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ABSTRACT

Exposure to External Country Specific Shocks and Income Volatility*

Using a dataset of 138 countries over a period from 1966 to 2004, this paper analyses the relevance of country specific shocks for income volatility in open economies. We show that exposure to country specific shocks has a positive and significant impact on GDP volatility. In particular, we find that the degree to which the cycles of different trading partners are correlated is more important in explaining exporters' GDP volatility than the volatility of demand in individual export market. We also show that geographical diversification is a significant determinant of countries' exposure to country specific shocks.

JEL Classification: C23, F43 and O19
Keywords: export diversification, external shocks and income volatility

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1. Introduction

Trade provides countries with new growth opportunities but also exposes them to external shocks. With openness increasing significantly over the past decades - from a median across countries of 44 per cent in 1960 to 85 per cent in 2004 -[2], policy makers and economists have shown a continuing interest in the relationship between trade, and in particular patterns of specialization, and economic stability.[3]

Economic volatility has been shown to reduce economic growth (Martin and Rogers, 2000; Imbs, 2007; Ramey and Ramey, 1995) and the positive growth impact of trade may therefore be attenuated if it leads to significant exposure to external shocks. Risk-averse individuals dislike volatility and increased volatility may therefore have undesirable social consequences. Rodrik (1998) has shown that more open economies are characterized by higher government expenditure. He argues that higher government expenditure is meant to protect economic actors against increased volatility through exposure to external shocks.

Understanding the sources of volatility is an important issue for developing countries not only because income fluctuations are larger in those economies,4 but also because their ability to hedge against fluctuations is particularly limited. Developing countries have shallow financial infrastructures and their compensatory fiscal and monetary policies are often underdeveloped which in turn makes difficult for those countries to attenuate the impact of external shocks.

In the economic literature there has been a particular interest in the role of commodity diversification of trade in explaining economic fluctuations in developing countries. It has been argued that the structure of developing countries' exports makes those countries particularly vulnerable to external shocks. Michaely (1958) showed five decades ago that countries with lower GDP per capita tend to be characterized by a higher commodity concentration of exports and argued that as a result, shocks affecting individual export products can have significant effects on overall export performance and potentially economic performance in developing countries. Using time series analysis for a sample of developing countries, Love (1986) found evidence of a positive relationship between product export concentration and export volatility, which indirectly affect income volatility. In a more recent study, Malik and Temple (2006) found a positive relationship between product concentration of exports and countries' terms of trade volatility. Terms of trade volatility, in turn, was found to be a significant determinant of income volatility. Focussing directly on the difference in income volatility between poor and rich countries, Koren and Tenreyro (2007) estimate that the sectoral composition of the economy (with poor countries specialised in fewer and more volatile sectors) explains roughly 50 percent of the differences in volatility.

The possible role of geographical concentration of exports and exposure to demand shocks in partner countries has been relatively under-researched in the literature examining economic volatility. The relative lack of interest in the role of country specific shocks can maybe be explained by the expectation that country specific shocks would either be reflected in price changes – and thus terms of trade changes – or be of no effect on exporters. In particular, country specific shocks that do not affect world prices were expected not to affect exporters, because they were expected to easily redirect production from one trading partner to the other.

Recent contributions to the theoretical trade literature (Melitz, 2003) emphasize the existence of fixed costs related to entry into new markets. In the presence of such fix costs, the re-direction of exports is

[2] Openness is defined as imports plus exports over GDP.

[3] See, for instance, Parris (2003) or Lee et al. (2008).

[4] In his seminal work, Lucas (1988) found that developed countries in general show stable growth rates over long periods of time, whereas poor countries exhibit large fluctuations in growth rates.

costly and may take time. To whom countries export and how much, would in such a context matter when it comes to the need to adjust to country specific shocks.

In this paper we focus on the role of demand shocks in partner countries for economic volatility in exporting countries and we measure exposure to foreign demand shocks by GDP volatility in partner countries. Using panel data regressions for different country samples and employing different regression techniques we provide a comprehensive analysis of the effect of our variable on volatility in exporting countries. Brainard and Cooper (1968) suggested that the correlation between individual external shocks are a significant determinant of the potential for such shocks to negatively affect exporters. Love (1979) showed that product diversification can indeed reduce instability of export earnings if the price movements of new export products are not strongly correlated with those already exported. Accordingly we decompose trading partners' volatility in a variance and a covariance component.[5] This allows us to distinguish between the risk countries face for trading with more or less volatile partners and the risk they face for choosing trading partners whose economic cycles are more or less correlated. It turns out that the covariance component is more important in explaining country's volatility. In addition, we find that geographical diversification is a significant determinant of countries' exposure to foreign demand shocks.

2. Previous literature on the relationship between external shocks and GDP volatility

Terms of trade volatility is probably the most widely used measure for external shocks. A number of studies have used quantitative, multi-sector equilibrium models to analyse the effect of terms of trade shocks on the variation in output volatility. Kose (2002) finds that world price shocks play an important role in driving business cycles in small open developing economies. His results confirm the results of earlier work by Mendoza (1995) or Kose and Riezman (2001).

A number of recent studies have analysed the relationship between terms of trade shocks and changes in GDP growth in vector auto-regression (VAR) models. Ahmed (2003) uses a VAR model to study the sources of short-term fluctuations in the output of six Latin-American countries and finds that the rate of change of the terms of trade and of foreign output growth play a role, albeit a limited one, in driving output fluctuations.[6] Also in Raddatz (2007) terms of trade changes are found to have an economically meaningful, even if small, effect on output volatility in low-income countries. Broda (2004) uses a panel VAR approach in a study that focuses on the role of exchange rate policies in insulating economies against real shocks. He finds that terms of trade shocks explain 30 percent of real output volatility in the long run in fixed exchange rate regimes against 10 percent in flexible exchange rate regimes.

Another strand of literature uses cross-country, time series or panel analysis to examine the relationship between terms of trade shocks and GDP volatility. Easterly and Kraay (2000) find a positive relationship between income volatility and terms of trade volatility in a cross-country analysis. In another cross country study Rodrik (1998) uses terms of trade volatility interacted with openness and finds that this variable affects GDP volatility positively. In a later study, focusing on Latin American economies, Rodrik (2001), however, finds that the relationship between terms of trade volatility and GNP volatility is positive but insignificant. Also Hausman and Gavin (1996) focus on Latin American countries. Their results are along the lines of Broda (2004), mentioned above, as they find that terms of trade shocks have a stronger effect on GDP volatility in countries pegging the exchange rate than in countries with more flexible exchange rate regimes. In a very recent paper, Di Giovanni and Levchenko (2008) use industry-level data and find that the risk content of exports is strongly positively correlated with the variance of terms of trade, suggesting that export specialization does affect macroeconomic volatility.

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[5] Brainard and Cooper (1968) examined the volatility of product prices.

[6] Foreign output is defined as the export-weighted aggregate of the real GDP of the eight largest export markets.

Terms of trade volatility is expected to affect countries income volatility through openness. Trade openness may expose economies to external shocks, but may also act as a buffer against domestic shocks. The overall impact of openness on volatility is therefore an empirical question. Easterly, Islam and Stiglitz (2001) and Calderon et al. (2005) find that higher trade openness leads to larger growth volatility. In contrast, Kose et al. (2002)do not find that trade openness have a robust effect on GDP volatility. A number of empirical studies have used the variable terms of trade interacted with openness as explanatory variable for income volatility (Rodrik, 2001; Calderon, Loayza, and Schmidt-Hebbel, 2005). A general result is that the impact of terms-of-trade volatility on income volatility is increasing with openness.

Only two recent studies have considered output volatility in partner countries as a potential determinant of domestic volatility. In the vector autoregression analysis mentioned above, Ahmed (2003) includes volatility in the export-weighted aggregate of the real GDP of countries' eight largest export markets as a measure for external shocks. In a paper that uses a methodology closer to ours, Calderon et al.(2005) consider three types of external shocks: terms of trade variation, changes in regional capital inflows and volatility in foreign growth, where the latter is measured by the standard deviation of the trade-weighted annual growth of the main trading partners. They tend to find a positive effect for this last variable on exporters' GDP volatility.

Our approach differs from Calderon et al. (2005) in that we use the trade-weighted annual growth of all trading partners as a measure for external shocks. While controlling for internal and other external shocks, our analysis focuses on the role of trading partners' volatility, in particular, by ensuring in a number of ways that the possible endogeneity of our variable does not affect results. Additionally, we decompose this variable in its variance and covariance components and we show that geographical concentration can be used as an instrument for exposure to output shocks in trading partners.

3. Stylized facts

Demand shocks in partner countries are likely to be linked to and even driven by income shocks in those countries. Increases in GDP are likely to increase demand for imports and decreases in GDP are likely to lower the demand for imports. GDP volatility in partner countries is therefore likely to be a good proxy for export demand volatility.

Countries' exposure to demand shocks in partner countries is likely to be higher, the higher the GDP volatility in those partner countries. But a country's degree of exposure is also likely to depend on whether GDP changes move in the same or in opposite directions in different partner countries. In the latter case demand changes in one country can balance out demand changes in other countries, reducing the exposure to partner country shocks in the exporting country.

The exposure to risk through economic integration with partner countries is therefore likely to depend on three factors: the geographical structure of exports, the volatility of markets that are served, and the correlation between the fluctuations in different partner countries.

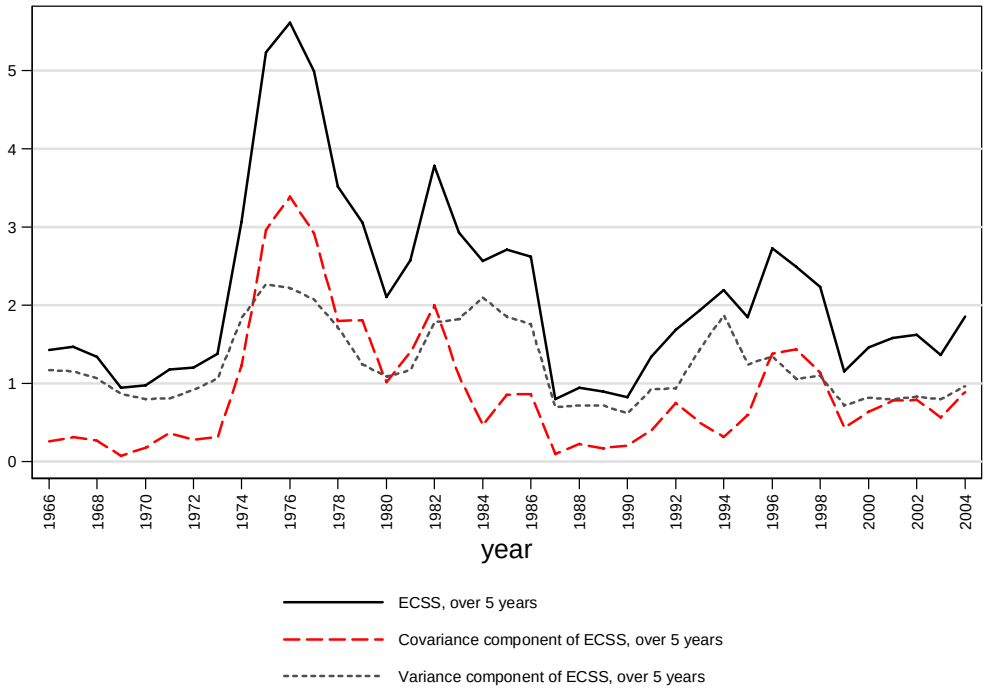
All these factors are taken into account in the following measure of country *i*'s "exposure to country-specific shocks" (ECSS):

$$ECSS_i = \sum_j \left(\frac{x_{i,j}}{Xi}\right)^2 \operatorname{var} GDPgrowth_j + \sum_j \sum_z \frac{x_{i,j}}{X_i} \frac{x_{i,z}}{X_i} \operatorname{cov}(GDPgrowth_j, GDPgrowth_z) \qquad (1)$$

The ECSS is the variance of the weighted average of the annual growth of all trading partners which can be expressed as in equation (1), where the first term on the right-hand side reflects the risk associated with variances of the growth rate of partner countries' GDP and the second term reflects the risk associated with the covariance of partner's GDP growth rate. Each variance and covariance is weighted by the importance of individual partner countries in country *i*'s export basket.

Figure 1 reflects how ECSS evolved, on average over five years, for our sample of countries over the period 1966–2004. Interestingly, the two highest picks of the covariance component are in the 1970s and early 1980s, two periods marked by oil crises. Therefore, peaks in the covariance could indicate that shocks affect large numbers of countries in the same way. This may generate a problem of endogeneity in our regressions that we will control for by including time fixed effects or oil-shocks dummies.

Figure 1: Average level of exposure to country specific shocks, 1966–2004



Source: Authors' calculations using GDP data from World Development Indicators (World Bank) and trade data from Comtrade.

Figure 2 and 3 illustrate how ECSS behaves for two individual countries: Singapore and Chile. Overall the pattern of ECSS looks quite differently in the two countries. Singapore's ECSS was clearly affected by the Asian financial crisis that started in 1997, while this is not really the case for Chile. This indicates that we may have to be careful about possible regional contagion effects in our regressions. We will, therefore, include region-time dummies in some of our specifications.

Appendix Table 1 reports ECSS-averages for different country groupings. It illustrates that low income countries are characterized by higher exposure to country specific shocks than middle income countries. The latter, in turn, are exposed to more external volatility than high income countries. The difference between middle and high income countries is much more pronounced than the difference between low and middle income countries. Values for standard deviations, minima and maxima also suggest that there are wide variations across countries and time.[7]

[7] These variations appear to be stronger in the case of ECSS than in the case of terms of trade (ToT).

Figure 2: Singapore's exposure to country specific shocks in trading partners, 1966–2004

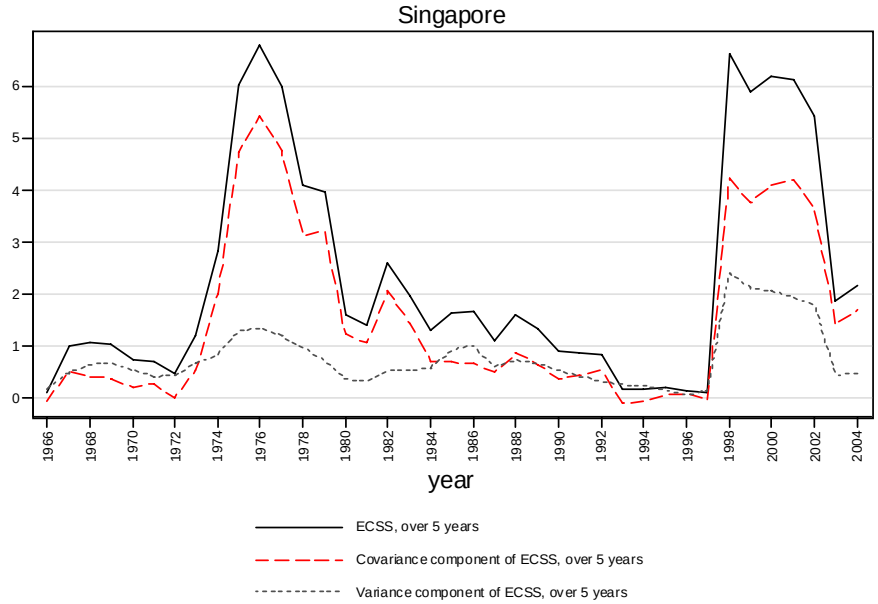
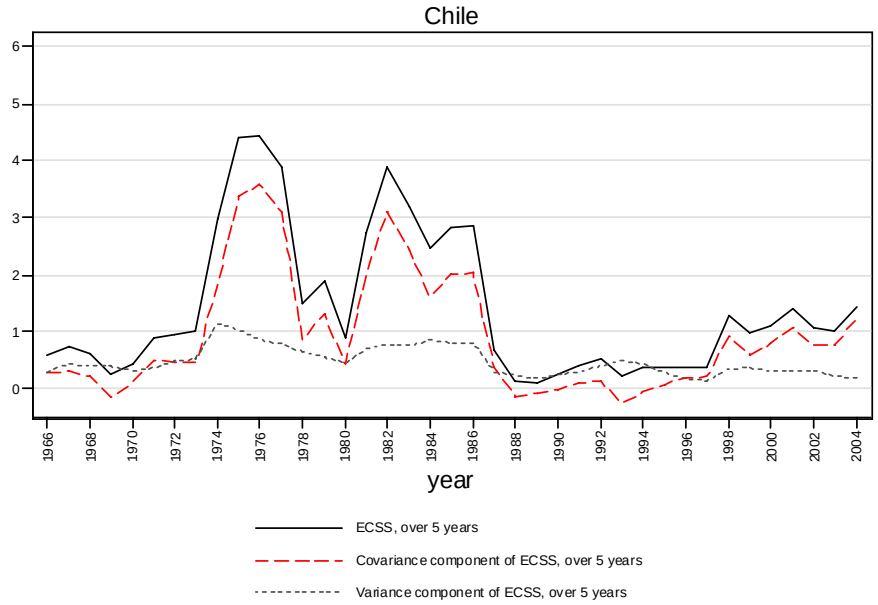


Figure 3: Chile's exposure to country specific shocks in trading partners, 1966–2004



4. Methodology and data

In our empirical analysis of external country specific shocks as a determinant of income volatility, we control for other external shocks, but also for domestic shocks, government policies that could attenuate or aggravate volatility and other country characteristics that may affect volatility.

The regression equation we estimate is of the following form:

$$GDPvol_{it} = \beta_0 + \beta_1 ECSS_{i,t} + \beta_2 CONTROL_{it} + \mu_i + \eta_t + u_{it} \qquad (2)$$

where *GDPvol* is the GDP volatility and it is calculated as the standard deviation of the growth rate of GDP, $ECSS_{i,t}$ is our main variable of interest, the variable denoting the overall exposure to country specific shocks, and $CONTROL_{i,t}$ is a vector of control variables. $u_{i,t}$ is the error term, μ_i and η_t are country and time dummies. Appendix Table 2 provides definition and sources for all the data used in our regressions. Appendix Table 3 provides sample statistics for all variables and Appendix Table 4 gives information on the correlation between the different included variables.

Most of existing economic literature on the determinants of income volatility has used terms of trade volatility as a measure external shocks. TOT fluctuations reflect changes in the prices of imports and exports and have, therefore, been traditionally linked to product specific shocks. But the variable may also be affected by country specific shocks. Demand shocks in large countries, for instance, may affect the world price of goods they export or import. We therefore control for TOT fluctuations in our regressions. Some studies have introduced external shocks interacted with openness in the regressions. We also allow for this possibility and in some specifications, we interact openness with our ECSS variable and TOT volatility to assess whether openness makes economies more or less responsive to external shocks. The results for these regressions are presented in the appendix (Appendix Tables 5a and 5b).

In addition, we control for other shocks associated with trade and capital flows by including exchange rate volatility. We include two types of domestic shocks in our regressions: civil wars and military interventions.[8] We control for two country characteristics that are standard variables in cross country regressions explaining GDP volatility: population and GDP per capita. Larger and wealthier countries are expected to be less volatile as they find it easier to dampen shocks.

Increased government expenditure could help to dampen external shocks along the line of the arguments presented in Rodrik (1998). We therefore include a measure for government expenditure in our regressions. Financial openness could help countries to dampen output fluctuations, but could also increase countries' exposure to external shocks. Existing evidence on the impact of financial openness on income volatility is not robust. Easterly, Islam and Stiglitz (2001) and Kose (2002) do not find a significant effect of financial openness on GDP volatility. Calderon et al. (2005) find negative effect of financial openness, but these results do not hold in all specifications. We include both variables in our regressions.[9]

All our regressions include country fixed effects. We do therefore not need to control for certain country specific characteristics that have been found to be relevant in the literature, like being landlocked (Malik and Temple, 2006) or being an oil exporter.

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[8] See, for example, Malik and Temple (2006).

[9] Note that financial openness, government expenditure and exchange rate volatility are only used in a selected number of regressions because they reduce sample size significantly.

We use panel regression analysis to assess the role of country specific external shocks as a determinant of domestic income volatility. Related papers, like Ahmed (2003) or Raddatz (2007), use a panel VAR approach to examine the effect of external shocks on domestic income. We do not follow this approach because of the level of diversity among countries in our sample. Given the length of the time series dimension of our data, we would need to assume that dynamics are common across countries in our sample in order to follow a VAR approach. If dynamics differ across countries –as it the case in our sample - we would end up underestimating (overestimating) the short-run (long-run) impact of exogenous variables by using the VAR approach (Pesaran and Smith, 1995).

5. Results

Columns 1-5 of Table 1 report the results of the estimation of equation (2) for the panel of 5 year averages, overlapping periods, using the panel estimations with exporter error clustering. To control for global shocks we use two alternative approaches. In columns 1 and 3 we use two oil dummies, covering the period of the first and second oil shock. These dummies are defined for the 5-year period after 1973 and 1979 respectively. In columns 2, 4 and 5 we use time fixed effects. We prefer the first alternative in order to avoid overextending the parameter requirements on the data. Throughout this paper we perform all tests with the overlapping and the non-overlapping sample. The former has the advantage of having significantly more observations, but it may suffer from stronger autocorrelation problems. Columns 6-10 of Table 1 replicate the regressions of the first five columns but with the non-overlapping sample.

The results show that countries' GDP volatility is positively affected by exposure to country specific shocks (ECSS). When we split ECSS into its variance and covariance components, the latter tends to have a large and more significant effect on income volatility. In general, we do not find significant results for terms of trade volatility as determinant of income volatility. But, this result is sensitive to the sample size. Population, military intervention and civil war are significant with the expected sign, but GDP per capita and openness are insignificant.

In the overlapping sample, ECSS becomes less significant when three additional controls – financial openness, government expenditure and exchange rate volatility – are introduced. Note that these three controls reduce our sample size significantly, from 3329 to 1280 observations. Of these three variables government expenditure turns out to be insignificant. Financial openness has a negative sign – i.e. dampens volatility – and is significant. Exchange rate volatility is highly significant with a positive sign.

The results for the regressions using the non-overlapping sample are very similar to the ones in the overlapping sample. ECSS remains significant at the 5 per cent level in all specifications. GDP per capita has once the expected negative sign and is significant. Openness is in one regression significant with a positive sign.

Table 1: Impact of ECSS on income volatility, 1966-2002

	5 years overlapping, cluster errors					5 years non overlapping, cluster errors				
	1	2	3	4	5	6	7	8	9	10
ECSS	0.162***	0.134**	0.101*	0.084#		0.254**	0.229**	0.148**	0.148**	
	[0.059]	[0.060]	[0.062]	[0.057]		[0.098]	[0.099]	[0.066]	[0.074]	
ECSS-variance					0.088***					0.079
					[0.028]					[0.064]
ECSS-covariance					0.351***					0.299**
					[0.110]					[0.136]
Government expenditure			0.07	0.05	0.075			0.022	0.01	0.022
			[0.047]	[0.051]	[0.048]			[0.038]	[0.039]	[0.038]
Financial Openness			-0.152	-0.082	-0.165*			-0.181*	-0.141	-0.195*
			[0.098]	[0.127]	[0.093]			[0.104]	[0.114]	[0.103]
Exchange Rate Volatility			0.004***	0.004***	0.004***			0.004***	0.004***	0.004***
			[0.001]	[0.001]	[0.001]			[0.001]	[0.001]	[0.001]
ToT volatility	0.004	0.006	0.019	0.021*	0.018	-0.004	0	0.017	0.02	0.018
	[0.008]	[0.008]	[0.012]	[0.013]	[0.012]	[0.010]	[0.010]	[0.013]	[0.014]	[0.013]
Military intervention	0.229	0.183	0.679**	0.627*	0.645**	0.347	0.311	0.671**	0.682**	0.626**
	[0.305]	[0.304]	[0.318]	[0.319]	[0.306]	[0.301]	[0.304]	[0.304]	[0.317]	[0.306]
Civil War	2.545***	2.469***	1.645***	1.680***	1.523***	3.642***	3.493***	1.395**	1.363**	1.400**
	[0.726]	[0.706]	[0.565]	[0.561]	[0.542]	[1.111]	[1.071]	[0.577]	[0.602]	[0.561]
Openness	0.781	1.413	0.188	0.532	0.212	1.097	1.867*	0.429	0.72	0.414
	[0.808]	[0.877]	[1.257]	[1.305]	[1.099]	[0.872]	[0.975]	[0.963]	[0.966]	[0.896]
GDP per capita	0	0	0	0	0	-0.000*	0	0	0	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Population	-0.000***	-0.000***	-0.000***	0	-0.000***	-0.000***	-0.000***	-0.000**	-0.000*	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
oil73	0.161		0		0	-0.037		0		0
	[0.285]		[0.000]		[0.000]	[0.489]		[0.000]		[0.000]
oil79	0.769**		0.31		0.066	0.523		0.09		-0.028
	[0.301]		[0.254]		[0.266]	[0.322]		[0.352]		[0.348]
Year fixed effects	NO	YES	NO	YES	NO	NO	YES	NO	YES	NO
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Constant	2.720***	2.423***	0.897	0.81	0.754	2.371***	0.618	1.755	1.126	1.815
	[0.503]	[0.552]	[1.348]	[1.350]	[1.349]	[0.559]	[0.900]	[1.116]	[1.198]	[1.103]
Observations	3329	3329	1280	1280	1280	714	714	279	279	279
Number of countries	138	138	74	74	74	136	136	72	72	72
R-sq: overall	0.09	0.08	0.05	0.04	0.05	0.12	0.13	0.05	0.05	0.05
R-sq: within	0.1	0.12	0.14	0.16	0.16	0.18	0.2	0.15	0.16	0.15
R-sq: between	0.12	0.07	0.06	0.01	0.07	0.15	0.13	0.05	0.04	0.05
Rho	0.6	0.62	0.62	0.58	0.66	0.58	0.58	0.6	0.56	0.64

Note: ***, **, *, # denote level of significance at 1, 5, 10 and 15 % respectively.

Our regressions explaining income volatility may suffer from endogeneity problems. First, endogeneity problems may arise because of a spurious relationship, for instances when a shock hits exporters' income and their trading partners' income at the same time and in a same direction. A second source of endogeneity can arise when a country is big enough to directly affect the income of its partner and in this way to generate a reversal causality problem. To control for the first source of endogeneity we include Oil crisis dummies and region-time dummies in order to account for global and regional shocks. finally , in order to control for second source of endogeneity we reduce our sample to include only low and middle income countries.

Table 2 shows the results, rows 1-4 for the overlapping sample and rows 5-8 for the non-overlapping sample. Column 1 and 2 can be compared with column 1 of Table 1. Column 1 and 5 of Table 2 show results after introducing region time dummies. Column 2 and 6 after excluding developed countries from the sample. In order to avoid overextending the parameter requirements on the data we excluded from our regressions the controls that significantly reduce our sample size. The ECSS variable remains significant when including region-time dummies and also when reducing the sample to low and middle income countries. The variable continues to have the expected positive sign but tends to be somewhat lower. This holds for the overlapping and the non-overlapping sample. Using equation (1), in columns 3, 4, 7 and 8, ECSS is split into its variance and covariance components. As in table 1 the results suggest that the covariance component is the most important factor in determining income volatility.

Table 2: Estimations including regional-time dummies and for low-middle income countries

	5 years overlapping				5 years non overlapping			
	1	2	3	4	5	6	7	8
	Region time dummies	Region time and low middle income	Region time dummies	Region time and low middle income	Region time dummies	Region time and low middle income	Region time dummies	Region time and low middle income
ECSS	0.118*	0.110*			0.219**	0.213**		
	[0.063]	[0.062]			[0.107]	[0.107]		
ECSS-variance			0.026	0.022			-0.087	-0.098
			[0.043]	[0.045]			[0.059]	[0.064]
ECSS covariance			0.428***	0.436***			0.751***	0.776***
			[0.125]	[0.128]			[0.223]	[0.227]
ToT volatility	0.003	-0.001	0.001	-0.004	-0.003	-0.009	-0.003	-0.01
	[0.008]	[0.011]	[0.008]	[0.010]	[0.012]	[0.018]	[0.012]	[0.018]
Military intervention	0.146	0.078	0.111	0.001	0.291	0.115	0.193	-0.015
	[0.336]	[0.422]	[0.340]	[0.423]	[0.341]	[0.461]	[0.366]	[0.488]
Civil war	2.485***	2.504***	2.226***	2.230***	3.630***	3.643***	3.194***	3.170***
	[0.720]	[0.740]	[0.703]	[0.727]	[1.111]	[1.149]	[1.015]	[1.055]
Openness	1.251	1.427	1.161	1.356	1.799*	2.117	1.594*	1.865
	[0.872]	[1.152]	[0.822]	[1.107]	[0.987]	[1.349]	[0.881]	[1.211]
GDP per capita	0	0	0	0	0	0	0	0
	[0.000]	[0.001]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]
Population	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
oil73	0.468	0.681**	-0.066	1.593	-1.953***	-0.26	-3.440***	-1.395*
	[0.781]	[0.297]	[0.767]	[1.145]	[0.684]	[0.652]	[0.818]	[0.809]
oil79	0.042	-0.234	0.612	0.37	-1.198***	0.827	-1.599***	0.445
	[0.656]	[1.108]	[0.614]	[0.414]	[0.311]	[0.578]	[0.313]	[0.350]
Country fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Constant	2.049**	1.669*	2.197***	0.893	2.639***	2.673**	2.782***	2.916**
	[0.922]	[0.992]	[0.829]	[1.588]	[0.718]	[1.290]	[0.623]	[1.126]
Observations	3329	2412	3329	2412	714	517	714	517
Number of countries	138	108	138	108	136	107	136	107
R-sq: overall	0.1	0.08	0.13	0.07	0.15	0.11	0.2	0.17
R-sq: within	0.17	0.19	0.19	0.21	0.23	0.24	0.28	0.29
R-sq: between	0.06	0.02	0.08	0.03	0.1	0.1	0.16	0.18
Rho	0.63	0.63	0.63	0.64	0.62	0.57	0.6	0.55

Note: ***, **, * denote level of significance at 1, 5 and 10 % respectively.

We use two additional approaches to control for a possible endogeneity problem in our panel regressions. First, we change the estimation method and use the generalized method of moments (GMM) for dynamic models of panel data developed by Arellano and Bond (1991). Second we instrument ECSS by the inverse of the number of trading partners. We expect that countries with a larger variety of trading partners will be less exposed to external country specific risk, because they find it easier to mitigate the impact of demand shocks in individual trading partners. This takes place through two channels: First, with a larger variety of partners, each individual partner matters less for overall exports, and exports become less volatile by the law of large numbers. Second, whenever a shock hits a particular partner, firms can adjust by redirecting exports to other partners to partially offset the shock.

Table 3 shows the results of the GMM and the instrumental variable regressions, again for overlapping and non-overlapping samples. The GMM regressions confirm our previous results as ECSS is always significant in both the overlapping and the non-overlapping samples. When instrumenting ECSS with the inverse of number of trading partners the ECSS is significant at the one per cent level in the overlapping sample. It is significant at the five per cent level in the larger non-overlapping sample, but it loses significance when using a smaller sample. Our instrument, however, always has the expected sign and is significant at the one per cent level in the first stage regression. In other words, the results suggest that there is a role for geographical diversification of exports to help reduce income volatility

Table 3: GMM and Instrumental variable estimations

	overlapping				non overlapping			
	Dynamic GMM	Dynamic GMM	Instrumental Variable (inverse N partners)	Instrumental Variable (inverse N partners)	Dynamic GMM	Dynamic GMM	Instrumental Variable (inverse N partners)	Instrumental Variable (inverse N partners)
ECSS	0.027*	0.034**	0.817***	0.829***	0.362***	0.174**	0.660**	0.284
	[0.014]	[0.015]	[0.259]	[0.235]	[0.053]	[0.080]	[0.294]	[0.309]
Government expenditure		0.050***		0.021		0.116**		0.017
		[0.019]		[0.032]		[0.058]		[0.046]
Financial Openness		0.001		0.133		-0.139		-0.111
		[0.069]		[0.131]		[0.199]		[0.196]
Exchange Rate Volatility		0.002**		0.004***		0.002		0.004***
		[0.001]		[0.001]		[0.003]		[0.001]
ToT Volatility	-0.008**	-0.001	0.001	0.022**	0.003	0.006	-0.007	0.016
	[0.004]	[0.004]	[0.006]	[0.009]	[0.011]	[0.012]	[0.010]	[0.011]
Military Intervention	-0.245	0.191	0.256	0.783***	0.985*	0.773	0.435	0.726*
	[0.172]	[0.184]	[0.182]	[0.267]	[0.504]	[0.588]	[0.384]	[0.414]
Civil war	1.304***	0.359	2.471***	3.287**	3.256***	1.154	3.144***	1.424***
	[0.226]	[0.276]	[0.463]	[1.279]	[0.633]	[0.870]	[1.106]	[0.520]
Openness	-1.024**	-1.633***	0.710*	0.825	1.488	0.501	0.734	0.452
	[0.457]	[0.474]	[0.375]	[0.547]	[1.179]	[1.309]	[0.779]	[1.102]
GPD per capita	0.000***	0.000*	-0.000***	0	-0.000**	0	-0.000*	0
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Population	-0.000*	-0.000**	-0.000***	-0.000*	-0.000*	0	-0.000***	-0.000**
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
oil73	0.278***		-1.848**		-0.457		-1.63	
	[0.106]		[0.786]		[0.381]		[1.197]	
oil79	0.414***	0.302***	-0.265	-0.593*	0.352	0.243	0.072	0.007
	[0.096]	[0.106]	[0.420]	[0.330]	[0.321]	[0.334]	[0.431]	[0.348]
Lagged volatility	0.707***	0.982			-0.189***	-0.005		
	[0.014]	[0.599]			[0.071]	[1.831]		
First stage regression: number of partners (inv.)			99.867***	137.24***			186.23***	210.72***
			[22.117]	[33.173]			[63.347]	[70.551]
Year fixed effects	NO	NO	NO	NO	NO	NO	NO	NO
Country fixed effects	NO	NO	YES	YES			YES	YES
Constant	1.152***	0.522***			3.126***	-0.126		
	[0.268]	[0.018]			[0.860]	[0.085]		
Observations	3152	1192	3329	1280	484	196	700	267
Number of countries	138	74	138	74	111	59	122	60
F-test			20.39	17.12			8.64	8.92

Note: ***, **, * denote level of significance at 1, 5 and 10 % respectively.

6. Conclusions

This paper contributes to the literature examining the effect of external shocks on domestic volatility by focusing on the role of demand shocks in partner countries. Recent contributions to the theoretical trade literature, however, emphasize the existence of fixed costs related to entry into new markets. In the presence of such fix costs, the re-direction of exports is costly and may take time. To whom countries export and how much, would in such a context matter when it comes to the need to adjust to country specific shocks.

We measure exposure to foreign demand shocks by GDP volatility in partner countries. Using panel regression analysis, our findings confirm that this measure consistently has a positive and significant impact on exporters' GDP volatility. When decomposing out this measure in a variance and a covariance component, we find that the correlation between trading partners' cycles is more important in explaining exporters' GDP volatility than the size of cycles in individual trading partners. We also show that geographical diversification is a significant determinant of countries' exposure to country specific shocks. Traditionally, empirical research and policy advisers have stressed the importance of diversify the range of commodity exported to reduce exposure to external shocks (Lee, Perry, and Birdsall, 2008). Our findings suggest that geographical diversification of exports deserves the same place on policy makers' agendas as product diversification

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Appendix

Table A.1: Sample statistics for main variables and different country groupings

Country group	variable	mean	min	max	sd	N
Total	ToT volatility	10.14	0.00	156.72	12.97	3281
High income	ToT volatility	5.05	0.13	156.72	10.85	917
Middle income	ToT volatility	10.08	0.00	78.38	10.85	1511
Low income	ToT volatility	15.71	0.10	104.10	15.93	853
Total	ECSS	2.13	0.02	71.34	3.23	3281
High income	ECSS	1.57	0.04	8.47	1.58	917
Middle income	ECSS	2.23	0.02	51.61	3.26	1511
Low income	ECSS	2.55	0.05	71.34	4.25	853
Total	ECSS-covariance	0.93	-13.27	24.58	1.55	3281
High income	ECSS-covariance	0.94	-0.86	6.79	1.09	917
Middle income	ECSS-covariance	0.93	-6.52	24.58	1.81	1511
Low income	ECSS-covariance	0.92	-13.27	13.04	1.48	853
Total	ECSS-variance	1.20	0.04	84.62	2.55	3281
High income	ECSS-variance	0.63	0.04	6.61	0.83	917
Middle income	ECSS-variance	1.30	0.06	32.80	1.98	1511
Low income	ECSS-variance	1.63	0.04	84.62	4.11	853

Note: Five year overlapping variables, all observations

Table A.2: Description of main variables and their sources

VARIABLE	DESCRIPTION	SOURCE
GDP volatility	Standard deviation of the growth rate of GDP at constant prices	WDI
ToT volatility	Standard deviation of the terms of trade index.	New York University
ECSS (Exposure to Country Specific Shocks)	$\sum_j (\frac{x_{i,j}}{Xi})^2 \operatorname{var} GDPgrowth_j + \sum_j \sum_z \frac{x_{i,j}}{X_i} \frac{x_{i,z}}{X_i} \operatorname{cov}(GDPgrowth_j, GDPgrowth_z)$ Variance of the growth rate of the demand for exports	WDI and COMTRADE
ECSS-covariance	Covariance component of ECSS, $\sum_j \sum_z \frac{x_{i,j}}{X_i} \frac{x_{i,z}}{X_i} \operatorname{cov}(GDPgrowth_j, GDPgrowth_z)$	
ECSS-variance	Variance component of ECSS, $\sum_j (\frac{x_{i,j}}{Xi})^2 \operatorname{var} GDPgrowth_j$	
Openness	Exports plus imports divided by GDP. All variables are in current prices, mean over 5 years	WDI
Military Intervention	Milit. disp. w/level o Hostility>2 (At least one dispute in the span of 5 years)	from the Correlates Of War (COW) project web http://www.correlatesofwar.org/
Civil War	Civil war (At least one event in the span of 5 years).	Martin, P., T. Mayer and M. Thoenig, 2008, "Civil Wars and International Trade", *Journal of the European Economic Association* 6(2-3)
GDP per capita	GDP per capita (constant 2000 US$), mean over 5 years.	World development Indicators (WDI), World Bank.
Population	mean over 5 years.	World development Indicators (WDI), World Bank.
Government expenditure	Government expenditure share of the real GDP, mean over 5 years.	Penn world tables
Financial Openness	Financial openness index, mean over 5 years	A New Measure of Financial Openness," mimeo (May 2007), (with Hiro Ito) http://www.ssc.wisc.edu/~mchinn/research.html
Exchange Rate Volatility	Standard deviation of the real effective exchange rate index	IMF, IFS database

Appendix Table 3: Sample statistics for all variables

variable	mean	p50	min	max	sd	Number of observations
GDP volatility	3.37	2.55	0.19	52.07	3.14	3281
ToT volatility	10.14	6.19	0.00	156.72	12.97	3281
ECSS	2.13	1.16	0.02	71.34	3.23	3281
ECSS-covariance	0.93	0.49	-13.27	24.58	1.55	3281
ECSS-variance	1.20	0.57	0.04	84.62	2.55	3281
Openness	0.64	0.56	0.08	3.69	0.36	3281
Disasters	2.67	3.00	0.00	5.00	1.81	3281
Military Intervention	0.25	0.00	0.00	1.00	0.43	3281
Civil War	0.09	0.00	0.00	1.00	0.28	3281
GDP per capita	5464.55	1780.52	94.84	41028.46	7596.46	3281
Population	3.76E+07	8.32E+06	4.08E+04	1.26E+09	1.20E+08	3281
Government expenditure	21.67	19.81	5.31	67.84	9.38	1280
Financial Openness	0.09	-0.18	-1.80	2.54	1.43	1280
Exchange Rate Volatility	17.71	6.11	0.33	1573.18	94.91	1280

Note: Statistics are provided for sample sizes used in regressions, i.e. 3281 without controls, and 1280 when three additional controls are added, five year overlapping.

Appendix Table 4: Correlations between main variables, regression samples, five-year overlapping

	GDP volatility	ToT volatility	ECSS	ECSS-covariance	ECSS-variance	Openness	GDP per capita	Population	Government expenditure	Financial openness	Exchange rate volatility	Military Intervention	Civil War
GDP volatility	1												
ToT volatility	0.14	1.00											
ECSS	0.26	0.10	1.00										
ECSS-covariance	0.26	0.13	0.63	1.00									
ECSS-variance	0.17	0.05	0.88	0.19	1.00								
Openness	0.09	-0.11	0.01	0.01	0.00	1.00							
IDP per capita	-0.25	-0.24	-0.13	-0.02	-0.15	0.07	1.00						
Population	-0.08	-0.04	-0.03	-0.01	-0.04	-0.24	-0.02	1.00					
Government expenditure	0.17	0.02	0.16	0.04	0.18	0.21	-0.20	0.05	1.00				
Financial Openness	-0.18	-0.17	-0.04	-0.02	-0.03	0.22	0.58	-0.06	-0.10	1.00			
Exchange Rate Volatility	0.10	0.16	0.03	0.04	0.01	-0.14	-0.10	0.00	-0.02	-0.13	1.00		
Military Intervention	0.04	0.02	-0.01	0.00	-0.01	-0.20	0.02	0.27	0.12	-0.04	0.07	1.00	
Civil War	0.15	0.07	0.04	0.06	0.02	-0.147	-0.18	0.12	0.01	-0.16	0.03	0.07	1.00

Appendix Table 5a: Interacting external shocks with openness (5 years overlapping)

	Overlapping sample					
	Panel regression, cluster errors				Dynamic GMM	Instrumental variable (inverse number partners as instrument)
ECSS	-0.081	-0.099	-0.147**	-0.153**	-0.069**	-0.215
	[0.067]	[0.065]	[0.064]	[0.066]	[0.028]	[0.326]
Openness*ECSS	0.403***	0.390***	0.585***	0.571***	0.153***	1.982***
	[0.142]	[0.142]	[0.173]	[0.193]	[0.039]	[0.593]
ToT volatility	-0.011	-0.01	-0.012	-0.01	-0.002	0.03
	[0.019]	[0.018]	[0.030]	[0.030]	[0.010]	[0.020]
Openness*ToT volatility	0.025	0.024	0.052	0.051	-0.01	-0.059
	[0.035]	[0.035]	[0.056]	[0.055]	[0.016]	[0.039]
Openness	-0.255	0.409	-1.656	-1.316	-1.415***	-2.852***
	[0.814]	[0.843]	[1.141]	[1.221]	[0.500]	[1.035]
Government expenditure			0.062	0.046		
			[0.045]	[0.050]		
Financial openness			-0.114	-0.057		
			[0.089]	[0.113]		
Exchange rate volatility			0.004***	0.004***		
			[0.001]	[0.001]		
oil73	0.175		0		0.288***	-2.271***
	[0.253]		[0.000]		[0.106]	[0.825]
oil79	0.733**		0.151		0.418***	-0.676
	[0.292]		[0.242]		[0.095]	[0.462]
Lagged volatility					0.697***	
					[0.014]	
Year fixed effects	NO	YES	NO	YES	NO	NO
Country fixed effects	YES	YES	YES	YES	NO	YES
Constant	3.292***	3.030***	2.115	1.923	1.377***	
	[0.452]	[0.471]	[1.292]	[1.273]	[0.289]	
Observations	3329	3329	1280	1280	3152	3329
Number of countries	138	138	74	74	138	138
R-sq: overall	0.1	0.09	0.05	0.04		
R-sq: within	0.12	0.14	0.18	0.2		
R-sq: between	0.16	0.1	0.11	0.08		
Rho	0.6	0.62	0.65	0.61		
F-test (varcov)						8.98
F-test (Open varcov)						10.72

Appendix Table 5b: Interacting external shocks with openness (5 years non overlapping)

	Non-overlapping sample					
	Panel regression, cluster errors				Dynamic GMM	Instrumental variable (inverse number partners as instrument
ECSS	-0.101	-0.12	-0.14	-0.156	-0.136	0.424
	[0.081]	[0.079]	[0.130]	[0.132]	[0.113]	[0.463]
Openness*ECSS	0.517**	0.507**	0.521**	0.547**	0.662***	0.398
	[0.202]	[0.199]	[0.223]	[0.236]	[0.136]	[0.532]
ToT volatility	-0.019	-0.016	-0.025	-0.021	-0.003	-0.02
	[0.023]	[0.023]	[0.036]	[0.036]	[0.029]	[0.027]
Openness*ToT volatility	0.025	0.025	0.07	0.068	0.013	0.02
	[0.042]	[0.042]	[0.059]	[0.059]	[0.045]	[0.044]
Openness	-0.361	0.463	-1.65	-1.468	-0.279	-0.432
	[0.861]	[0.931]	[1.108]	[1.172]	[1.232]	[1.210]
Government expenditure			0.021	0.012		
			[0.040]	[0.039]		
Financial openness			-0.152	-0.131		
			[0.108]	[0.114]		
Exchange rate volatility			0.004***	0.004***		
			[0.001]	[0.001]		
oil73	0.158		0		-0.063	-1.628
	[0.386]		[0.000]		[0.374]	[1.123]
oil79	0.554*		-0.025		0.435	0.054
	[0.309]		[0.330]		[0.310]	[0.410]
Lagged volatility					-0.202***	
					[0.067]	
Year fixed effects	NO	YES	NO	YES	NO	NO
Country fixed effects	YES	YES	YES	YES	NO	YES
Constant	3.191***	1.414*	3.002**	2.442*	4.175***	
	[0.497]	[0.830]	[1.259]	[1.402]	[0.848]	
Observations	714	714	279	279	484	700
Number of countries	136	136	72	72	111	122
R-sq: overall	0.16	0.15	0.05	0.05		
R-sq: within	0.22	0.24	0.18	0.19		
R-sq: between	0.19	0.16	0.07	0.06		
Rho	0.58	0.59	0.64	0.62		
F-test (varcov)						4.87
F-test (Open varcov)						4.72

Note: Military intervention, civil war, GDP per capita and population were included in the regressions, but are not reported in tables 5a and 5b. ***, **, * denote level of significance at 1, 5 and 10 % respectively.