The MAI and Foreign Direct Investment in Developing Countries," Discussion Papers EC 10/98, Lancaster University.

Balavac, M. and Pugh, G., 2016. The link between trade openness, export diversification, institutions and output volatility in transition countries. Economic Systems, 40(2), pp.273-287.

Beck, T. and Levine, R., 2001. Stock Markets, Banks, and Growth: Correlation or Causality. The World Bank and Carlson School of Management. Mimeo.

Bejan, M., 2006. Trade openness and output volatility. MPRA Paper 2759. University Library of Munich, Germany.

Black, F., 1987. Business Cycles and Equilibrium. New York: Basil Blackwell.

Blalock, G., 2001. Technology from foreign direct investment: strategic transfer through supply chains. In empirical investigations in international trade conference at Purdue University.

Blanchard, O. and Simon, J., 2001. The Long and Large Decline in U.S. Output Volatility. Brookings Papers on Economic Activity 32, 135–174.

Blonigen, B.A. and Wang, M., 2004. Inappropriate pooling of wealthy and poor countries in empirical FDI studies (No. w10378). National Bureau of Economic Research.

Borensztein, E., De Gregorio, J., and J-W. Lee, 1998. "How Does Foreign Direct Investment Affect Economic Growth?" Journal of International Economics 45, 115-135.

Buch, C.M., Döpke, J. and Strotmann, H., 2009. Does Export Openness Increase Firm-level Output Volatility? TheWorld Economy 32, 531–551.

Campos, N.F. and Kinoshita, Y., 2002. When is FDI good for growth? A First Look at the Experience of the Transition Economies (No. 438). Working Paper.

Caporale, T. and McKiernan, B., 1998. The Fischer–Black Hypothesis:

Some Time-Series Evidence. Southern Economic Journal 64 (3): 765–771.

Chinn, M.D. and Ito, H., 2008. A new measure of financial openness. Journal of comparative policy analysis, 10(3), pp.309-322.

Comin, D. and Philippon, T., 2005. 'The Rise in Firm-level Volatility: Causes and Consequences', NBER Working Paper 11388 (Cambridge, MA: National Bureau of Economic Research).

De Backer, K. and Sleuwaegen, L., 2003. Does foreign direct investment crowd out domestic entrepreneurship? Review of Industrial Organization, 22(1), pp.67-84.

Di Giovanni, J. and Levchenko, A.A., 2009. Trade openness and volatility. Rev. Econ. Stat. 91 (3), 558–585.

Easterly, W.R., Islam, H. and Stiglitz, J.E., 2001. Explaining growth volatility. Annual World Bank Conference on Development Economics, Washington D.C..

Federico, P., Vegh, C. A. and Vuletin, G., 2013. "The effect of capital flows composition on output volatility," Policy Research Working Paper Series 6386, The World Bank.

Gabaix, X., 2011. The granular origins of aggregate fluctuations. Econometrica, 79(3), pp.733-772.

Giovanni, J.D. and Levchenko, A.A., 2011. Country size, international trade, and aggregate fluctuations in granular economies (No. w17335). National Bureau of Economic Research.

Gorodnichenko, Y., Svejnar, J. and Terrell, K., 2010. Globalization and innovation in emerging markets. American Economic Journal: Macroeconomics, 2(2), pp.194-226.

Harding, T., Javorcik, B.S., 2012. Foreign direct investment and export upgrading. The Review of Economics and Statistics 94, 964–980.

Harding, T. and Javorcik, B. S., 2011. "Roll Out the Red Carpet and They Will Come: Investment Promotion and FDI Inflows", Economic Journal 121, 1445–1476.

Harding, T. and Javorcik, B.S., 2012. Foreign direct investment and export upgrading. The Review of Economics and Statistics 94, 964–980.

Hnatkovska, V., Loayza, N., 2004. Volatility and growth. Policy ResearchWorking Paper Series 3184. The World Bank.

Imbs, J. (2007), 'Growth and Volatility', Journal of Monetary Economics, 54, 7, 1848–62.

Jansen, M., Bacchetta, M., Lennon, C. and Piermartini, R., 2009. Exposure to external country specific shocks and Jansen, M., Income Volatility in Small and Developing Countries: Export Concentration Matters, WTO Discussion Paper 3, 2004, World Trade Organization.income volatility. CEPR Discussion Papers 7123. Centre for Economic Policy Research.

Javorcik, Beata S., 2004. "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers Through Backward Linkages," American Economic Review 94, 605-627.

Kalemli-Ozcan, S., Sorensen, B. and Volosovych, V., 2014. Deep financial integration and volatility. Journal of the European Economic Association, 12(6), pp.1558-1585.

Koren, M. and Tenreyro, S., 2007. "Volatility and Development." Quarterly Journal of Economics, 122, 243–287.

Koren, M. and Tenreyro, S., 2013. "Technological Diversification." American Economic Review, 103, 378–414.

Krishna, P., Levchenko, A.A., 2013. Comparative advantage, complexity, and volatility. Journal of Economic Behavior and Organization 94, 314–329.

Lin, S.C., Kim,D.H., 2014. The link between economic growth and growth volatility. Empirical Economics 46, 43–63.

Lucas, R. E. J. (1988). On the mechanics of economic development, Journal of Monetary Economics 22(1): 3-42.

Madsen, J.B., 2002. The Causality between Investment and Growth. Economics Letters 74, 157–163.

Malik, A. and Temple, J.R.W., 2009. The geography of output volatility. J. Dev. Econ. 90 (2), 163–178.

Mirman, L., 1971. Uncertainty and optimal consumption decisions. Econometrica 39:179-85

Moudatsou, A., 2003. Foreign direct investment and economic growth in the European Union. Journal of Economic Integration, pp.689-707.

Norrbin, S.C., Yigit, F.P., 2005. The Robustness of the Link between Volatility and Growth of Output. Review of World Economics 141, 343–356.

Reinhart, C.M. and Rogoff, K.S., 2009. The aftermath of financial crises. Am. Econ. Rev. 99 (2), 466–472.

Ramey, G., Ramey, V.A., 1995. Cross-Country Evidence on the Link between Volatility and Growth. American Economic Review 85, 1138–51.

Schoors, K. and van der Tol, B., 2001. The productivity effect of foreign ownership on domestic firms in Hungary. EAE Conference in Philadelphia, PA.

Schumpeter, J.A., 1939. Business cycles (Vol. 1, pp. 161-74). New York: McGraw-Hill.

Swenson, D.L., Chen, H., 2014. Multinational exposure and the quality of new Chinese exports. Oxford Bulletin of Economics and Statistics 76.

UNCTAD, 2006. World Investment Report: FDI from Development and Transition Economies: Implications for Development. United Nations, New York.

Wells, L.T. and Wint, A.G., 2000). Marketing a country, Occasional Paper No. 13, Foreign Investment Advisory Service (FIAS).

Appendix

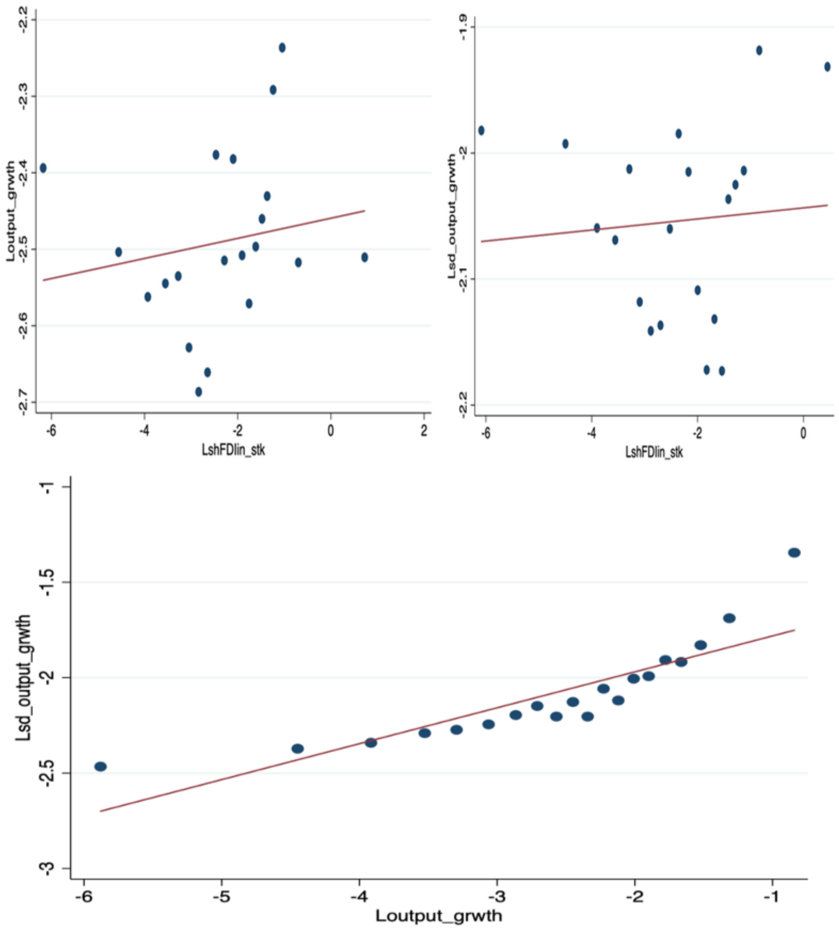
Table A1: List of Countries

Australia	Isreal	Austria	Italy
Belgium	Japan	Canada	Korea
Switzerland	Netherlands	Chile	Norway
Czech Republic	New Zealand	Germany	Poland
Denmark	Portugal	Spain	Slovakia
Estonia	Slovenia	Finland	Sweden
France	Luxembourg	UK	Mexico
Greece	Turkey	Hungary	USA
Ireland	Iceland		

A2: List of Industries- ISIC Rev. 3

No.	Codes	Names	Remark
1	15	Manufacture of food products and beverages	
2	17	Manufacture of textiles	Combined
	18	Manufacture of wearing apparel; dressing and dyeing of fur	
3	20	Manufacture of wood and of products of wood and cork	
	21	Manufacture of paper and paper products	Combined
	22	Publishing, printing and reproduction of recorded media	
4	23	Manufacture of coke, refined petroleum products and nuclear fuel	
5	24	Manufacture of chemicals and chemical products	
6	25	Manufacture of rubber and plastics products	
7	27	Manufacture of basic metals	Combined
	28	Manufacture of fabricated metal products	
8	29	Manufacture of machinery and equipment	
9	30	Manufacture of office, accounting and computing machinery	
10	32	Manufacture of radio, television and communication equipment	
11	33	Manufacture of medical, precision and optical instrument, watches etc.	
12	34	Manufacture of motor vehicles, trailers and semi-trailers	
13	35	Manufacture of other transport equipment	

Figure 1: Graphical descriptive evidence of the nexus among Inward FDI Stock, Ouptut Volatility and Volatility growth



A3: Summary Statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
shFDI	overall	0.514	5.192	-17.738	130.585	N = 4370
	between		1.875	-0.636	16.601	n = 360
	within		4.790	-16.587	114.499	T = 12.139
TrdOpenness	overall	1.683	15.325	0.002	517.560	N = 8979
	between		13.699	0.004	189.010	n = 432
	within		10.547	-187.244	330.234	T-bar = 20.785
lnGFCF	overall	19.532	2.038	5.733	24.193	N = 7781
	between		2.013	12.235	23.644	n = 424
	within		0.724	9.002	24.376	T-bar = 18.351
lnSalaries_Wages	overall	20.626	2.033	11.081	25.554	N = 9404
	between		2.034	12.299	25.043	n = 433
	within		0.610	16.426	24.237	T-bar = 21.718
shPfl_Invst	overall	1.517	6.966	0.000	63.011	N = 9721
	between		8.599	0.002	50.931	n = 442
	within		1.007	-10.787	13.596	T-bar = 21.993
FinOpenness	overall	1.603	1.188	-1.904	2.374	N = 10722
	between		0.913	-0.576	2.374	n = 429
	within		0.761	-1.189	3.668	T-bar = 24.993
InSch_enrol	overall	4.616	0.166	3.918	5.091	N = 8801
	between		0.143	4.211	4.966	n = 442
	within		0.086	4.143	4.896	T = 19.912
lnOutput	overall	22.658	2.098	11.101	27.445	N = 9649
	between		2.099	13.651	27.048	n = 433
	within		0.666	15.914	26.512	T-bar = 22.284
CapInt	overall	1.047	0.425	0.638	3.327	N = 9721
	between		0.328	0.775	2.095	n = 442
	within		0.271	-0.236	2.280	T = 21.993

Table A4: Estimates- Impact of inward FDI on output growth volatility in high and low growth Industries

Dependent Variable: log[Volatility_output_growth]							
HIGH GROWTH INDUSTRIES							
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
L5.shFDIin_stk	0.825***	0.841***	0.852**	0.940**	0.995**	0.598**	0.629**
	(0.284)	(0.305)	(0.336)	(0.371)	(0.428)	(0.272)	(0.252)
L5.Loutput		0.583***	0.357**	0.396**	0.463	0.489	
		(0.157)	(0.170)	(0.183)	(0.296)	(0.390)	
L5.Openness			0.504**	0.482**	0.459*	0.531**	0.428*
			(0.235)	(0.238)	(0.239)	(0.243)	(0.258)
L5.fopen				-0.0761	-0.221**		
				(0.090)	(0.108)		
L5.Lsch_enro_sec					0.534	0.426	0.119
					(0.797)	(0.758)	(0.740)
L5.Lwage_salaries					-0.039	-0.308	0.0459
					(0.251)	(0.430)	(0.278)
L5.LGFCF					0.00429	0.178	0.125
					(0.147)	(0.197)	(0.188)
L5.shPfl_invst						0.603*	0.654**
						(0.317)	(0.324)
A_out_grwth							-0.406
							(1.676)
Year FE	YES	YES	YES	YES	YES	YES	YES
Country_Sector	YES	YES	YES	YES	YES	YES	YES
Observations	339	339	298	298	278	245	245
R-squared	0.358	0.414	0.564	0.566	0.576	0.527	0.511
Dependent Variable: log[Volatility_output_growth]							
LOW GROWTH INDUSTRIES							
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
L5.shFDIin_stk	0.354***	0.346***	0.347***	0.349***	0.304**	0.244*	0.244*
	(0.102)	(0.107)	(0.105)	(0.106)	(0.117)	(0.135)	(0.139)
L5.Loutput		-0.099	0.037	0.040	0.185	0.214	
		(0.095)	(0.093)	(0.094)	(0.227)	(0.226)	
L5.Openness			0.182***	0.184***	0.182***	0.158*	0.130
			(0.036)	(0.037)	(0.044)	(0.087)	(0.099)
L5.fopen				-0.011	-0.004		
				(0.057)	(0.084)		
L5.Lsch_enro_sec					0.203	-0.285	-0.414
					(0.662)	(0.941)	(0.962)
L5.Lwage_salaries					-0.051	-0.077	0.082
					(0.230)	(0.236)	(0.155)
L5.LGFCF					-0.075	-0.085	-0.072
					(0.098)	(0.091)	(0.096)
L5.shPfl_invst						-0.057	-0.020
						(0.208)	(0.199)
A_out_grwth							0.051
							(1.475)
Year FE	YES	YES	YES	YES	YES	YES	YES
Country_Sector	YES	YES	YES	YES	YES	YES	YES
Observations	430	430	428	428	359	336	336
R-squared	0.234	0.243	0.297	0.297	0.379	0.392	0.386

∗ ∗ ∗,∗∗,∗ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable follows the standard deviation method

Table A5: Estimates- Impact of inward FDI on output growth volatility in high and low growth Industries

	Dependent Variable: log[Volatility_output_growth]					
	HIGH GROWTH INDUSTRIES					
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
L.shFDIin_stk	0.023***	0.022***	0.027***	0.027***	0.032***	0.027**
	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)	(0.011)
L.Loutput		-0.276	-0.312	-0.339*	0.607*	0.415
		(0.177)	(0.192)	(0.196)	(0.363)	(0.444)
L.Openness			-0.007*	-0.008*	-0.068	-0.025
			(0.004)	(0.004)	(0.059)	(0.068)
L.fopen				0.096	0.741***	
				(0.132)	(0.182)	
L.Lsch_enro_sec					-1.218	-0.935
					(1.203)	(1.219)
L.Lwage_salaries					-1.880***	-1.017**
					(0.449)	(0.469)
L.LGFCF					0.025	-0.071
					(0.222)	(0.236)
L.shPfl_invst						-1.133**
						(0.489)
Year FE	YES	YES	YES	YES	YES	YES
Country_Sector	YES	YES	YES	YES	YES	YES
Observations	2,044	2,044	1,999	1,999	1,538	1,426
R-squared	0.075	0.076	0.079	0.079	0.074	0.060

	Dependent Variable: log[Volatility_output_growth]					
	LOW GROWTH INDUSTRIES					
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
L.shFDIin_stk	0.003	0.003	0.005	0.008	0.010*	0.010*
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.006)
L.Loutput		0.151	0.113	0.229	1.137***	1.362***
		(0.184)	(0.193)	(0.191)	(0.366)	(0.421)
L.Openness			-0.007	-0.005	0.003	-0.008
			(0.008)	(0.009)	(0.009)	(0.009)
L.fopen				-0.553***	-0.603***	
				(0.143)	(0.163)	
L.Lsch_enro_sec					0.207	-0.229
					(1.148)	(1.172)
L.Lwage_salaries					-0.337	-0.999**
					(0.394)	(0.448)
L.LGFCF					-0.300	-0.224
					(0.225)	(0.233)
L.shPfl_invst						0.267
						(0.476)
Year FE	YES	YES	YES	YES	YES	YES
Country_Sector	YES	YES	YES	YES	YES	YES
Observations	1,972	1,972	1,923	1,922	1,494	1,358
R-squared	0.096	0.097	0.103	0.113	0.108	0.100

* * *,**,* represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable follows the residual method.

Table A6: Estimates- Impact of inward FDI on output growth volatility in sector's initial share of VA

	Dependent Variable: log[Volatility_output_growth]						
	HIGH SHARE OF VA SECTORS						
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
L5.shFDIin_stk	0.583***	0.614***	0.581***	0.615***	0.454***	0.354**	0.376**
	(0.147)	(0.145)	(0.159)	(0.161)	(0.157)	(0.163)	(0.177)
L5.Loutput		0.0927	0.241**	0.314***	0.468***	0.394**	
		(0.112)	(0.099)	(0.110)	(0.173)	(0.190)	
L5.Openness			0.171***	0.193***	0.139**	0.09	0.0556
			(0.063)	(0.065)	(0.059)	(0.062)	(0.054)
L5.fopen				-0.117**	-0.135**		
				(0.051)	(0.065)		
L5.Lsch_enro_sec					0.447	0.348	0.0502
					(0.397)	(0.378)	(0.412)
L5.Lwage_salaries					-0.204	-0.254	0.0455
					(0.149)	(0.175)	(0.123)
L5.LGFCF					-0.122	-0.102	-0.113
					(0.080)	(0.079)	(0.090)
L5.shPfl_invst						0.136	0.18
						(0.156)	(0.153)
A_out_grwth							-0.399
							-0.603
Year FE	YES	YES	YES	YES	YES	YES	YES
Country_Sector	YES	YES	YES	YES	YES	YES	YES
Observations	501	501	471	471	412	380	380
R-squared	0.397	0.4	0.474	0.485	0.545	0.544	0.53

	Dependent Variable: log[Volatility_output_growth]						
	LOW SHARE OF VA SECTORS						
VARIABLES	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
L5.shFDIin_stk	0.244*	0.238*	0.465***	0.468***	0.407***	0.359***	0.365***
	(0.130)	(0.123)	(0.122)	(0.125)	(0.134)	-0.122	(0.121)
L5.Loutput		-0.142	-0.174	-0.172	0.041	0.024	
		(0.124)	(0.153)	(0.153)	(0.299)	(0.314)	
L5.Openness			0.161	0.155	0.215	0.039	0.044
			(0.220)	(0.219)	-0.199	-0.195	(0.189)
L5.fopen				-0.039	-0.050		
				(0.119)	(0.150)		
L5.Lsch_enro_sec					0.241	0.515	0.524
					(0.595)	(0.581)	(0.597)
L5.Lwage_salaries					0.116	0.071	0.0706
					-0.284	-0.272	-0.172
L5.LGFCF					(0.026)	0.008	0.0119
					(0.120)	(0.127)	(0.128)
L5.shPfl_invst						0.448***	0.444***
						(0.162)	(0.162)
A_out_grwth							-0.302
							(1.013)
Year FE	YES	YES	YES	YES	YES	YES	YES
Country_Sector	YES	YES	YES	YES	YES	YES	YES
Observations	263	263	250	250	222	198	198
R-squared	0.319	0.33	0.4	0.4	0.452	0.48	0.481

∗ ∗ ∗,∗∗,∗ represent 1%, 5% and 10% significant level respectively, standard errors are in brackets. The dependent variable follows the standard deviation method.

Trade Liberalization and its impact on income distribution in Ghana.

Isaac Mensah*

Abstract

In this paper, we analyze the impact of trade liberalization on income distribution in Ghana using a Computable General Equilibrium (CGE) model. We focus on household income groups defined by location, economic activities and income quintiles using the 2013 social accounting matrix (SAM) for Ghana.

Consistent with the existing literature, we find that trade liberalization affects negatively the total and factor income and consumption spending of rural farm households, while it benefits urban non-farm households. Our results also suggest that import tariff reduction creates a substitution effect which decreases the demand for domestic commodities, ultimately affecting farmers income, demand for labour and land, and crop capital rents.

JEL classifications: O13, Q54, Q56

Keywords: Trade liberalization, income distribution, CGE model, Ghana

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1 Introduction

Since the 1980s, most developing countries adopted a number of policies under the Structural Adjustment Program (henceforth, SAP) for which the aim was to achieve macroeconomic stability, growth and development. Trade liberalization, a policy under the SAP[1], is believed to: accelerate growth, provide stimulus to new forms of production, enhance specialization, increase job creation and reduce poverty around the world (World Bank, 2002).

The dramatic trade liberalizations implemented by developing countries or by their trading partners since the 1980s have provided an unprecedented opportunity to learn about the effects of trade on growth, inequality, and poverty in developing countries (Goldberg and Pavcnik 2007a, 2016). In particular, the analysis in (Pavcnik, 2017) on the distributional consequences of trade for China will be a useful benchmark for our analysis for Ghana given the recent increasing trade relations between both countries.

As part of Ghana's recovery program in 1986, the country adopted a massive liberalization program consisting of import tariff reduction, removal of import quotas and licensing and other quantitative restriction as well as the initiation of rigorous export orientation policies. Moreover, to allow for trade financing, the liberalization program was extended to cover the financial sector. Additionally, the country moved from a fixed to a flexible exchange rate regime. Ghana signed-up for the SAP in 1986.

[1]The SAP consists of a number of different policies designed by the IMF and the World Bank. The policies include: liberalization of markets; privatization and divestiture; wage cuts and currency devaluation; promoting good governance and fighting corruption etc. The policies of the SAP are the same as the principles of the Washington Consensus. The *Washington Consensus* is again used in this text and it follows the definition given above.

To date, the literature on the welfare impact of trade liberalization, at least in developing countries, is inconclusive (see, Santos-Paulino, 2012 and Goldberg and Pavcnik, 2007a for a comprehensive survey of the literature). To that effect, our objective in this study is to analyze the impact of trade liberalization in Ghana. More specifically, our analysis will focus on the impact of trade liberalization on the income of different groups of households defined according to their geographical location, farm or non-farm activity and income quintiles using the 2013 Social Accounting Matrix (henceforth, SAM) for Ghana in a static Computable General Equilibrium (henceforth, CGE) framework. Based on our results, we also discus how trade liberalization affects households' factor income and consumption spending.

In this paper, we construct a baseline model, i.e., we find by calibration a set of parameters which generate values consistent with the SAM. We then test the impact of a policy that reduces tariffs for all agricultural commodities. This is motivated by the fact that Ghana is largely dependent on trade in agricultural commodities, and most of Ghana's trade agreements with international trade partners, which are reciprocal in nature, are in the agricultural sector. Moreover, trade liberalization in Ghana usually takes the form of reducing import tariffs and extending the market access to foreign products which come with some preferential benefits (aids/loan) from foreign partners rather than reducing the cost of accessing external markets.

Finally, we evaluate the effect of the tariff reduction on income for different groups of households, which can be identified by their location (i.e. rural and urban), whether the income is earned from a farming or non-farming activity, and income quintiles. The latter reclassifies households into five income groups on the basis of their location and activity. In a nutshell, we focus on fifteen (15) household groups. This extensive focus on household groups in Ghana is made possible by the high level of disaggregation of the 2013 SAM for Ghana.

In the literature that studies the impact of a policy change on income distribution, the consensus is that rural workers (especially farm workers) suffer the most, in terms of losses in income and employment, given any adverse consequence of trade liberalization. Our results are consistent with the consensus view. Additionally, our results also indicate that urban and in part, rural non-farm households are better-off under import liberalization policies. All simulations and computations are done using the General Algebraic Modeling System (GAMS).

Our findings add to the recent policy debate about Ghana's membership to the European Partnership Agreements (EPA). This partnership, if fully realized, will allow European products 80 percent access (i.e. 20% of the tariff lines remain subject to normal duty) to West African markets over a period of 15 years. In return, it will allow 100 percent EU market access (i.e. duty-free and quota free except trade in arms and ammunition) for West African products. In the interim, Ghana and Ivory Coast have signed a bilateral EPAs limited to trade in goods.

The rest of the paper is organized as follows. In Section 2 we provide a brief overview of trade and income distribution in Ghana; in Section 3 we review the literature; in Section 4 we describe the data; in Section 5 we present and discuss the model; in Section 6 we describe the policy simulation; in Section 7 we discuss the simulation results and conclude in Section 8.

2 Overview of trade and income distribution in Ghana

Historically, Ghana has undergone (and it is still implementing) a series of trade reforms after her political independence in 1957. Before the early 1980s, when much of trade reforms in Ghana began, the country adopted an import substitution strategy nested in a broader economic industrialization policy. Despite Ghana's GATT membership in 1957, the country was less open to international trade. Exports were limited to cocoa and minerals, while imports were mainly composed of capital goods. Significant trade reforms began in 1983 under the SAP which openned the economy to international trade. Darku (2012) categorizes the trade reforms into three different regimes. They are the attempted liberalization regime of 1983-1986; the import liberalization regime of 1987-1989; and the liberal trade regime of 1990-till date.

The first regime consisted of the devaluation of the Ghana Cedi to improve exports and the transition from a fixed to a flexible exchange rate. This phase also saw the commencement of the removal of import licensing, quota and other quantitative restrictions which were completely abolished by the end of the second regime. As a result, the cost of importing in Ghana went down by a range of 5 percent to 10 percent points in all commodities groups, except for luxury goods (Ocran, 2006). Also, the transition to a fully liberalized exchange rate system was achieved in the second regime. To support trade financing, the financial sector also saw significant reforms consisting of the privatization of some state-owned financial institutions and the licensing of international financial institutions to operate in Ghana. Much of the reforms in the third regime are induce by membership agreements of international bodies. For example, as an ECOWAS member, Ghana fully adhere to the Common External Tariff (see Table A1 in the appendix). Also, the country is bound by WTO agreements following membership in 1995.

The structure of the Ghanaian economy has changed in recent times. About a decade or two ago, agricultural production was the main source of economic activity and the highest contributor to GDP. Lately, the service sector has gained in relevance, contributing the largest share of GDP. In 2016, the service sector dominated with 56.6 percent of GDP (48.8 percent in 2006), followed by the industrial sector with 24.3 percent of GDP (20.8 percent in 2006) and the agricultural sector with 19.1 percent of GDP (30.4 percent in 2006). That notwithstanding, even after the discovery of oil in commercial quantities in 2007, the agricultural sector provides the highest source of foreign exchange revenue via the export of agricultural commodities such as cocoa, timber, cashew nuts etc. to South Africa, United Arab Emirates (UAE), Switzerland, Italy and France. These countries were also the top five export partners of Ghana in 2013.

Relative to other low middle-income countries, the Ghanaian economy is more open to the international market with trade amounting to 81.65 of GDP in 2013. Moreover, the index[2] of export penetration was 2.61 in 2013 and in the same year the country suffered a trade deficit[3] of 13.3 percent of GDP. Regardless of its diminishing contribution to GDP, the agricultural sector

[2]The index is calculated as the number of countries to which the reporter exports a particular product divided by the number of countries that report importing the product that year (WITS).

[3]Table A2 shows trade balance by agricultural commodities using data from the SAM.

employs the highest share of workers in Ghana. The agricultural, forestry and fishing sector holds a share of 44.7 percent of the employed population, while the service and the manufacturing sectors account for 40.9 percent and 9.1 percent respectively.

With respect to employment by location, the agricultural sector employs the majority of rural dwellers (71.1 percent) compared to urban dwellers (16.8 percent). On the other hand, the services sector employs 64.4 percent of the urban dwellers compared to 18.7 percent of their rural counterpart (see Figure 1 in the appendix). The subsistence nature of agricultural production in Ghana affects the remuneration of workers in the agricultural sector. Thus, skilled agricultural and fishery workers earn an average hourly wage of 0.81 GHS (less than a dollar) working 25-44 hours per week. On the other hand, skilled workers in other sectors earn on the average 4.7-5.44 GHS (a little over a dollar) working similar hours per week. The average hourly earnings for workers in all occupations is 1.82 GHS (GLSS 6 labour force report).

Ghana imports both agricultural commodities/products (rice, processed food and diary, meat etc.) and non-agricultural products (automobiles, petroleum oil etc.) alike, and China, India and UK are among the top import partners. Ghana is less diversified in her export trade compared to her import trade. This is true in terms of the number of products imported/exported and the number of trading partners involved. Thus, Ghana imports about 4078 products from 171 countries, while exports account for a little over half of the number of imported products (2282), and to 145 countries. Overall, the Ghanaian economy is highly diversified in trade as indicated by a

Hirschman-Herfindahl concentration index[4] of 0.06.

3 Literature Review

Standard trade theories by (Ricardo 1817; Heckscher 1929; Ohlin 1933; Stolper-Samuelson 1941; Dornbush et al., 1977) are among the first to explain the mechanism underlining international trade flows. These theories are based on the concept of "comparative advantage" which encourages countries to specialize in the production and trade of goods for which they have the natural endowment/resource abundance. These theories heavily hinge on four important assumptions: full employment and capacity utilization; trade balance; factor immobility across countries and perfectly competitive market structure. Aside from the fact that these assumptions are superficial and practically inconsistent with today's international structure of trade, the existing empirical evidence linking trade specialization to comparative advantage(s) is not strong enough (see Leamer 1980, 2000; Feenstra 2004).

That notwithstanding, the policy agenda for most countries (whether developed, developing or in transition) is to push further the free trade dogma. Inherent in free trade and specialization in trade is the plausible polarization of growth and development across the world. Countries that specialize in the production/export of agricultural/raw commodities suffer a comparative disadvantage to countries that mechanize production, because of gains in

[4]Hirschman-Herfindahl index is a measure of the dispersion of trade value across an exporter's partners. A country with trade (export or import) that is concentrated in very few markets will have an index value close to 1. Similarly, a country with a perfectly diversified trade portfolio will have an index close to zero (World Integrated Trade Solution (henceforth, WITS)).

increasing returns and value creation.

Alternatively, the concept of "absolute advantage" (see Kaldor, 1980; Shaikh, 2007; Lavoie 2014) stipulate that region/sectors that are able to produce at a lower price or at a higher quality than any other regions/sectors will export more and eventually accrue all the benefits of trade. While consumers in the high cost/low-quality regions benefit from cheap/quality imported products, they are likely to face sustained unemployment at least in the short-run. In principle, trade occurs between firms rather than nations and firms are more concerned in gaining and sustaining their market shares. Thus, in general, firms production decision is driven by profit motives.

Whether or not trade liberalization benefits countries is more of an empirical question than a theoretical one following the dichotomy in the theoretical underpinning of international trade. With reference to the literature that uses regression analysis, Bhagwati and Srinivasan (2002) argue that cross-country regressions are a poor way to approach policy questions. This is further supported by Baker (2000), who argued that in assessing the welfare impact of a policy change, it is important to set the counterfactual "no-change" against a post-implementation scenario.

Following the pioneering work of Leif Johansen and Hollis Chenery (see, Taylor et. al, 1980; Taylor, 2011), Computable General Equilibrium models (henceforth, CGE) are mostly used to explore possible responses of the economic system to shifts in policy, regarding market-based interventions (taxes, changes in the exchange rate, fiscal spending, etc.) and more direct actions such as supporting specific investment projects, through an agency such as a development bank (Taylor, 2011).

There are a number of country-studies that apply CGE models to study the impact of a policy change in most developing countries. Gibson and Seventer (2000) analyze two opposing models, namely the neoclassical and the structuralist CGE models[5] to study the impact of the principles of the *Washington Consensus* (i.e., liberalization of the current and capital account and reduction of government spending) adopted in South Africa. Using the same data (i.e., the 1992 South African SAM) in the application of the two models, their conclusions were that the neoclassical model seems to fully support the principles of the *Washington Consensus*, while the structuralist model requires the adoption of heterodox policies (i.e., consumption driven recovery as a results of increasing real wages and government spending) to avoid slow growth and high inflation.

A more comprehensive study was done by Sahn, Dorosh and Younger (1997), where the authors draw on the analysis of information gathered from ten African countries: Cameroon, The Gambia, Ghana, Guinea, Madagascar, Malawi, Mozambique, Niger, Tanzania, and Zaire (now The Democratic Republic of Congo- Changed in May 1997). They combine household survey data and macroeconomic data for conducting a range of quantitative simulations using multi-market and CGE models. The central message of their study is that structural adjustment policies do not harm the poor in Africa,

[5]These two models, though similar in practice, depart from each other in terms of the assumptions and the nature of the macro closure. Moreover, structuralist models are usually formulated in a demand-driven and dynamic setting. The latter permits the construction of an independent investment function which is determined by previous year savings. Thus, in the structuralist context, modellers attempt to depict the structural properties of the country under study and the characteristics of the SAM. Taylor (1990) and Dervis et al. (1982) are good expositions of the structuralist and neoclassical CGE models, respectively.

but, in fact, they slightly benefit the poor.

Interestingly, most of the earlier contributors that studied the policy impact of the SAP in developing countries (specifically, Africa) seem to support the adoption of the policies under the SAP. Thus, the conclusion in Sahn et al. (1997) is consistent with that in Dorosh and Sahn (2000).

In 1993, the first SAM for Ghana was published. Being the first in its kind for Ghana, the SAM was a simple compilation of the input-output tables as well as detailed and extensive household survey information obtained from recent Ghana Living Standards Surveys (up to and including GLSS3). Bussolo and Round (2003), is one of the interesting studies on Ghana that uses the 1993 SAM for Ghana. In their study, the authors examined the effects of introducing poverty-alleviating income transfers to poor households in a budget-neutral (a revenue-neutral) regime. The sources of the income transfer were analyzed on income taxation, corporate taxation, indirect taxes, and tariffs.

As part of their sensitivity analyses, the authors set-up two different factor market closure rules (long and short-run) which follow the suggestions in De Maio et al. (1999). The main trade-off between their long-run and short-run closure is that in the long-run model capital and labour are perfectly mobile across sectors and in excess supply (i.e. factor returns are fixed), while in the short-run model they assume that both capital and labour are fixed and fully employed. Moreover, in this closure, labour is perfectly mobile across sectors while capital is sector-specific.

On the basis of these closure rules, they concluded on a host of broad factors. However, their findings seem to be sensitive to the closure rule adopted. With the long-run closure, their conclusion was that the impact of poverty reduction is different according to the sources of finance used i.e., tariffs, indirect taxes, corporate taxes and household direct taxes. The short-run outcomes were not very clear, except that there appeared to be an increase in overall poverty under the corporate tax financing rule.

Importantly, contrary to the belief that CGE models are "black box", casting a doubt on the reliability of the results, they introduced a more transparent procedure to understand the mechanisms underlying the distributional outcomes of the experiments, by using a new decomposition procedure. This procedure refers to the process whereby authors uses different computational tools to extract the direct causality among sectors/activities, agents and variables that they intend to study.

Similarly, but using the 1999 SAM for Ghana, Bhasin and Obeng (2007) showed that elimination of import and export duties accompanied by an increase in foreign aid reduces the incidence, depth, and severity of poverty of all categories of households defined by agricultural farmers, public sector workers, private sector workers, non-farm self-employed and unemployed. The classification is based on information collected on each household member aged seven years and above. They, however, show that the income distributions of public and private sector employees and non-farm self-employed improve to a larger extent when trade-related import duties are eliminated in comparison to export duties accompanied by an increase in foreign aid. Their model, though based on Bhasin and Annim (2005) and Bhasin and Obeng (2006), is not methodologically different from Adelman and Robinson (1978), Chia et al. (1994), Demery and Demery (1992) and Decaluwé et al.

(1999). Moreover, they all follow the theoretical perspective given in Dervis et al. (1982).

Gibson (2005) is one of the few contributions to the CGE trade liberalization literature whose conclusions denote some degree of pessimism about trade openness. The author used a structuralist model in the spirit of Taylor (1990). As part of his contribution, he modelled and integrated human capital formation and the informal sector in his set of models . The latter, though interesting for studies that focus on developing countries, is not considered in this work given our research interest. While growth, poverty and human development factors form the focal point of most contributions to the literature on Ghana, we focus on income distribution which we believe is less studied.

In this paper, we follow the CGE literature and this allows us to mimic the structural features of the Ghanaian economy in our model. However, we do not strictly follow the theoretical perspective in either Taylor (1990) or Dervis et al. (1982). Thus, we follow both methodological perspective picking on which is applicable given the structural characteristics of the Ghanaian economy. We distinguish our work from those discussed above by focusing on a more comprehensive household consumption quintiles and labor categories given by the high level of disaggregation of the 2013 SAM for Ghana. For example, in the previous SAMs (1993, 2005) for Ghana, labour is disaggregated by only self-employed, skilled and unskilled and household by only rural and urban locations.

Finally, Darku (2012); Tutu (1999); Lopez (1997) are a few important non-SAM based studies that focus on the impact of trade liberalization on varied economic indicators in Ghana. First, Darku (2012) using a post-Keynesian demand-side model concluded that trade liberalization has led to an increase in export growth in Ghana but raised import growth by more. Also, given the dependence of rural farm income on environmental factors, Lopez (1997) analyze the impact of reducing import protection and export taxation on national income through the exploitation of biomass in agricultural production. They found that trade liberalization is likely to induce further losses in biomass and national income. Using the case of "mercosur", Porto (2006) findings indicate that trade reforms, in general, can help improve the distribution of income and reduce poverty.

4 Description of the SAM

In this study, we used the 2013 Social Accounting Matrix for Ghana published in 2017 under the "Nexus Project" led by the International Food Policy Research Institute (IFPRI). The advantage of using this SAM rather than the others published in previous years is that, it is highly disaggregated by sector, location, income sources and education. All these elements serve the interest of this paper.

The structure of the SAM is given as follows: there are fifty-five (55) activities which are disaggregated economic activities of the agricultural, service, construction and manufacturing sectors. Each commodity[6] represents the output of an activity. There are three factors of production- labour, capital

[6] There is one commodity named "cocer- other cereals" which has no activity. This commodity is imported, used in the production process as intermediate commodity and consumed as finished goods by households.

and land. Labour is further disaggregated by location- rural and urban- and by education levels- uneducated, primary, secondary and tertiary- while capital is classified by crops, livestock, mining and others. The land serves the purpose of agricultural (crops) production.

As in most SAMs, there are four agents, namely: the households and the firms (both forming the private sector), the government (public sector) and the external sector (Rest of the World, ROW). The households are further classified into income quintiles (determined by household per capita expenditure defined at the national level), farming/non-farming and location (rural and urban). The rural households are classified by farming and non-farming income generating activities, while the urban households are only identified by non-farming activities.

The richness of the information available in the SAM allows for linkages among sectors/activities and all other agents and accounts which permits the evaluation of complex interactions in a general equilibrium framework through the application of CGE models. The SAM is constructed using data from various sources. These include the Ghana Living Standard Survey (GLSS round 6) published by the Ghana Statistical Service, World Bank's World Development Indicators and IMF's BPM6 online database among others. For example, household incomes and expenditures were disaggregated across representative household groups using information from the 2012/13 GLSS 6.

5 The Model

While the theoretical and empirical justification for trade openness and its distributional effects remain inconclusive, it is generally known that, according to neoclassical models, international trade benefits all. This generalization could least be made of some developing and small countries whose structural characteristics differ significantly from developed and emerging countries for which the above subject is well studied. For several African countries, limited and poor quality of individual and household data have hindered such research endeavour. However, the recent publications of SAMs for some African countries have mitigated the traditional data unavailability challenge, as one can use the SAM in a general equilibrium framework to study the macro-micro effect of a policy change.

CGE models that utilize SAMs, embody their own limitations (i.e., they are data demanding in terms of model elasticities and require a number of functional form assumptions). However, there are a number of interesting arguments which make this methodology appealing. Firstly, the macro-micro approach allows for assessing the micro effect of macroeconomic policy change and investigating the *second round effect*[7] of policy change (Bourguignon, Bussolo and Da Silva, 2008). Secondly, we can introduce various market imperfections specific to Ghana and test the effects of each of them against a hypothetical neoclassical equilibrium.

Finally, and as put forward by Palatnik and Roson (2009), a CGE model

[7]This refers to the behavioural responses to a given policy direction. For example, household or firm's decision to consume or produce a given commodities given a policy change in income or tax (see Bourguignon and Da Silva, 2003 for other illustrations).

insures for finite resources and accounting consistency by relying on social accounting matrices. This allows capturing inter-industry linkages between sectors of an economy and provides an economy-wide perspective of analysis. Moreover, they further added that CGE models capture implications of international trade for the economy as a whole, covering the circular flow of income and expenditure and depicting inter-industry relations.

The first step to making a general equilibrium analysis using CGE models is to construct a SAM. Given one's research question and data, there are standard CGE models that one could adopt. We adopted the model structure of Löfgren et. al (2001) and McDonald (2005). In general, the model of Löfgren et. al (2001) and McDonald (2005) are literally identical. Both models are quite comprehensive in their applications, allowing the modeller to tailor the model specification to the country under study. Our models just as other CGE models are based on the neoclassical optimization theory. They also follow the canonical circular flow framework for which factors are employed in production, and compensation to labour and capital are transferred to households net of tax. The households and government spend proportions of their income on commodities and the remaining is saved. There are other accounts linkages relating to savings-investment, transaction cost, transfers to/from the rest of the world (ROW).

Consumers choose bundles of commodities by maximizing their utility function given their budget constraint. We assume that the functional form of consumers' utility function is Stone-Geary. This function is preferable for developing countries since it allows for subsistence consumption expenditures, which is an arguably realistic assumption when there are substantial numbers of very poor consumers (McDonald, 2005). Similarly, producers maximize their profit function subject to the production technology.

The system of equations is classified into four blocks namely: the price block, the production and trade block, the institution block and the closure block. Output follows a Constant Elasticity Substitution (CES) production function. Value-added and intermediate commodities are the two components of the production function, which are themselves a (CES) function of factors, and a Leontief function of imported and domestic inputs respectively.

The output of commodities is distinguished between those used in the domestic market and others supplied to foreign markets. A CES function is used to define commodities consumed both domestically and supplied to external markets. Similarly, for domestic demand and foreign supply of commodities the Armington[8] function is applied. Since Ghana is a price taker in the international market, the value of import and export prices are assumed to be exogenous. Demand includes investment and government consumption. Investment and government demand for commodities are proportional to the total absorption. Hence, government savings is only a residual which represent the tax revenue net of government expenditure.

Given that Ghana is characterized by persistent budget deficits, we do not assume a balanced government budget. This is also consistent with the idea that the cut in import tax is a further loss to the government in terms of revenue mobilization. Our macro closure is slightly different from the so-called *Johansen Closure*[9]. We follow a savings-driven macro-closure because

[8]This CES function implies that products are differentiated by country of origin.

[9]This closure is usually given as; Government- flexible government savings and fixed direct tax rate; Rest of the World (ROW)- fixed foreign savings and flexible real exchange

it creates an increase in demand in investment goods. Thus, households save a fixed share of their income, so income growth will cause savings to increase and therefore investment spending to rise. This is likely to result in an increase in demand for and production of machinery and equipment. In Ghana, households invest in capital goods because of falling government investment spending.

However, we apply the standard closure to the government sector and ROW. Thus, both direct and indirect tax rates applicable to households and firms are fixed, while government savings, which in most cases are negative, will vary. The real exchange rate adjusts so that the savings of the external sector is on target. Parameters in the model are assigned a value following recent literature and empirical findings, while others are estimated from the SAM. For example, and in our case, activities' production technology is computed using information from the SAM coupled with our assumption of the production function.

Our closure of the labour market is in line with the standard microeconomic theory. We assume that in the short-run the supply of labour is fixed and fully employed (i.e., the economy is in full capacity utilization). This implies that the labour market clears through the reaction of the economy-wide wages. Thus, higher wages imply a fall in the demand for labour while lower wages permit an increase in the demand for labour. Moreover, we assume imperfect mobility of labour among market segments defined by different activities. Hence, we include a wage distortion factor to vary wages across

rate; Savings and Investment (S-I)- fixed capital formation and uniform Marginal Propensity to Save (MPS) across all institution. In this closure, the modeller assumes exogenous real investment and full employment.

different activities. Other factors such as capital are also fully employed and activity-specific.

We adopted the value of elasticities from (Annabi et al., 2006; Sanchez C., 2004; and Zeitsch et al., 1991) fine-tuned with our prior beliefs of the Ghanaian economy. Given the research objective of this paper, the choice of the value of the trade elasticities (especially the Armington elasticities) might affect our results. Unfortunately, there exist a few known estimates of parameters[10] available for Ghana and it is imperative to follow some guiding principle which might lead to plausible values that might help mitigate the variability of the results. Our choice of parameters follows from the trade literature on Ghana which is the usual practice in CGE modelling.

6 The Policy Simulation

The model as described in Section 3, permits a study of the impact of trade liberalization with a focus on different household income groups which are defined by the income, location and quintiles classifications in the SAM. To start with, we obtain a baseline solution for the CGE model, on the basis of the set of values for all model parameters. Then we introduce a shock to the tariff on imported agricultural commodities by reducing the import tax rate by 20 percent. This exogenous shock destabilizes the initial equilibrium to form a new equilibrium system by the change in the value of the endogenous variables. Our choice of the magnitude of the import tax reduction does not affect our results. This is because the effect of a reduction in a tax rate of

[10]The entire set of parameters adopted in our CGE model is available upon request. There exist income elasticity estimate for Ghana by Breisinger et al., (2011).

40 percent implies effects twice as large as those reported in this paper.

Historically, Ghana's liberalization agreements are usually reciprocal and embody some transfer packages from its foreign non-African trade partners. A way to implement this in the model is to add an exogenous transfer (say T) to the government revenue equation as done by Bhasin and Obeng (2006) and Bussolo and Round (2003). We, however, do not implement such transfers in our model for the following reasons: (i) usually, the transfer comes with tough conditionalities that are in many cases infeasible in their attainment; (ii) during periods of high fiscal deficits, the government sometimes renege on its agreements, jeopardizing the whole liberalization scheme; (iii) packages that allow access to credit usually lead to large public debt, which in part, motivates our assumption of flexible government savings.

7 Simulation Results

Before analyzing the impact of the import tax cut of agricultural commodities on households income, we solve our model to the 2013 base year equilibrium. Also in the base year, economic activities in terms of agricultural production across sectors, the household supply of factor and demand for commodities are expected to be fairly stable so are the international commodities prices. Unfortunately, we do not have enough sector-level data to check whether 2013 is a “normal year”. However, growth in total GDP (excluding oil) is similar to that of previous years. Thus, our results should be interpreted with caution as they may be sensitive to peculiar economic conditions in 2013.

Table 1 reports the impact of a 20% import tax cut of agricultural commodities on total household and factor income. To start with, the results are quite intuitive and consistent in part with the result in Darku (2012) and Bhasin and Obeng (2007) . Clearly, the results show that rural farm households suffer a fall in total income due to import tariff reduction. The influx of cheaper imports creates a substitution effect (i.e. domestic commodities are now relatively more expensive, hence demand for foreign products increases while demand for domestic agricultural products falls) which negatively affects domestic agricultural production and ultimately farmers' income.

The results are consistent when we aggregate them to the level of rural farm households, rural non-farm households and urban households. They show that a 20% import tariff reduction reduces the total income (including transfers) of rural farm and rural non-farm households by 0.147% and 0.008% respectively. On the other hand, the income of urban households increases by 0.119%. The case of rural non-farm households improves if we exclude the effect of institutional transfers. Importantly, without government transfers, rural farm households are even worse-off. They suffer an income change of about -0.310%. This seems to suggest that government transfers mitigate the negative impact of trade liberalization on the rural households.

Losses in terms of demand for labour (employment) is widespread covering almost all labour categories. In table 2, except for rural uneducated and tertiary-educated workers, all other labour types suffer a fall in demand. Not surprisingly, uneducated (rural and urban) workers face the largest fall followed by rural primary and secondary educated workers. The high employment of rural uneducated workers is not surprising given the nature of compensation to some rural uneducated workers. In most cases, compensa-

Table 1: Impact of trade liberalization on households income

HOUSEHOLD TOTAL INCOME, INCLUDING TRANSFERS		
	BASE	**20% Import tax cut**
Household groups:	**Value**	**% change**
HH-Rural farm 1	2289.664	-0.052
HH-Rural farm 2	3261.236	-0.036
HH-Rural farm 3	3653.005	-0.025
HH-Rural farm 4	3658.469	-0.020
HH-Rural farm 5	4097.314	-0.014
HH-Rural Non-farm 1	1494.903	-0.015
HH-Rural Non-farm 2	963.689	-0.021
HH-Rural Non-farm 3	1014.785	0.001
HH-Rural Non-farm 4	1699.262	0.012
HH-Rural Non-farm 5	3435.255	0.015
HH-Urban 1	2925.104	0.022
HH-Urban 2	2904.295	0.029
HH-Urban 3	6809.281	0.029
HH-Urban 4	12155.679	0.021
HH-Urban 5	34135.862	0.018
	Aggregates	
HH-Rural farm	16959.688	-0.147
HH-Rural Non-farm	8607.894	-0.008
HH-Urban	58930.221	0.119
HOUSEHOLD TOTAL FACTOR INCOME		
HH-Rural farm	13831.665	-0.310
HH-Rural Non-farm	32035.334	1.050
HH-Urban	24075.193	0.500

tions are determined along family lines (i.e., size) and usually paid in kind. Aside from labour income, our results (table A3) also show a decrease in land rent of about 0.033%. Despite the aggregate positive increase in capital rent, the results indicate a decrease in crop capital rent of about 0.032%. Thus, much of the gains in the aggregated capital rent can be accounted for by the increase in rent from mining capital (increased by 0.035%).

Table 2: Impact of trade liberalization on labour demand across activities

	Demand for labour	
Labour (Workers)	BASE Value	20% Import tax cut % change
Rural-Uneducated	4736.055	5.864
Rural- Primary educated	5592.973	-1.765
Rural-Secondary educated	1157.869	-1.332
Rural- Tertiary educated	473.144	-0.579
Urban- Uneducated	2762.143	-1.607
Urban- Primary educated	9364.105	-0.656
Urban- Secondary educated	4671.201	-1.027
Urban- Tertiary educated	4453.314	2.232

We report in table A4 (see appendix) the impact of import tariff reduction on household consumption spending. Usually, a change in income whether transitory or permanent is likely to affect consumption spending. As already stated, import tariff reduction affects labour income through the substitution effect of consumption. Hence, one would expect rural households to reduce their consumption due to their income loss. We find a consistent result to that effect as our results show a fall in the consumption spending of all rural farm households and rural non-farm households in the first two income quintiles. The urban households, on the other hand, increase their consumption following the very reason stated above but in an opposite direction.

In general, domestic consumers benefit from a relatively cheaper consumption basket because of cheaper imports. Urban households not only benefit from the cheap consumption basket but their income also increases. On the contrary, the net loss of import tariff reduction is borne by both rural farm households and the government. The simulation results show a deterioration of government budget of about 0.465% decrease in government revenue. This is not surprising since the fall in tariff rate implies a fall in the government revenue all other things being equal.

Table 5A (see appendix) shows the consumption of some marketed commodities by households. Except for fish, meat, beverage and textile, households generally increased their consumption in most marketed commodities. The implication of the results in table 5A could be better understood if analyzed together with the results in table A2. For example, the trade deficit in rice is valued at 555.513 million GHS. Since Ghana depend heavily on external markets for rice consumption, the increase in households consumption of rice of about 22.5% only implies a further worsening of the deficit position. Except for fruit and vegetables, the results indicate a similar pattern in other commodities, noticeably maize.

In principle, more taxes can be derived from the increase in consumption of commodities, however, such gains have to be set against the losses in terms of the foregone tariff revenue as a result of the liberalization. The foregone tariff revenue is likely to be large in the case of Ghana since import tariffs are an important source of government revenue. As already discussed, transfers by way of aids and loans are usually used to mitigate the net loss of the public sector in import tariff reductions. They provide some leverage to the government against the fiscal deficit. However, the problem is that these transfers are only accessible under very stringent conditions of which Ghana defaults in most cases.

Because of the high level of informal and non-market based activities in Ghana, unemployment figures tend to be very low. That notwithstanding, we test the appropriateness of our labour market assumption by applying an alternative where we assume that the real wage is fixed and the aggregate supply of labour is flexible. The implication of this labour market closure is that the loss of jobs may cause unemployment, however, this will have no effect on wages. Importantly, previous studies (Burfisher, 2017) have shown that allowing for factor unemployment in this type of models will have strong consequence on the level of production capacity and real GDP.

Our results, as presented in Table A6 (see appendix), are similar to the baseline findings in Table 1. However, it appears that the negative effects on the poorest quintiles (rural households) are much smaller while the positive effects on the richest quintiles are also relatively larger. In the unemployment model, the assumption of fixed wages implies that an increase in unemployment will not affect the labour income of households as it would in the full employment model. Importantly, since employment does not depend on falling wages, rural and urban households are likely to be better off.

8 Conclusion

This paper set out to analyze the impact of trade liberalization on income distribution in Ghana using the 2013 SAM for Ghana. Thus, this analysis is prompted by the conclusions of (Pavcnik, 2017; Goldberg and Pavcnik 2007a, 2016) and the fact that the 2013 SAM for Ghana allows for comprehensive analyses covering more disaggregated rural and urban households. We then test the impact of a 20% import tariff reduction of agricultural commodities on households income using a standard CGE model.

Consistent with the existing literature and specifically some of the conclusions of (Pavcnik, 2017) in the case of Brazil, China, Vietnam etc, we find that trade liberalization creates income disparity by geographical location and by the type of economic activity in Ghana. Our results suggest that rural farm and non-farm households are largely affected by import tariff reduction in the form of a reduction in total and factor income, while urban households benefit by an increase in both total households income and consumption. Our results also indicate that except for consumers, domestic producers and the public sector suffer a net loss under such a policy. We ascribe these findings to the substitution effect created by the influx of cheap imports of foreign commodities. This also has negative implication on the demand for labour and the consumption of some marketed commodities.

From a policy point of view, our results, suggest that the cost of import tariff reduction in Ghana is comprehensive, affecting the income of rural farm and non-farm households, the land rent and crop capital rent, the demand for labour and trade balance. Thus some compensation by way of income transfer or some subsidies payment should be given to rural household and domestic producers. Indeed, our results indicate that transfers lessen the burdens rural workers. On the part of the government, there should be some commitment to complying with partners' standards in obtaining donor funds that could help mitigate the loss of tax revenue.

That notwithstanding, there are some caveats that prompt the need for further research investigations. To start with, our results are based on a static CGE model, hence our conclusion is limited in the sense that we do not analyze the long-run distributional effects on households. Moreover, further policy simulations could be conducted using different liberalization scenarios.

Reference

Adelman, I. and Robinson, S., 1978. Income Distribution Policies in Developing Countries, Stanford University Press, California.

Annabi, N., Cockburn, J. and Decaluwe, B., 2006. Functional Forms and Parametrization of CGE Models. PEP Working Paper No. 2006-04.

Baker, J.L., 2000. Evaluating the impact of development projects on poverty: A handbook for practitioners. World Bank Publications.

Bhagwati, J. and Srinivasan, T.N., 2002. Trade and poverty in the poor countries. The American Economic Review, 92(2), pp.180-183.

Bhasin, V. and Annim, S., 2005. "Impact of Elimination of Trade Taxes on Poverty and Income Distribution in Ghana", International Monetary Fund: Macroeconomic Policy Challenges in Low Income Countries, 1-42.

Bhasin, V. and Obeng, C., 2006. "Trade Liberalization, Foreign Borrowing, Poverty and Income Distributions of Households in Ghana, ICFAI Journal of Applied Economics, July 2006, Vol 5, No. 4.

Bhasin, D.V.K. and Obeng, C.K., 2007. Trade Liberalization, Foreign Aid, Poverty and Income Distributions of Households in Ghana. In 12th Annual Conference on Econometric Modelling for Africa. Cape Town: AES. Retrieved from http://www. africametrics. org/documents/conference07/Day (Vol. 2).

Bourguignon, F. and Pereira da Silva, L. A., (eds.) 2003. The Impact of Economic Policies on Poverty and Income Distribution: Evaluation Techniques and Tools. Washington, DC: World Bank; Oxford and New York: Oxford University Press.

Bourguignon, F., Bussolo, M. and da Silva, L.A.P., 2008. The impact of macroeconomic policies on poverty and income distribution. World Bank.

Breisinger, ClemensDiao, Xinshen Diao, Shashidhara Kolavalli, Ramatu M. Al-Hassan, and James Thurlow. 2011. "A New Era of Transformation in Ghana: Lessons from the Past and Scenarios for the Future." IFPRI Research Monograph 171. Washington, D.C.: International Food Policy Research Institute.

Burfisher, M.E., 2017. Introduction to computable general equilibrium models. Cambridge University Press.

Bussolo, M. and Round, J., 2003. "Poverty Reduction Strategies in a Budget- Constrained Economy: The Case of Ghana". OECD Development Centre Working Paper No 220.

Chia, N.C., Wahba, S.M. and Whalley, J., 1994. "Assessing Poverty-Reducing Programmes: A General Equilibrium Approach", Journal of African Economies, 3(2), pp. 309-338.

Colatei, D. and Round, J.I., 2000, August. Poverty and Policy: Experiments with a SAM-based CGE Model for Ghana. In XIII International Conference on Input-Output Techniques (pp. 21-25).

Darku, Alexander Bilson. 2012. "The Balance of Payments Constraint Growth Model and the Effect of Trade Liberalization on the Trade Balance and Income Growth in Ghana." African Finance Journal 14 (1): 37–66.

Decaluwe, B., Praty, A., Savard, L. and Thorbecke E., 1999. "Poverty Analysis Within a General Equilibrium Framework", CRÉFA, Département d'economique, University of Laval, Working Paper 9909.

De Maio, L., Stewart, F., and Van Der Hoeven R., 1999. "Computable General Equilibrium Models, Adjustment and the Poor in Africa", World Development, Vol. 27, No. 3, 453-70.

Demery, D. and Demery L., 1992. Adjustment and Equity in Malaysia, OECD Development Centre, Paris

Dervis, K., J. De Meleo and Robinson, S., 1982. General Equilibrium Models for Development Policy, Cambridge University Press and the World Bank, Washington, D.C.

Dornbusch, R., Fischer, S. and Samuelson, P.A., 1977. Comparative advantage, trade, and payments in a Ricardian model with a continuum of goods. The American Economic Review, 67(5), pp.823-839.

Dorosh, P. A., and Sahn, D. E., 2000. "A General Equilibrium Analysis of the Effect of Macroeconomic Adjustment on Poverty in Africa", Journal of Policy Modelling, Vol. 22, No. 6, 753-76.

Ghana Statistical Services; Institute for Statistical, Social and Economic Research (ISSER); International Food Policy Research Institute (IFPRI), 2017, "2013 Social Accounting Matrix for Ghana", https://doi.org/10.7910/DVN/YVZ8KR, Harvard Dataverse, V1

Gibson, B. and Seventer, V. E., 2000. A Tale of Two Models: Comparing structuralist and neoclassical computable general equilibrium models for South Africa, International Review of Applied Economics, 14:2, 149-171.

Gibson, B., 2005. The transition to a globalized economy: Poverty, human capital and the informal sector in a structuralist CGE model. Journal of Development Economics, 78(1), pp.60-94.

Goldberg, PK. and Pavcnik, N., 2007a. "Distributional Effects of Globalization in Developing Countries". Journal of Economic Literature, 45(1): 39–82.

Goldberg, PK. and Pavcnik, N., 2016. "The Effects of Trade Policy," in Staiger, B. and K. Bagwell (eds.), the Handbook of Commercial Policy, Volume 1A, Elsevier, pp. 161–206.

GSS. 2014a. 2012/13 Ghana Living Standards Survey Round 6 (GLSS6): Main Report. Accra, Ghana: Ghana Statistical Services.

Heckscher, Eli F. (1929). A plea for theory in economic history. Economic History (A supplement to the Economic Journal), 1, 525–534.

Kaldor, Nicholas. 1980. "The Foundations of Free Trade Theory and their Implications for the Current World Recession," in E. Malinvaud and J. P. Fitoussi (eds), Unemployment in Western Countries. MacMillan Press, London. 85–100.

Lavoie, Marc. 2014. Post-Keynesian Economics: New Foundations. Edward Elgar, Cheltenham. pp. 507–512.

Löfgren, H., Harris, R.L. and Robinson, S. (2001). "A Standard Computable General Equilibrium (CGE) Model in GAMS." International Food Policy Research Institute: Trade and Macroeconomics Division Discussion Paper, No.75, May 2001.

López, Ramón. 1997. "Environmental Externalities in Traditional Agriculture and the Impact of Trade Liberalization: The Case of Ghana." Journal of Development Economics 53 (1): 17–39.

McDonald, S., 2005. The PROVIDE project standard computable general equilibrium model: version 2 (No. 15625). PROVIDE Project.

Palatnik, R., R. and Roson, R., 2009. Climate Change Assessment and Agriculture in General Equilibrium Models: Alternative Modeling Strategies. Working Paper No. 08/WP/2009, Department of Economics, University of Ca' Foscari, Venice.

Porto, G.G. 2006. "Using Survey Data to Assess the Distributional Effects of Trade Policy." Journal of International Economics 70: 140–160.

Pavcnik, N., 2017. The impact of trade on inequality in developing countries (No. w23878). National Bureau of Economic Research.

Ricardo, David (1817), On the Principles of Political Economy and Taxation (1 ed.), London: John Murray, retrieved 2017-11-28 via Google Books

Sanchez C., M.V. 2004. Rising inequality and falling poverty in Costa Rica's agriculture during trade reform. A macro-micro general equilibrium analysis, Maastricht:Sahker. Chapter 7, pp. 189-226.

Sahn, D. E., Dorosh, P. A. and Younger, S.A., 1997. Structural Adjustment Reconsidered: Economic Policy and Poverty in Africa, Cambridge University Press, Cambridge.

Santos-Paulino, A.U., 2012. Trade, income distribution and poverty in developing countries: a survey (No. 207). United Nations Conference on Trade and Development.

Shaikh, A. 2007. "Globalization and the Myth of Free Trade," in A. Shaikh (ed.), Globalization and the Myths of Free Trade: History, Theory, and Empirical Evidence. Routledge, London 50–68.

Stolper, W.F. and Samuelson, P.A., 1941. Protection and real wages. The Review of Economic Studies, 9(1), pp.58-73.

Taylor, L. et.al. 1980. Models of Growth and Distribution for Brazil, New York: Oxford University Press (for the World Bank). Taylor, L. (Ed.), 1990. Socially Relevant Policy Analysis: Structuralist Computable General Equilibrium Models for the Developing World. MIT Press, Cambridge.

Taylor, L., 2011. "CGE Applications in Development Economics" Schwartz Center for Economic Analysis and Department of Economics, The New School for Social Research, Working Papers Series.

Tutu, Kwadwo, and Abena Oduro. 1999. "Trade Liberalization in Ghana." In Regional Integration and Trade Liberalization in SubSaharan Africa. Volume 2. Country Case-Studies, edited by Ademola Oyejide, Benno Ndulu, and Jan Willem Gunning, 80–146. New York

Ocran, M. K., Osei R. D. and Adjasi, C. K. D. 2006. Trade liberalization and Poverty: empirical evidence from household surveys in Ghana. A paper presented at CSAE Conference on the Reducing Poverty and Inequality: How can Africa be included? Oxford UK.

Ohlin B., 1933. Interregional and international trade. Cambridge, 1933.

World Bank 2002. Global Economic Prospects and the Developing Countries. Washington DC: World Bank.

Zeitsch, J., McDougall, R., Jomini, P., Welsh, A., Hambley, J., Brown, S. and Kelly, J., 1991. SALTER: A general equilibrium model of the world economy. In SALTER working paper, No. 4. Industry Commission Canberra, Australia.

Appendix

Table A1: ECOWAS CET Tax Structure

Category	Type of Good	Duty Rate
0	Basic Social Goods	0%
1	Basic Goods, Raw Goods and Capital Goods	5%
2	Input and Semi-Finished Goods	10%
3	Finished Goods	20%
4	Specific Goods for Economic development	35%

Source: Ecowas, 2017

Figure 1: Employment by Sector and Sex

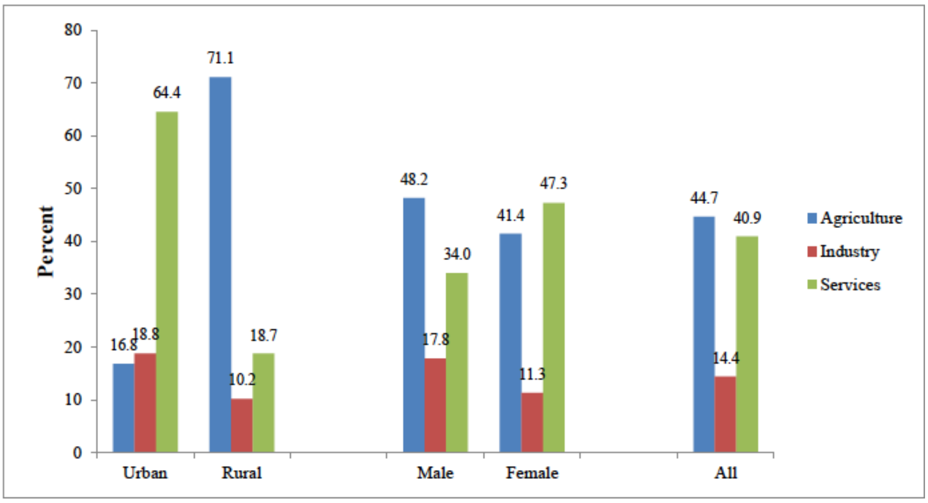

Table A2: Trade Balance for selected agricultural commodities (in millions of Ghana cedis

Commodities	Import	Export	Deficit/Surplus
Maize	8.549	0.969	-7.580
Beverages	342.087	91.343	-250.744
Rice	553.514	0.001	-553.513
Other cereals	195.136	0.320	-194.816
Pulses	4.531	2.335	-2.196
Other oilseeds	0.328	139.451	139.123
Other roots	2.121	0.012	-2.109
Vegetables	40.255	52.001	11.747
Cotton and fibers	0.446	14.806	14.360
Fruits and nuts	33.798	681.330	647.532
Cocoa	0.116	3,468.926	3,468.810
Coffee and tea	2.748	8.502	5.754
Other crops	15.923	168.867	152.943
Cattle	8.247	0.043	-8.204
Poultry	26.925	0.074	-26.851
Other livestock	14.996	0.851	-14.145
Forestry	39.784	34.317	-5.466
Fishing	4.071	0.511	-3.560
Meat, fish and dairy	2,092.402	161.564	-1,930.838
Fruit and veg. processing	340.359	573.262	232.903
Fats and oils	143.591	397.822	254.231
Other foods	596.670	253.488	-343.181
Textiles	507.179	34.832	-472.347
Clothing	348.004	20.600	-327.404
Leather and footwear	195.204	10.771	-184.433
Wood and paper	745.491	1,216.354	470.864

Source: Author's calculation

Table A3: Trade liberalization on factor Income

	Factor Income	
	BASE	20 % Import tax cut
	Value	% Change
labour	33210.801	0.129
land	6864.57	-0.033
Capital	49209.032	0.012

Table A4: Impact of trade liberalization on household consumption

HOUSEHOLD CONSUMPTION EXPENDITURE		
	BASE	**20% Import tax cut**
Household groups:	**Value**	**% change**
HH-Rural farm 1	2077.941	-0.052
HH-Rural farm 2	2888.125	-0.036
HH-Rural farm 3	3115.712	-0.025
HH-Rural farm 4	3045.706	-0.020
HH-Rural farm 5	3376.779	-0.014
HH-Rural Non-farm 1	1438.68	-0.015
HH-Rural Non-farm 2	863.853	-0.021
HH-Rural Non-farm 3	865.638	0.001
HH-Rural Non-farm 4	1258.942	0.012
HH-Rural Non-farm 5	2425.575	0.015
HH-Urban 1	2750.433	0.022
HH-Urban 2	2478.556	0.029
HH-Urban 3	5413.983	0.029
HH-Urban 4	8667.965	0.021
HH-Urban 5	21339.19	0.018

Table A5: Impact of trade liberalization on some marketed commodities

	HOUSEHOLDS CONSUMPTION OF MARKETED COMMODITIES						
	Maize	**Sorghum**	**Rice**	**Pulses**	**Groundnuts**	**Cassava**	**Other roots**
Base	280.122	42.539	342.348	159.274	205.66	305.555	776.193
Rural	2.361	-0.044	14.969	0.293	0.255	0.021	0.267
Urban	1.357	0.171	7.577	0.336	0.317	0.202	0.323
	Fruits	**Poultry**	**Fish**	**Meat**	**Beverage**	**Textile**	**Vegetables**
Base	1194.72	706.639	1181.73	2356.62	890.269	1147.25	2151.248
Rural	0.631	-0.182	-0.263	-0.744	-0.603	-0.688	0.105
Urban	0.502	0.102	0.062	-0.174	-0.104	-0.149	0.245

Table A6: Impact of trade liberalization on households income

Household groups:	BASE Value	20% Import tax cut % change
HH-Rural farm 1	2289.664	-0.032
HH-Rural farm 2	3261.236	-0.018
HH-Rural farm 3	3653.005	-0.007
HH-Rural farm 4	3658.469	-0.001
HH-Rural farm 5	4097.314	0.006
HH-Rural Non-farm 1	1494.903	-0.002
HH-Rural Non-farm 2	963.689	-0.006
HH-Rural Non-farm 3	1014.785	0.015
HH-Rural Non-farm 4	1699.262	0.027
HH-Rural Non-farm 5	3435.255	0.032
HH-Urban 1	2925.104	0.041
HH-Urban 2	2904.295	0.049
HH-Urban 3	6809.281	0.048
HH-Urban 4	12155.679	0.041
HH-Urban 5	34135.862	0.04

Equations

The following are the equation definitions and specifications of the static CGE model for Ghana (see Lofgren et al., (2001) and McDonald (2005));

C Set of commodities produced by activities

c A single commodity from the set C, C is also disaggregated into imported (IC) and non-imported commodities (NIC), exported commodities (EC) and non-exported commodities (NEC), domestically consumed commodities (DC), and commodities of domestic output (CX).

A Set of activities producing the commodities

a A single activity from the set A

f A single factor used by activities in the production process

F Set of factors

h A single household

INS Set of Institutions, INS is further disaggregated into domestic non-government, domestic government and rest of the world (ROW) institutions.

1. **Declaration and definition of parameters**

pim_c Proportion of the transaction cost associated with imported commodities

imp_c International import price of commodities in c.i.f

it_c Import tariffs

iep_c International export price in f.o.b

et_c Export tariff

pem_c Proportion of the transaction cost associated with exported commodities

pdm_c proportion of the transaction cost associated with domestically consumed commodities

st_c Sales tax on commodities

$\Theta_{a,c}$ Yield of activity A of commodity c

t_a Tax on activity A

cwt_c Weight of commodity c in the consumer price index

dwt_c Weight of commodity c in the producer price index

$ica_{c,a}$ Per unit of commodity c used as intermediate input of Actvty A

α_a The efficiency parameter of the CES activity function

δ_a Share of input components of the CES activity function

p_a CES activity exponent parameter

α_a^{va} The efficiency parameter of the CES value-added function

$\delta^{va}_{f,a}$ Share of input components of the CES value-added function

p^{va}_{a} CES value-added exponent parameter

α^{t}_{c} CET shift parameter

δ^{t}_{c} CET share parameter

p^{t}_{a} CET exponent parameter

iva_{a} Quantity of value-added per unit of activity

$inta_{a}$ Quantity of intermediate output per unit of activity

α^{d}_{c} Armington shift parameter

δ^{d}_{c} Armington share parameter

tva_{a} Tax rate on value-added of activity A

p^{d}_{a} Armington exponent parameter

$\alpha^{a,c}_{c}$ CES shift parameter (marketed output aggregation function)

$\delta^{a,c}_{a,c}$ CES share parameter (marketed output aggregation function)

$p^{a,c}_{c}$ CES exponent parameter (marketed output aggregat. function)

$shif_{i,f}$ Domestic Institution i share of factor income

tf_{f} Direct tax rate on factor income

$trnsfr_{row,f}$ Transfer of factor income to ROW

$shii_{i,i'}$ Share of net income transfer from Institution i' to i

$\gamma^{m}_{c,h}$ Subsistence consumption of marketed comm. c of household h

$\zeta^{m}_{c,h}$ incremental consumption of marketed comm. c of household h

$\gamma^{h}_{ac',h}$ Subsistence consumption of non-marketed comm. c of activity a for household h

$\zeta^{h}_{ac,h}$ incremental consumption of non-marketed comm. c of activity a for household h

$\overline{qind_{c}}$ Base-year quantity of fixed investment demand

$\overline{qgid_c}$	Base-year quantity of government investment
$qdst_c$	Quantity of changes in stock
$\overline{tins_i}$	Exogenous institutional tax rate
$\overline{mps_i}$	Exogenous marginal propensity to save

2. **Declaration and definition of variables**

EXR	Exchange rate
PQ_c	Aggregate market value of commodity c
IP_c	Import price of commodities
EP_c	Export price of commodities
DDP_c	Domestic demand price of commodity c
DSP_c	Domestic supply price of commodity c
DQD_c	Domestic quantity demanded for commodity c
QQ_c	Aggregated quantity demand of commodity c
IQD_c	Import quantity demanded
PX_c	Domestic producers' price of commodity c
QX_c	Domestic producers' supply quantity of commodity c
EQS_c	Export quantity supplied
PPI	Producer price index
AP_a	Activity price
$PINTA_a$	Aggregate intermediate input price
PVA_a	Price of value-added in Activity A
QVA_a	Quantity of value-added in Activity A
$QINTA_a$	Quantity of intermediate commodities in Activity A
$QINT_{c,a}$	Qty. of commodities c used as intermediate input for Activity A
AQ_a	Aggregate output of activities

$QF_{f,a}$ The qty of factors used in the production process by Activity A

$QXA_{a,c}$ Quantity of marketed commodity c produced by activity a

$PQXA_{a,c}$ Producer price of commodity c for activity a

$QH_{a,c,h}$ Quantity of home production and home consumption of non-marketed good by household h

QT_c Value of demand for transaction services

$QH_{c,h}$ Quantity of household consumption

WF_f Average wage of factors

$TDIY_{i,f}$ Total domestic institutions income from factors

TFY_f Total factor Income

$TDNGIY_i$ Total non-government domestic Institution Income

$TRII_{i,i'}$ Transfer from institution i' to i, where $(i, i' \in NGDINS)$

$DTINS_{i'}$ Direct tax rate for institution i'

$MPS_{i'}$ Marginal propensity to save for Institution i'

HCE Household consumption expenditure

QID_c Quantity of fixed investment demand for commodity c

QGD_c Quantity of government consumption demand for commodity c

GY Government Income

GE Government Expenditure

QSF_f Quantity supply of factors

GS Government savings

$TABS$ Total nominal absorption

$INVSHR$ Investment share of total nominal absorption

$GOVSHR$ Government share of total nominal absorption

3. **Declaration and definition of exogenous variables**

$\overline{CPI}$ Consumer price index

$\overline{WFDIST}_{f,a}$ Activity-wise wage distortion factor

$\overline{GIADJ}$ Government fixed investment adjustment factor

$\overline{IADJ}$ Fixed investment adjustment factor

$\overline{ROWS}$ Rest of the world savings

EQUATIONS;

A. **Price Block**

1. Import Price (domestic)

$IP_c = imp_c(1+it_c) \times \text{EXR} + \sum_{c' \in CT}(PQ_{c'} \times pim_{c'})$

2. Export Price

$EP_c = iep_c(1-et_c) \times \text{EXR} - \sum_{c' \in CT}(PQ_{c'} \times pem_{c'})$

3. Price of domestically consumed commodities

$DDP_c = DSP_c + \sum_{c' \in CT}(PQ_{c'} \times pdm_{c'})$

4. Total Absorption of marketed commodities

$PQ_c(1-st_c) \times QQ_c = (DDP_c \times DQD_c) + (IP_c \times IQD_c)$

5. Total supply of commodities

$PX_c \times QX_c = (DSP_c \times DQD_c) + (EP_c \times EQS_c)$

6. Activity Price

$AP_a = \sum_{c \in C} PQXA_{a,c} \times \Theta_{a,c}$

7. Price of Intermediate inputs

$PINTA_a = \sum_{c \in C} PQ_c \times ica_{c,a}$

8. Activity cost and revenue function

$AP_a(1-ta_a) \times AQ_a = (PVA_a \times QVA_a) + (PINTA_a \times QINTA_a)$

9. Consumer Price Index

$\overline{CPI} = \sum_c^C PQ_c \times cwt_c$

10. Producers Price Index

PPI = $\sum_{c}^{C} DSP_c \times dwt_c$

B. **Production and Trade Block**

1. Aggregate output of activities

$AQ_a{=}\alpha_a^a(\delta_a^a QVA_a^{-p_a^a} + (1-\delta_a^a) \times QINTA_a^{-p_a^a})^{\frac{-1}{p_a}a}$

2. Price-Ratio of value-added and intermediate input

$\frac{QVA_a}{QINTA_a} = (\frac{PINTA_a}{PVA_a} \times \frac{\delta_a^a}{1-\delta_a^a})^{\frac{1}{1+p_a^a}}$

3. Aggregate value-added of activities

$QVA_a = \alpha_a^{va} \sum_{f \in F} (\delta_{f,a}^{va} QF_{f,a}^{-p_a^{va}})^{\frac{-1}{p_a^{va}}}$

4. Aggregate value-added of activities***

$QVA_a = iva_a \times AQ_a$

5. Aggregate intermediate inputs of activities***

$QINTA_a = inta_a \times AQ_a$

6. Quantity of commodity c used as input of Activity A

$QINT_{c,a} = ica_{c,a} \times QINTA_a$

7. Allocation of commodity consumption

$QXA_{a,c} + \sum_{h}^{H} QH_{a,c,h} = AQ_a \times \Theta_{a,c}$

8. Allocation of marketed domestic output (supply)

$QX_c = \alpha_c^t(\delta_c^t EQS_c^{p_c^t} + (1-\delta_c^t) \times DQD_c^{p_c^t})^{\frac{1}{p_c^t}}$

9. Export-domestic supply ratio

$\frac{EQS_c}{DQD_c} = (\frac{EP_c}{DSP_c} \times \frac{1-\delta_c^t}{\delta_c^t})^{\frac{1}{p_c^t - 1}}$

10. Allocation of marketed domestic (demand)

$QQ_c = \alpha_c^d(\delta_c^d IQD_c^{-p_c^d} + (1-\delta_c^d) \times DQD_c^{-p_c^d})^{\frac{-1}{p_c^d}}$

11.Aggregation of domestic supply

$QX_c = DQD_c + EQS_c$

12. Import-domestic demand ratio

$\frac{IQD_c}{DQD_c} = (\frac{DDP_c}{IP_c} \times \frac{\delta_c^d}{1-\delta_c^d})^{\frac{1}{1+p_c^d}}$

13. Aggregation of domestic demand

$QQ_c = DQD_c + IQD_c$

14. Demand for transaction services

$QT_c = \sum_{c' \in C'} (pim_{c,c'} \times IQD_{c'} + pem_{c,c'} \times EQS_{c'} + pdm_{c,c'} \times DQD_{c'})$

15. Factor Demand

$WF_f \times \overline{WFDIST}_{f,a} = PVA_a(1-tva_a) \times OVA_a \times (\sum_{f \in F} \delta_{f,a}^{va} QF_{f,a}^{-p_a^{va}})^{-1} \times \delta_a^{va} QF_{f,a}^{-p_a^{va}-1}$

16. Aggregation of marketed output of commodity c

$QX_c = \alpha_c^{a,c} \sum_{a \in A} (\delta_{a,c}^{a,c} QXA_{a,c}^{-p_c^{a,c}})^{\frac{-1}{p_c^{a,c}-1}}$

17. First order condition for output aggregation

$PQXA_{a,c} = PX_c \times \mathrm{QX}_c(\sum_{a \in A} \delta_{a,c}^{a,c} QXA_{a,c}^{-p_c^{a,c}})^{-1} \delta_{a,c}^{a,c} QXA_{a,c}^{-p_c^{a,c}-1}$

C. **Institution Block**

1. Total Factor Income

$TFY_f = \sum_{a \in A} WF_f \times WFDIST_{f,a} \times QF_{f,a}$

2. Total Domestic-Institution Income

$TDIY_{i,f} = shif_{i,f} \times [(1 - tf_f) \times TFY_f - (trnsfr_{row,f} \times EXR)]$

3. Total Non-Government Domestic Institution Income

$TDNGIY_i = \sum_{f \in F} TDIY_{i,f} + \sum_{i'} TRII_{i,i'} + trnsfr_{i,gov} \times CPI + (trnsfr_{i,row} \times EXR)$

4. Intra-Non-Government Domestic Institution transfer

$TRII_{i,i'} = shii_{i,i'} \times (1 - MPS_{i'}) \times (1 - DTINS_{i'}) \times TDNGIY_{i'}$

5. Household Consumption Expenditure

$HCE_h = (1 - \sum_{i \in NGDINS} shii_{i,h}) \times (1 - MPS_h) \times (1 - DTINS_h) \times (TDNGIY_h)$

6. Household Consumption Spending (marketed commodities)

$PQ_c \times QH_{c,h} = PQ_c \times \gamma^m_{c,h} + \zeta^m_{c,h} \times (HCE_h - \sum_{c' \in C} PQ_{c'} \times \gamma^m_{c,h} - \sum_{a \in A} \sum_{c' \in C} PQXA_{a,c'} \times \gamma^h_{ac',h})$

7. Household Consumption Spending (non-marketed commodities)

$PQXA_{a,c'} \times QH_{ac,h} = PQXA_{a,c'} \times \gamma^h_{ac,h} + \zeta^h_{ac,h} \times (HCE_h - \sum_{c' \in C} PQ_{c'} \times \gamma^m_{c,h} - \sum_{a \in A} \sum_{c' \in C} PQXA_{a,c'} \times \gamma^h_{ac',h})$

8. Investment Demand

$QID_c = \overline{IADJ} \times qind_c$

9. Government Consumption demand

$QGD_c = \overline{GIADJ} \times qgid_c$

10. Government Revenue

$GY = \sum_f^F tf_f \times TFY + \sum_{i \in NGDINS} DTINS_i \times TDNGIY_i + \sum_{f \in F} TDIY_f + \sum_{c \in IC} it_c \times IQD_c \times IP_c \times imp_c \times EXR + \sum_{c \in EC} et_c \times EQS_c \times EP_c \times iep_c \times EXR + \sum_{c \in C} st_c \times QQ_c \times PQ_c + \sum_{a \in A} ta_a \times AP_a \times AQ_a + \sum_{a \in A} tva_a \times PVA_a \times QVA_a + trnsfr_{gov,row} \times EXR$

11. Government Expenditure

$GE = \sum_{c \in C} PQ_c \times QGD_c + trnsfr_{i,gov} \times CPI$

D. **Macro-closure Block**

1. Factor Market

$\sum_{a \in A} QF_{f,a} = QSF_f$

2. Commodity Market

$DQS_c = \sum_{a \in A} QINT_{c,a} + \sum_{h \in H} QH_{c,h} + QID_c + QGD_c + QT_c + qdst_c$

3. Rest of the World (ROW)

$\sum_{c \in C} imp_c \times IQD_c + trnsfr_{row,f} = \sum_{c \in C} iep_c \times EQS_c + trnsfr_{i,row} + \overline{ROWS}$

4. Government Balance

$GY = GE + GS$

5. Domestic Institutional Tax

$DTINS_i = \overline{tins_i}$

6. Domestic Institutional Savings

$MPS_i = \overline{mps_i}$

7. Savings-Investment Balance

$MPS_i \times (1 - DTINS_i) \times TDNGIY_i + GS + \overline{ROWS} \times EXR = QID_c \times PQ_c + qdst_c \times PQ_c$

8. Total Absorption

$TABS = \sum_{c \in C} \sum_{h \in H} PQ_c \times QH_{c,h} + \sum_{a \in A} \sum_{c \in C} \sum_{h \in H} AP_{a,c} \times QH_{ac,h} + \sum_{c \in C} PQ_c \times QGD_c + \sum_{c \in C} PQ_c \times QID_c + \sum_{c \in C} qdst_c \times PQ_c$

9. Investment Share of Total Absorption

$INVSHR \times TABS = \sum_{c \in C} PQ_c \times QID_c + \sum_{c \in C} qdst_c \times PQ_c$

10. Government share of Total Absorption

$GOVSHR \times TABS = \sum_{c \in C} PQ_c \times QGD_c$