The Economic Complexity Index (ECI) and economic shocks: Developed vs developing countries[1]

Marthinus C Breitenbach, Carolyn Chisadza, and Matthew Clance[2]

Abstract

In this study, we contribute to the empirical literature by introducing a relatively new index on economic complexity, the Economic Complexity Index (ECI) developed by Hausmann et al. (2011). ECI measures the productive capabilities of countries by explaining the knowledge accumulated in a population based on the goods they produce and export and to which countries they export. As such, not only does this measure capture diversification but also the technology embedded in the products. Using panel data analysis for a cross section of countries from 1970 to 2015, we find that countries with higher ECI have reduced output volatility. Further disaggregation by regions reveals that economic complexity in Asia is relatively better at reducing output volatility than that in Africa. The difference between the two regions could be due to the Africa's primary production and exports being in relatively homogenous goods with no differentiation and subject to the volatility of world markets.

[1] First draft prepared for the Biennial Conference of The Economic Society of South Africa, Johannesburg. 3-5 September 2019.

[2] University of Pretoria – Corresponding author martin.breitenbach@up.ac.za

1. Introduction

Around 2006, research was started around the idea of product space – the view of economic development of countries as a process of discovering which products a country can master; also called self-discovery. In other words, research that would provide a deeper understanding of the relationship between a country's ability to produce certain products and its potential to grow and develop. This research that was started among others, by Ricardo Hausmann, César Hidalgo, Albert-Laszlo Barabasi and Baily Klinger, and they were later joined by Dani Rodrik and Jason Hwang. A number of different implications around the basic approach were explored in subsequent papers by these and other authors, but it culminated in the seminal Atlas of Economic Complexity by Hausmann, Hidalgo, et.al (2011). Hausmann and Hidalgo propose the concept of an Economic Complexity Index (ECI) not only as a descriptive measurement tool, but also as predictive for economic growth. According to the models presented in their Atlas of Economic Complexity (2011), the ECI is a more accurate predictor of GDP per capita growth than traditional measures of governance, competitiveness (World Economic Forum's Global Competitiveness Index) and human capital (as measured in terms of educational attainment).

To be more exact, their research clearly shows that if there is a positive gap between ECI and GDP per capita, this will lead to accelerated growth in GDP per capita. ECI represents the broadest possible measure of a country's productive capabilities – much broader than any other measure of export diversity. For this reason, we opted to investigate the idea that countries that have larger amounts of productive knowledge embedded in it, in other words more complex economies, would better be shielded against output shocks. Put differently, we investigate the relationship between ECI and GDP volatility. We do this by separating developed and developing countries.

2. Literature review

Output volatility has been shown to have serious implications. Ramey and Ramey (1995) have shown that countries with higher output volatility have a tendency to grow more slowly. It is the sources of output volatility that is not well understood. A number of papers focus on the sources of output volatility and explore terms-of-trade volatility, the degree of openness to trade, and country size (see Malik and Temple (2006), Jansen (2004), Easterly and Kraay (2000), and Rodrik (1997)). Researchers have also considered other sources of volatility. Malik and

Malik and Temple (2006) distinguish three strands in the literature in addition to the one that is concerned with external sources. These emphasise the role of governance (domestic policy mismanagement resulting in high inflation, overvalued exchange rates or sustained budget deficits), the role of the financial sector and the role of institutional and political factors. There is some evidence that democracy is associated with less volatility than autocracy, both across countries and over time.

Malik and Temple (2006) use Bayesian methods to examine the structural determinants of output volatility. They find that terms-of-trade volatility explains output volatility regardless of the choice of conditioning variables, which supports the view that external shocks are paramount in explaining volatility in poorer countries. They also find that export diversification has substantial explanatory power even though it is lower than that of terms of trade volatility.

Among all the variables that have strong explanatory power, all can be related to trade and external shocks. Bacchetta, et al. (2007), focus on the external sources of volatility. They pay special attention to determine whether diversification affects developed and developing economies in different ways. They also distinguish between product and geographic diversification and find that for lower income countries product differentiation (export concentration in terms of product basket) plays an important role in income volatility. For richer countries, product diversification plays a smaller role and geographical diversification (level of diversification of their export markets), plays a more significant role in determining income volatility.

Numerous papers also investigate the higher volatility in some countries (regions) relative to other countries. These fall mainly in two broad categories. The first of these is that developing countries are subject to larger shocks than developed countries (Mendoza, 1995; Koren and Tenreyro, 2006; Imbs and Wacziarg, 2003; Uribe and Yue, 2006), and the second, that countries are more vulnerable to these shocks because government policy or structural characteristics (such as the degree of financial development or labor regulations) tend to amplify the real effects of shocks in developing countries whereas in developed countries they help to mitigate aggregate instability (Caballero and Krishnamurty, 2001; Fatas and Mihov, 2006). Radatz (2008), looks at the ability of these two types of explanations to account for differences in volatility between Latin America compared and other groups of countries. They determine, in other words, the contribution of the volatility of external shocks (exposure) and of the responsiveness of output to these shocks (vulnerability) to the level of output volatility observed in Latin America and other regions. They use a comprehensive set of real and financial external shocks and find that higher output volatility of Latin America relative to countries in East Asia and Pacific, Western Europe, or High Income countries in general, is mainly driven by higher volatility of external shocks (i.e. a higher exposure), and not by a higher vulnerability to them.

Khrishna and Levchenco (2009) attempts to explain the central concept driving the linkage between trade openness, specialization, and volatility in terms of the complexity of goods being produced. Complexity is defined by them as the number of different inputs required for the production of one unit of the good (as in Becker and Murphy 1992). They show that sectoral output volatility depends on the complexity of goods produced in that sector. This is because when individual inputs to production are subject to shocks, the volatility of output will depend on how many such inputs there are. In particular, the more complex goods are less volatile, as the production in a sector that uses many inputs will be less affected, on average, by shocks to any particular input (a point also emphasized by Koren and Tenreyro 2008). In summary, they find that less developed countries with low levels of human capital, or alternately, with lower institutional ability to enforce contracts, will specialize in less complex goods which are also characterized by higher levels of output volatility.

In this paper, we build on the work of these authors and especially the work by Khrishna and Levchenco (2009) by investigating the link between economic complexity and output volatility. Our contribution to the literature is that we make the first attempt at investigating the link between ECI (the economic complexity index developed by Hausmann and Hidalgo, et. al., 2011) and output volatility for both developed and developing countries. The next section is devoted to briefly explain the ECI.

3. The Economic Complexity Index (ECI)

The ECI developed by Hausmann and Hidalgo, et al. (2011) looks to essentially explain the differences that arise in level of income of countries by the differences in the knowledge accumulated in a countries' population; which is expressed in a countries' industrial composition or complexity. According to Hausmann and Hidalgo, ultimately, the complexity of an economy is related to the multiplicity of useful knowledge embedded in it. With some exception, countries with high GDP per capita tend to be complex and countries with low GDP per capita have low complexity. The ECI combines metrics of the diversity of countries and the ubiquity of products to create measures of the relative complexity of a countries' exports. Diversity is related to the number of products a country is connected to, in other words the number of different products that a country exports. Ubiquity is related to the number of countries that a product is connected to, in other words, how many other countries export the same products. If many other countries export the same product as country A, then country A has a high ubiquity. As the index is based on export data, the easiest way to explain this, is by using the example of Singapore and Pakistan by Hausmann and Hidalgo.

The population of Pakistan is 34 times larger than that of Singapore. At market prices their GDPs are similar and therefore Singapore is 38 times richer than Pakistan in per capita terms. They both export a similar number of different products, about 133. Why are their levels of development so different? How can products tell us about this? Pakistan exports products that are on average exported by 28 other countries, while Singapore exports products that are exported on average by 17 other countries. Moreover, the products that Singapore exports are exported by highly diversified countries, while those that Pakistan exports are exported by poorly diversified countries. Their mathematical approach creates measures that approximate the amount of productive knowledge held in each of these countries. Ultimately, what countries make reveals what they know. Increased complexity is necessary for society to be able to hold and use larger amounts of productive knowledge.

In its strict mathematical definition, the ECI is defined in terms of an eigenvector of a matrix connecting countries to countries, which is a projection of the matrix connecting countries to the products they export. Since the ECI considers information on the diversity of countries and the ubiquity of products, it is able to produce a measure of economic complexity containing information about both the diversity of a country's export and their sophistication.

As said earlier in this paper, we build on the work of earlier work, among them Khrishna and Levchenco (2009) by investigating the link between economic complexity and output volatility.

4. Empirical Analysis

4.1 Data and Methodology

The specification of our base model is:

$$Y_{it} = \alpha_i + \delta_t + \beta_1 ECI_{it-1} + \beta_i \boldsymbol{X}_{it-1} + \mu_{it}$$

where Y is output volatility in GDP per capita in country i in year t, ECI is the Economic Complexity Index, X is a vector of controls, and α and δ are country and year fixed effects. The dependent variable (*Y*) is the output volatility calculated as the squared standard deviation of the logged difference of the real gross domestic product at constant 2010 US$ between 1964 and 2016.[3] The variable $\boldsymbol{X}$ is a vector that includes trade openness (exports and imports as a percentage of GDP), general government final consumption expenditure as a percentage of GDP, and inflation measured as the annual percentage of consumer prices. These variables, including GDP, are obtained from the World Development Indicators and are logged. We also include an institutional variable, the constraints on the executive, from the Polity IV Project. It measures the checks and balances on the executive or the extent of institutionalized constraints on the decision-making powers of chief executives, whether individuals or collectivities. A seven-category scale is used: 1 (unlimited authority of the decision-making body) to 7 (executive parity, i.e. the accountability of the executive i.e. groups have effective control over the executive). The index is normalised to range between zero and one.

The main explanatory variable is the economic complexity index (*ECI*). Economic complexity is a measure of the knowledge in a society that gets translated into the products it makes. A country is considered 'complex' if it exports not only highly complex products (determined by the Product Complexity Index), but also a large number of different products. For example, the heterogeneity between the economies of Germany and South Africa goes beyond differences in area, population size or policies. The South African economy has different inputs (productive capability) that can be used to produce a different mix of outputs compared to Germany.

However, measuring such different and complex productive capabilities is difficult. As such, Hausmann et al. (2014) propose using a proxy, called the *Economic Complexity Index*, which tries to measure capabilities indirectly by looking at the mix of products that countries export[4]. The ECI takes data on exports, and reduces a country's economic system into two dimensions: (i) The 'diversity' (i.e. the number) of products in the export basket, and (ii) the 'ubiquity' of products in the export basket (i.e. is the number of countries that are able to export a product competitively). The least complex countries, at the bottom of the ECI rank, are those that export few different types of products (i.e. have export baskets that are not diversified) and those products that they do export are produced in many other countries. Therefore, a country like Germany ranks high in economic complexity, because it exports many different kinds of sophisticated things that are only produced by a handful of other countries with similarly diversified productive capacities. As a result, the ECI in effect captures significantly more

[3] The specific method is estimating

$$\Delta \ln(RGDPpc) = \ln(GDPpc)_{t-1} + \ln(GDPpc)_{t-2} + \ln(GDPpc)_{t-3}$$

and predicting the residual which is then squared.

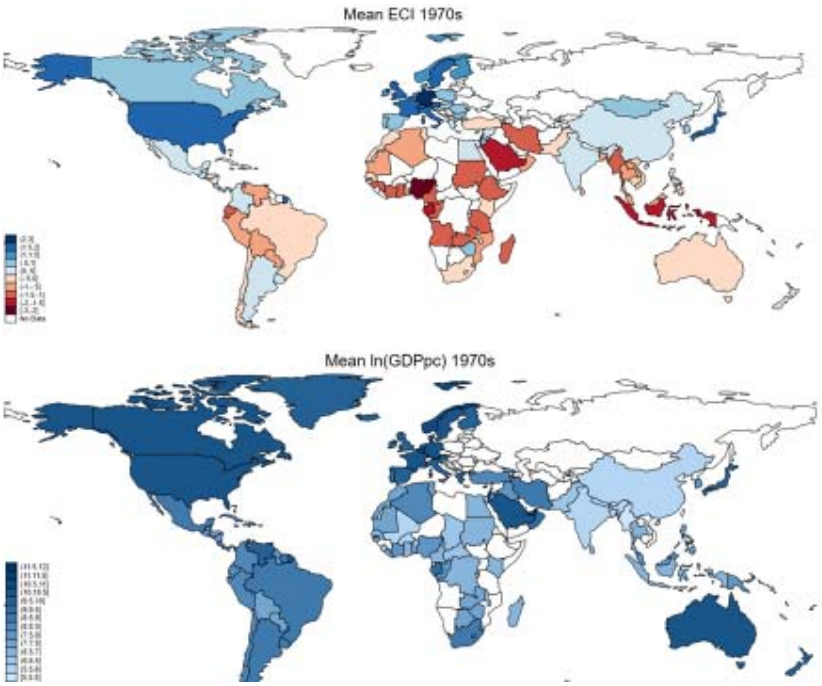
[4] The assumption is that productive capabilities determine the number and quality of products that a country can export; so export bundles tell us something about the underlying productive capabilities. For example, we might infer that Germany and Japan have similar productive capabilities, because they are both able to produce a similar set of goods.

growth-relevant information, such as human capital and technology capabilities than traditional export diversification measures, such as terms of trade shocks. All explanatory variables are lagged by one year to allow for delays in the changes of the observed variables on output volatility[5].

4.2 Descriptive Statistics

A brief overview of the data in Figure 1a and 1b highlights that countries with relatively higher levels of economic complexity tend to have higher levels of income per capita. Evidence by Hausmann et al. (2014) shows that there is a robust and positive correlation between the ECI and GDP per capita. The data also highlights that countries can move from high levels to low levels of productive capabilities. For example, Argentina in South America and Zimbabwe in Southern Africa both had higher levels of economic complexity in the 1970s, which corresponded with relatively high incomes per capita. However, both these countries suffered reversals in their productive capabilities such that today they have low economic complexity, also coinciding with delays in their levels of income per capita. Both these countries underwent economic and political crises, which may have contributed to the reversal in their economic complexity.

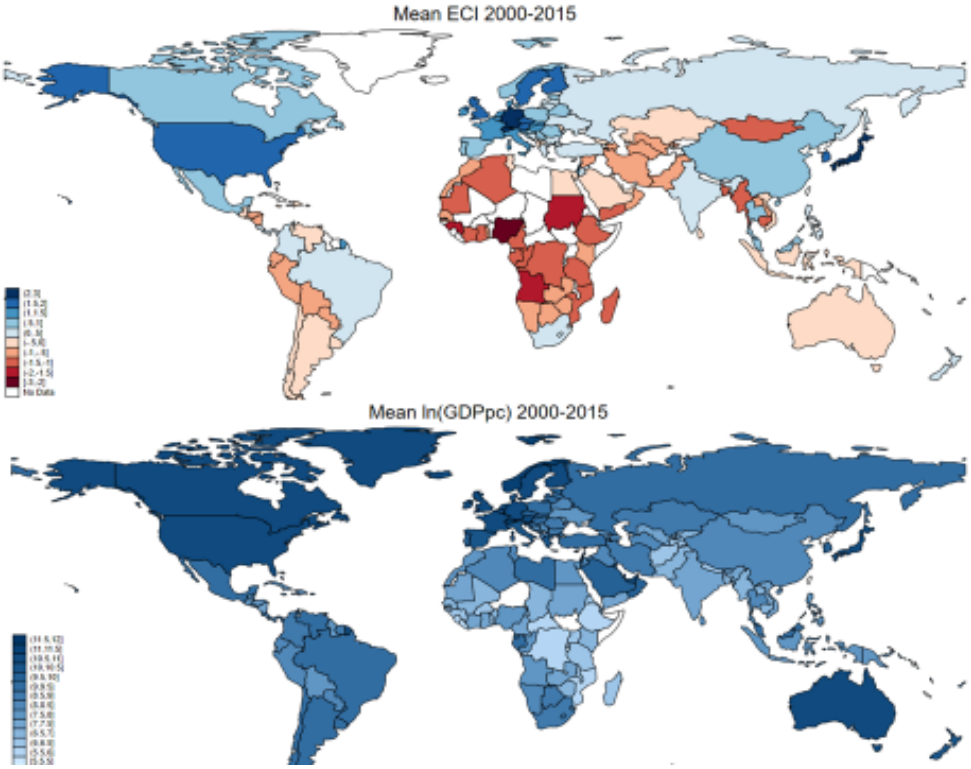
Figure 1a: Mean Economic Complexity and mean income per capita in 1970



Source: Hausmann et al. (2014), World Development Indicators

[5] We conduct robustness checks with two and five year lagged variables. The results remain consistent. They are available on request.

Figure 1b: Mean Economic Complexity and mean income per capita in 2000's



Source: Hausmann et al. (2014), World Development Indicators

According to Hausmann et al. (2014), the more complex a country's economy, the more adaptable it is to market changes. We therefore expect a negative correlation between economic complexity and output volatility, as indicated in the correlation table below. The control variables are in line with the literature, with increased openness to trade, increased government expenditure and higher consumer prices positively associated with output volatility, while countries with good institutions are less vulnerable to output shocks.

Table 1: Correlation Matrix

	Gdp volatility	ECI	Openness	Democracy	Gvtexp	Inflation
Gdp volatility	1.000					
ECI	-0.1346*	1.000				
Openness	0.0255*	0.1151*	1.000			
Democracy	-0.1819*	0.5260*	-0.0017	1.000		
Gvtexp	0.0445*	0.3468*	0.1362*	0.2127*	1.000	
Inflation	0.0537*	-0.0425*	-0.0182*	-0.0400*	-0.0114*	1.000

Source: Hausmann et al. (2014), Polity IV Project, World Development Indicators

* significant at 5%

4.3 Results

We observe a negative and significant association between the economic complexity index and output volatility in Table 2, Column 1. These findings imply that countries with better productive capabilities may be able to manage risks that arise from trade volatility. According to Balavac and Pugh (2016), export diversification offers protection against adverse external trade shocks by providing countries with a broader range of commodities and services to trade on the global market. Our findings are also in line with Calderón and Schmidt-Hebbel (2008) who only observe a negative relationship between trade and output volatility when exports are diversified. Similarly, Haddad et al. (2013) find that output volatility decreases as a country's level of export diversification increases.

Given that the effects of the economic complexity index on output volatility may be biased towards developed economies in a global sample, we classify our countries by income categories (low to high income) as per the World Bank classifications[6]. We find that the negative effects of economic complexity on output volatility are consistent with more developed countries in relation to the developing countries. Low-income countries tend to have export goods that are not diversified and that are produced in many other countries compared to developed countries that typically have technologically advanced exports produced by a few other countries with similar productive capabilities. For example, Bejan (2006) only finds a stabilising effect of export diversification on output volatility in advanced economies.

Table 2: ECI and Income Effects

	(1)	(2)	(3)	(4)	(5)
Gdp volatility	Full Sample	Low income	Lower middle	Upper middle	High income
ECI_{t-1}	-0.001***	0.001	-0.000	-0.001***	-0.001**
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
$Openness_{t-1}$	0.001***	0.000	0.001*	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Democracy_{t-1}$	-0.002***	-0.001	-0.002**	-0.001**	-0.001*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
$Gvtexp_{t-1}$	0.001**	0.000	0.001	0.002***	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
$Inflation_{t-1}$	0.000***	0.000	0.001***	0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

[6] Low income is below US$995; lower middle income is between US$996 and US$3895; upper middle income is between US$3896 and US$12055; high income is above US$12055.

Observations	4,061	518	1,256	981	1,306
R-squared	0.078	0.125	0.089	0.175	0.320
Region FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
F-statistic	12.33***	0.62***	3.19***	3.82***	4.52***

Coefficients reported. Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The effects on output volatility from the control variables are in line with the literature. Openness is significantly associated with output volatility. Trade openness exposes countries to external shocks that can be a source of macroeconomic stability (Di Giovanni & Levchenko, 2009; Rodrik, 1998; Easterly et al., 2001). Government expenditure and inflation also contribute to higher output volatility (Klomp and de Haan, 2009; Hausmann & Gavin, 1996; Fatas & Mihov, 2006; Rohn et al., 2009). For example, the government instability, in the form of uncertain monetary and fiscal policies in Zimbabwe since the 2000's, has increased output volatility by negatively influencing the business climate which has discouraged domestic and foreign investments. On the other hand, we find that strong institutions reduce output volatility. According to Rodrik (1999) and Cavallo et al. (2008), countries with less democratic political institutions are more vulnerable to growth volatility as it can affect the country's ability to manage the risk from external shocks.

We also examine the effects of the economic complexity index across regions in Table 3. We observe heterogeneous effects for Asia in relation to the other regions. This result may be driven by the numerous countries in the region that were affected by the Asian financial crisis in the late 1990's. The negative effects observed for the African and Middle East region may be driven by the abundance of natural resources, which contributes to the diversity of their export baskets. The effects of the control variables on output volatility are consistent with previous results.

Table 3: ECI and Region Analysis

	(1)	(2)	(3)	(4)
Gdp volatility	Europe and North America	Middle East and Africa	Asia	South America
ECI_{t-1}	-0.000**	-0.002***	0.000***	-0.000
	(0.000)	(0.001)	(0.000)	(0.000)
$Openness_{t-1}$	0.001**	0.002**	0.000**	0.000*
	(0.000)	(0.001)	(0.000)	(0.000)
$Democracy_{t-1}$	-0.001	-0.002**	-0.001**	-0.002**

	(0.001)	(0.001)	(0.000)	(0.001)
$Gvtexp_{t-1}$	-0.001	0.001	-0.000	0.001
	(0.000)	(0.001)	(0.000)	(0.000)
$Inflation_{t-1}$	0.001***	0.000**	0.000	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	1,295	1,129	699	938
R-squared	0.246	0.126	0.173	0.092
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
F-statistic	6.66***	5.95***	4.40***	2.43**

Coefficients reported. Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

To check the validity of our results, we include the lagged residual of Gdp in the estimations. This dynamic specification allows for the persistence of output volatility while also accounting for time-varying unobserved heterogeneity. The results in Table 4 are consistent with our previous conclusions. Wealthier countries have more diversified exports, which protects them from growth shocks.

Table 4: Income classifications with dynamic effects

	(1)	(2)	(3)	(4)	(5)
Gdp volatility	Full Sample	Low income	Lower middle	Upper middle	High income
ECI_{t-1}	-0.000***	0.001	-0.000	-0.001***	-0.001*
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
$Openness_{t-1}$	0.000***	0.000	0.001	0.000	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Democracy_{t-1}$	-0.002***	-0.001	-0.002**	-0.001**	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
$Gvtexp_{t-1}$	0.001	0.000	0.000	0.002**	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
$Inflation_{t-1}$	0.000**	0.000	0.000**	0.000**	-0.000

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$Gdpvolatility_{t-1}$	0.231***	0.148**	0.192***	0.150*	0.142
	(0.060)	(0.067)	(0.062)	(0.083)	(0.159)
Observations	4,061	518	1,256	981	1,306
R-squared	0.127	0.144	0.124	0.192	0.333
Region FE	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
F-statistic	11.29***	1.08	3.66***	3.35***	3.95***

Coefficients reported. Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The inclusion of the lagged output volatility makes no difference to the final outcomes in the regional analysis. The findings in Table 5 are consistent with the previous results.

Table 5: Regions with dynamic effects

	(2)	(3)	(4)	(5)
Gdp volatility	Europe and North America	Middle East and Africa	Asia	South America
ECI_{t-1}	-0.000	-0.001**	0.000***	-0.000
	(0.000)	(0.001)	(0.000)	(0.000)
$Openness_{t-1}$	0.000**	0.002**	0.000*	0.000
	(0.000)	(0.001)	(0.000)	(0.000)
$Democracy_{t-1}$	-0.000	-0.001*	-0.001**	-0.002**
	(0.000)	(0.001)	(0.000)	(0.001)
$Gvtexp_{t-1}$	-0.001	0.001	-0.000	0.000
	(0.000)	(0.001)	(0.000)	(0.000)
$Inflation_{t-1}$	0.000**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
$Gdpvolatility_{t-1}$	0.282***	0.203**	0.098	0.202**
	(0.095)	(0.084)	(0.060)	(0.086)

Observations	1,295	1,129	699	938
R-squared	0.305	0.162	0.181	0.127
Region FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
F-statistic	6.66***	5.29***	3.91***	2.46**

Coefficients reported. Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

As a final analysis, we interact the economic complexity with a dummy for resource abundant countries in our sample. According to Cavalcanti et al. (2012), export diversification can act as a security net against commodity price volatility in resource abundant countries. We observe this attenuated effect on output volatility from the interaction term, though it loses significance once we include the lagged gdp residual.

Table 6: Resource abundant countries

	(1)	(2)
Gdp volatility	Resource Abundant	Resource Abundant
ECI_{t-1}	-0.000**	-0.000*
	(0.000)	(0.000)
resources	0.000	-0.000
	(0.000)	(0.000)
$ECI*resources_{t-1}$	-0.001*	-0.001
	(0.000)	(0.000)
$Openness_{t-1}$	0.001***	0.001***
	(0.000)	(0.000)
$Democracy_{t-1}$	-0.002***	-0.002***
	(0.000)	(0.000)
$Gvtexp_{t-1}$	0.001**	0.001
	(0.000)	(0.000)
$Inflation_{t-1}$	0.000***	0.000**
	(0.000)	(0.000)
$Gdpvolatility_{t-1}$		0.232***

		(0.061)
Observations	3,766	3,766
R-squared	0.082	0.131
Region FE	YES	YES
Year FE	YES	YES
F-statistic	10.17***	10.06***

Coefficients reported. Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This study contributes to the nexus between export diversification and output volatility by using a relatively new measure (the economic complexity index) that captures not only the types of goods exported, but also the human capital in the exported goods (i.e. the productive capabilities). We find that output volatility is mitigated as the economic complexity of a country increases. This result appears to hold only for upper middle to high-income countries, as well as resource abundant countries. We also find that the effects of the Asian financial crisis are persistent twenty years later as the region is still vulnerable to output shocks despite increasing levels of productive capabilities.

References

Bacchetta, M. Jansen, M, Piermartini, R and Amurgo-Pacheco, A. (2007). Export Diversification as an absorber of external shocks. Preliminary Paper, World Bank.

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

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

Caballero, R.J. and Krishnamurthy, A. (2001). “International and Domestic Collateral Constraints in a Model of Emerging Market Crises.” Journal of Monetary Economics 48(3): 513-548.

Calderón, C., & Schmidt-Hebbel, K. (2008). “Openness and growth volatility.” Working Papers Central Bank of Chile No. 483. Central Bank of Chile.

Cavalcanti, T.V. de V., Mohaddea, K., & Raissi, M. (2012). "Commodity price volatility and the sources of growth." IMF Working Papers 12/12. International Monetary Fund.

Cavallo, E.A., De Gregorio, J., & Loayza, N.V. (2008). "Output Volatility and Openness to Trade: A Reassessment (with comments)." Economia, 9(1):105-152.

Correia, Sergi. (2014). "REGHDFE: Stata module to perform linear or instrumental-variable regression absorbing any number of high-dimensional fixed effects." Statistical Software Components S457874, Boston College Department of Economics, revised 10 Mar 2019.

Di Giovanni, J., & Levchenko, A.A. (2009). "Trade openness and volatility." Review of Economics and Statistics, 91(3):558–585.

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

Easterly, W. and A., Kraay (2000). Small states, small problems? Income, growth and volatility in small states, World Development, vol. 28(11), pp. 2013-2027.

Fatas, A., & Mihov, I. (2006). "The macroeconomic effects of fiscal rules in the US states." Journal of Public Economics, 90(1–2):101–117.

Haddad, M., Lim, J.J., Pancaro, C., & Saborowski, C. (2013). "Trade openness reduces growth volatility when countries are well diversified." Canadian Journal of Economics, 46(2):765– 790.

Hausmann, R., & Gavin, M. (1996). "Securing stability and growth in a shock-prone region: the policy challenge for Latin America." In: Hausmann, R., & Reisen, H. (Eds.), "Securing Stability and Growth in Latin America: Policy Issues and Prospects for Shock-prone Economies." Organisation for Economic Co-operation and Development, Paris.

Hausmann, R., Hidalgo, C. A., Bustos, S., Coscia, M., Simoes, A., & Yildirim, M. A. (2014). The Atlas of Economic Complexity: Mapping Paths to Prosperity. MIT Press.

Imbs, J., and Wacziarg, R. (2003). "Stages of Diversification", American Economic Review, vol. 93, no.1, March 2003.

Jansen, M. (2004) Income volatility in small and developing economies: export concentration matters, WTO Discussion Papers No 3, Geneva: World Trade Organization.

Klomp, J., & de Haan, J. (2009). "Political institutions and economic volatility." European Journal of Political Economics, 25(3): 311–326.

Koren, Mikl´os and Silvana Tenreyro, "Volatility and Development," Quarterly Journal of Economics, February 2007, 122 (1), 243–87.

Khrishna, P. and Levchenco, A.A. (2009). Comparative advantage, Complexity and Volatility. NBER. Working Paper 14965. Cambridge.

Malik, A. and Temple, J. (2006). 'The Geography of Output Volatility' CEPR Discussion

Paper 5516.

Mendoza, E.G., (1995). The Terms of Trade, the Real Exchange Rate, and Economic Fluctuations. International Economic Review 36, 101-137.

Radatz, C. (2008). External Shocks and Macroeconomic Volatility in Latin America. Working Paper. Development Economics Research Group, World Bank.

Ramey, G. and V.A., Ramey (1995). Cross-country evidence on the link between volatility and growth, American Economic Review, vol. 85(5), pp. 1138-1151.

Rohn, O., Orazbayev, S., & Sarinzhipov, A. (2009). “An institutional risk analysis of the kazakh economy.” Ifo Working Paper No.70. Ifo Institute for Economic Research at the University of Munich.

Rodrik (1997). Has globalization gone too far? Washington, D.C.: Institute for Economics.

Rodrik, D. (1998). "Why Do More Open Economies Have Bigger Governments?" Journal of Political Economy, 106(5): 997-1032.

Rodrik, D. (1999). “Where did all the growth go? External shocks, social conflict, and growth collapses.” Journal of Economic Growth, 4(4):385–412.

Uribe, M., and Yue, V. (2006). “Country Spreads and Emerging Countries: Who Drives Whom?.” Journal of International Economics, 69, 6-36.