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Managing East Asia's Macroeconomic Volatility

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Abstract

East Asia has experienced a dramatic decrease in output growth volatility over the past 20 years. This is good news, as output growth volatility affects poor households because of coping strategies that have long-term, harmful consequences, and the overall economy through its negative impact on economic growth. This paper investigates the factors behind this long decline in volatility, and derives lessons about ways to mitigate renewed upward pressure in face of the financial crisis. The authors show that if, on the one hand, high trade openness has sustained economic growth in the past several decades, on the other hand, it has made countries more vulnerable to external fluctuations. Although less frequent terms of trade shocks and more stable growth rates of trading partners have helped to reduce volatility in the past, the same external factors are now putting renewed pressure on volatility. The way forward seems therefore to be to counterbalance the external upward pressure on volatility by improving domestic factors. Elements under domestic control that can help countries deal with high volatility include more accountable institutions, better regulated financial markets, and more stable fiscal and monetary policies.

This paper—a product of the Social Protection unit, East Asia and Pacific Region —is part of a larger effort in the unit to study main sources of vulnerability. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at jrigolini@worldbank.org.

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Produced by the Research Support Team

MANAGING EAST ASIA'S MACROECONOMIC VOLATILITY

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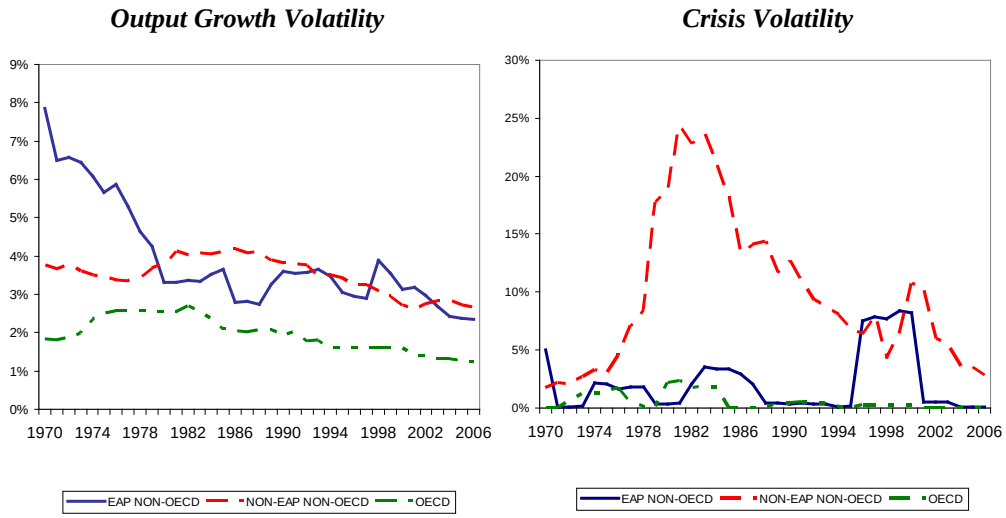
1 INTRODUCTION AND EXECUTIVE SUMMARY

Before the current financial crisis hit progressively high, middle, and low-income countries, the world economy was experiencing a remarkable decrease in macroeconomic volatility. Since the 1970s output growth volatility had steadily declined in almost every region of the world (Figure 1). In its 2007 World Economic Outlook the IMF reported that volatility had fallen progressively since its 1970s peak, from 3.8 to 2.7 percent of GDP.[2] Furthermore, the frequency of major recessions had also diminished: crisis volatility, which captures the frequency and magnitude of major recessions, declined from an average of more than 4 percent of total volatility at the end of the 1970s, to less than 1 percent at the beginning of the new century. The decrease in macroeconomic volatility was even more significant for non-OECD East Asian countries, were volatility dropped from an average of 7.85 percent in the beginning of the 1970s, to an average of 2.35 percent in 2006. This process began at a very strong pace in the 1970s, slowed down in the 1980s and 1990s (a spike can be even observed during the 1997/98 financial crisis), but gained momentum again at the beginning of the new century driving volatility below pre-crisis levels.

This is good news, as output growth volatility negatively affects in the short term poor households adopting detrimental coping strategies, and, in the medium term, economic growth. Output growth volatility reduces people's welfare through its effect on the labor market, earnings, and consumption. Households, in particular poor ones, have limited capacity to insure against shocks. Their earnings and consumption patterns follow therefore closely overall macroeconomic trends, increasing in good times and decreasing in bad ones, and the very limited ability of these poor households to insure against shocks makes them often adopt coping strategies that can have long-term harmful consequences, in particular on future generations. Moreover, macroeconomic volatility has a negative and robust impact on GDP growth. Our estimates indicate that if the standard deviation of the growth rate of per capita GDP in East Asia would decrease from 1.4 percent (the volatility in the period 1996-2000) to 0.9 percent (the average level observed in OECD countries over the same period), the growth rate would increase by 0.48 percentage points. Reducing volatility therefore improves both household welfare and economic performance.

[2] World Economic Outlook (2007), *Globalization and Inequality*, Chapter V: "The Changing Dynamics of the Global Business Cycle," www.imf.org

Figure 1: Output growth volatility and crisis volatility, 1970-2006



Source: author's own calculations using WDI data. Volatility is measured as the standard deviation GDP per capita growth using a ten year window. Crisis Volatility is measured the portion of the standard deviation of per capita GDP growth that corresponds to downward deviations below the world average volatility threshold (see Box 1). Average volatilities are weighted by GDP.

Nonetheless, volatility in East Asia remains well above OECD levels, and the current financial crisis is bound to exert an upwards pressure. The current financial crisis demonstrates that East Asian economies remain sensitive to external shocks. Terms of trade in low and middle-income countries in the region are rapidly worsening, in particular in commodity exporting countries, and both domestic and foreign direct investments are drying up, limiting the potential for domestic growth. Recent evidence and forecasts suggest that the downturn in East Asia will be significant and that in many countries recovery will be slow. Overall GDP growth in East Asia is projected to fall to 5.3 percent in 2009 (against 8 percent in 2008), and some countries such as Malaysia, Thailand, Singapore, and Cambodia are facing negative expected growth rates. Moreover, while recessions tend to last on average one year, recessions such as the current one linked to Banking crises and equity busts are likely to last longer.[3]

This study investigates factors that drove the long decline in output growth volatility in East Asia and the rest of the world, and derives lessons about ways to mitigate the impact of a more volatile international environment. Our objective is to discover the overriding factors that contributed to lower macroeconomic volatility in the past decades, and to investigate factors that could reduce it further (or at least manage the current pressure of a more volatile international environment). We consider both domestic factors under countries'

[3] World Bank East Asia and Pacific update, April 2009.

control, and external factors, such as the volatility of terms or trade and the volatility of growth of trading partners. The empirical analysis is based on a dynamic panel General Method of Moments (GMM) estimation that corrects for unobserved effects and endogenous regressors, and data used cover 80 countries over the 1975-2005 period (see the Appendix for details).

Part of the long-term observed decline in volatility is related to improved domestic fundamentals and better macroeconomic management. Output growth volatility has fallen thanks to improved institutions, business practices, and other structural features that have enhanced the ability of East Asian economies to absorb shocks. In line with existing studies, we find that the shift towards more democratic and stable institutions and the increased depth and sophistication of financial markets are among the structural changes that have contributed to increase macroeconomic stability, both in East Asia and in the rest of the world. The most significant contribution to the long decline in volatility stem however from improved macroeconomic management: more stable fiscal policies are robustly linked to lower output fluctuations, and the success of policy makers in maintaining low and steady inflation has driven down uncertainty, fostering investment and bringing volatility down.

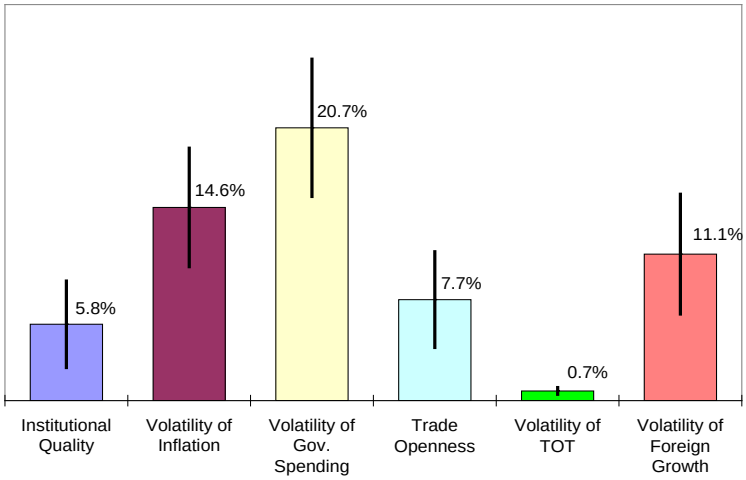
Part of the long-term decline in volatility is however also related to improved external conditions out of countries' control, which in face of the financial crisis are now exerting strong upwards pressure on volatility. The long-term decline in volatility is also imputable to a decrease in the magnitude and frequency of external shocks. The study shows that while less frequent terms of trade shocks and more stable growth rates of trading partners helped reducing volatility in the past decades, these very same external factors are now exerting strong upwards pressure on volatility. Over the last two years world economic growth declined from 5.1 percent in 2007 to 3.4 percent in 2008, and is projected to fall to 0.5 percent in 2009, its lowest rate since World War II. While the impact of these dramatic changes are only beginning to be captured by formal volatility measures,[4] they are bound to increase medium-term volatility of terms of trade and foreign growth, which, in turn, will affect countries' volatility.

East Asia also remains more vulnerable to external shocks because of its high openness to trade. Average openness to trade in East Asia (i.e. the sum of imports and exports) is 77.8 percent of GDP, against 46.0 for OECD countries (Figure 10). The impact of trade openness on output growth volatility is significant: an increase of one percent in trade openness raises volatility by 0.7 percent. While the expansion of trade has been a key driver of economic growth, it has therefore also increased East Asia's vulnerability to external output fluctuations.

[4] Output growth volatility is usually estimated using a 5 or 10 years rolling window, hence the full impact of the current financial crisis will only be captured some years from now.

The way forward points therefore at improving domestic determinants of volatility under countries' control, so to counterbalance the upwards pressure caused by a more volatile world environment and high trade openness. There seems to be space for improvement in the areas of institutional quality, as well as monetary and fiscal policies (Figure 2). The quality of institutions across the region could, on average, be further improved. It would be essential for parliaments to exert strong control over the executive, to prevent implementation of uncertain and discretionary policies and to avoid continuous shifts in fiscal policy. Furthermore, stable monetary and fiscal policies are essential instruments to reduce output growth volatility, and are also the areas where improvements could lead to the most significant drops in volatility (Figure 2). In that context, medium term monetary and fiscal frameworks could be adopted to better steer these instruments and provide policy makers with a benchmark and a target for monetary and fiscal policies. Finally, given the strong impact banking crises have on crisis volatility (Table A.1), it is vital to improve prudential supervision and create fast response plans for handling banking problems. Improved financial depth would also allow a better allocation of resources where needed, with a beneficial impact on volatility.

Figure 2: Estimated average reduction in volatility if factors were brought at OECD levels (middle income East Asia)



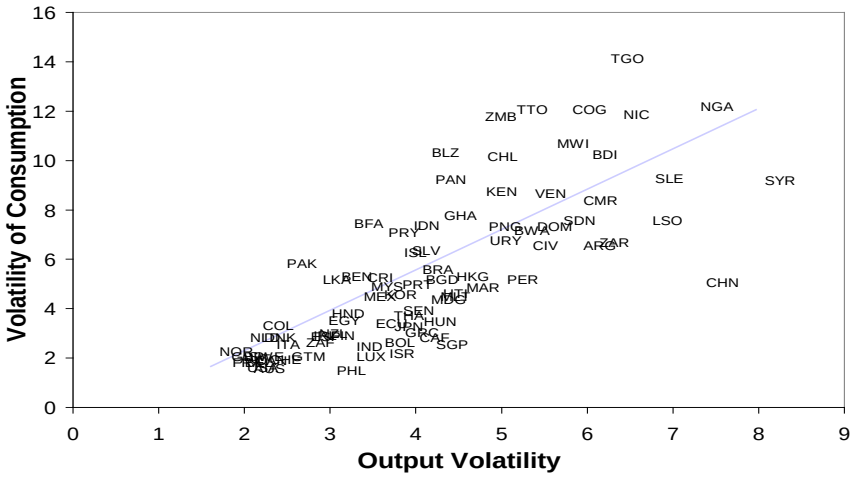
Non-OECD EAP (average of China, Indonesia, Thailand, Malaysia and the Philippines) vs. average OECD levels in 2000-05. The bars represent the estimates' standard deviation. Source: Author's own calculations using data from WDI, IMF and Polity IV.

The paper is structured as follows. Section 2 reviews the impact of output growth volatility on poverty, welfare, and economic growth. Sections 3 and 4 present world trends of output growth volatility and review its determinants. Section 5 discusses factors that contributed to the reduction in output growth volatility in East Asia, and factors that could further reduce it. Section 6 concludes.

2 WHY SHOULD WE CARE ABOUT MACROECONOMIC VOLATILITY?

Output growth volatility reduces people's welfare through its effect on the labor market, earnings, and consumption. Households, in particular poor ones, have limited capacity to insure against shocks. Their earnings and consumption patterns follow therefore closely overall macroeconomic trends, increasing in good times, and decreasing in bad ones, leading to a strong macro-economic correlation between output growth volatility and consumption volatility (Figure 3). Volatile consumption patterns have a strong impact on households' welfare, who would rather face a smooth path of consumption that an unpredictable one. Among others, Reis (2006), based on Lucas' (1987) approach, shows that the welfare costs of output fluctuations in the United States amount to 5 percent of per capita consumption. And in developing countries, where fluctuations are of larger magnitude and shocks are more persistent, the welfare costs of output fluctuations are even higher. The World Bank (2000), for instance, using an approach based on Athanasoulis and van Wincoop (2000), reports welfare costs amounting to up to 10 percent of consumption for various Latin American countries.

Figure 3: Volatility of Output Growth vs. Volatility of Consumption



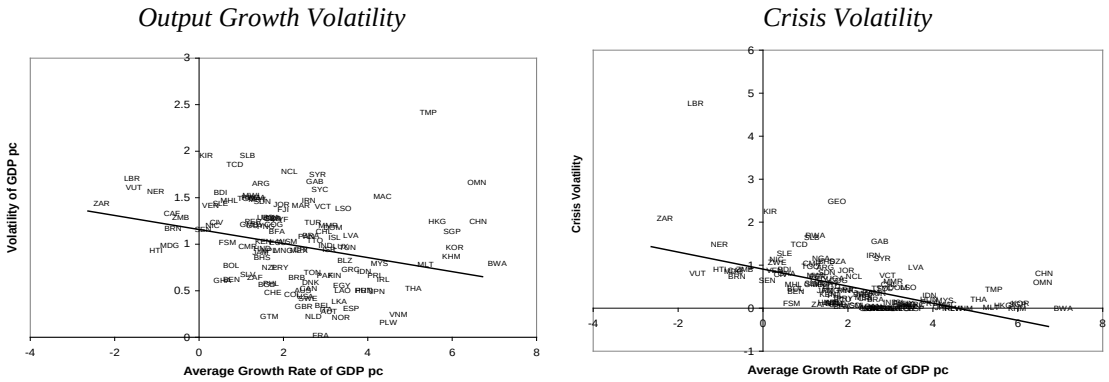
Sources: author's own calculations using WDI data. Volatility is measured as the standard deviation of GDP per capita growth between 1960 and 2005.

Output growth volatility also affects particularly poor households because of coping strategies that have long-term harmful consequences. Households' preference for "smooth" consumption patterns is not only a matter of taste. The very limited ability of poor

households to insure against shocks makes them often adopt coping strategies in bad times that can have harmful consequences in the long term, even for generations. In times of crisis, poor households are not able to feed anymore infants with the nutrients they need, which affects their long term development prospects; pull children out of school; and sell assets, such as their house or farm land, initiating a vicious spiral towards increased destitution.[5]

Finally, macroeconomic volatility has also proven to have a negative and robust impact on economic growth, and thus on future consumption. Output growth volatility is negatively correlated with economic growth (Figure 4), and several studies have proven the existence of a robust causal link.[6] The link between volatility and growth remains strong for East Asia as well: our estimates indicate that if the standard deviation of the growth rate of per capita GDP in East Asia would decrease from 1.4 percent (the volatility in the period 1996-2000) to 0.9 percent (the average level observed in OECD countries over the same period), the growth rate would increase by 0.48 percentage points.

Figure 4: Volatility of Output Growth vs. Average Growth



Sources: author's own calculations using WDI data. For a definition of crisis volatility see Box 1.

[5] See, among others, Ravallion, 2008, and Grosh *et al.*, 2008, for a review of coping strategies.

[6] Ramey and Ramey's (1995) were the first to document empirically the negative relationship between volatility and growth. This link was explored further in Fatàs (2002), Acemoglu *et al.* (2003), and Hnatkovska and Loayza (2005). The negative effect of macroeconomic volatility on long term economic growth acts for instance through increasing economic uncertainty, which reduces investment and tightens binding investment constraints. See Aizenman and Pinto (2005) and Wolf (2005) for a -review.

3 MACROECONOMIC VOLATILITY: TRENDS

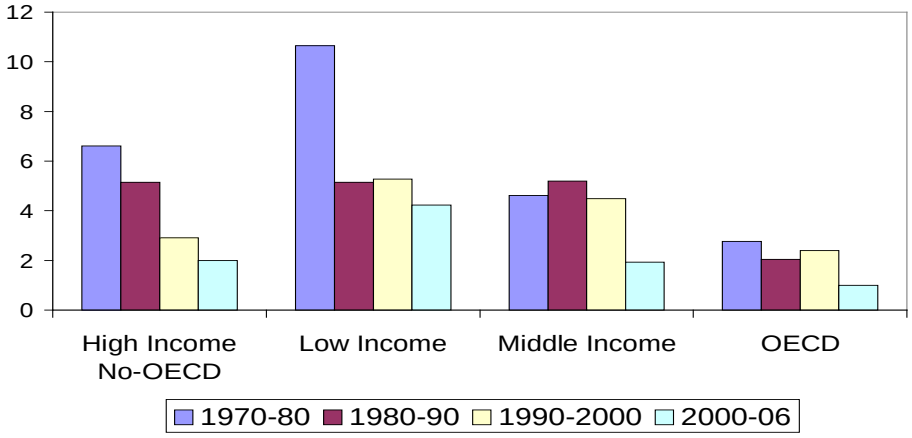
During the past 20 years output growth volatility has decreased in almost every region in the world, including East Asia (Figure 1). World volatility has fallen from an average of 3.8 percent in the 1970s, to 2.7 percent nowadays.[7] The decrease has been even more marked for non-OECD East Asia, where output growth volatility has decreased from 7.85 percent in the 1970s, to 2.35 percent in 2006. The reduction in macroeconomic volatility began at a very strong pace in the 1970s, slowed down in the 1980s and 1990s (a spike can be even observed during the financial crisis in the late nineties), but gained momentum again at the beginning of the new century driving current volatility below pre-1997 crisis levels (Figure 1). However, despite the large decline in recent years, average output growth volatility in non-OECD East Asia remains significantly higher than in OECD countries, but slightly lower than the world average for non-OECD countries.

One of the striking features of reduced volatility in East Asia is that the process happened in countries at different levels of economic development. As shown in Figure 5, the decrease in output volatility has been observed in high, middle, and low-income countries. The most striking reduction in output growth volatility can be observed among high-income non-OECD East Asian countries, where volatility is now less than a third of what it was in the 1960s and close to OECD levels (below 2 percent). The performance of middle-income countries is also remarkable, with the most marked reduction happening in the post-financial crisis years. In contrast, in the last twenty years low-income East Asian countries did not make significant progress in reducing output growth volatility, which remains high (4.23 percent).

Output growth volatility is computed using a 5 or 10 years rolling window, hence it is too early to assert the impact of the current financial crisis. Nonetheless, to the extent that economic growth already slowed significantly in most East Asia economies, the crisis is bound to raise volatility – making it even more important to mitigate the impact of external factors on volatility by improving domestic structural features (see below, next section for details).

[7] As reported by the IMF in the 2007 World Economic Outlook. Volatility is measured using a weighted average of a 10-year rolling window of countries' GDP standard deviation. Weights consist of average GDP per capita in 2000 US$.

Figure 5: Volatility of output growth in East Asia and the Pacific (by income level)



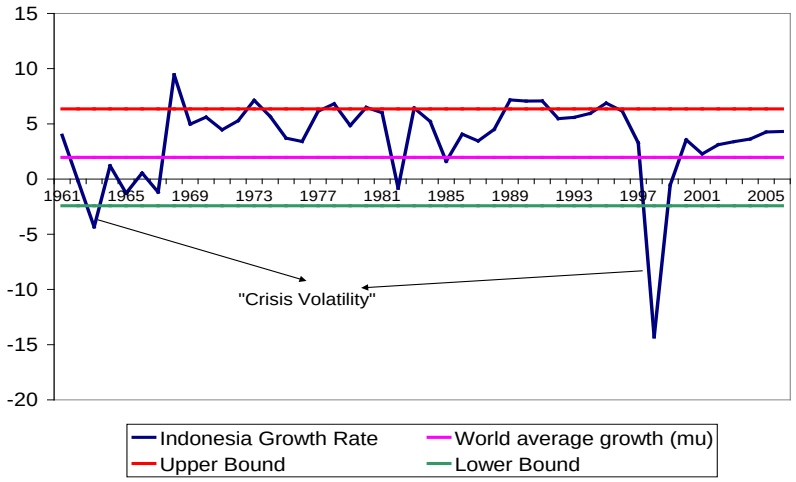
Volatility is measured as the group's average (weighted by GDP) of the standard deviation of output growth. OECD: Korea (Rep), New Zealand, Australia, Japan. High Income Non-OECD: French Polynesia, New Caledonia, Singapore, Hong Kong. Middle Income: Philippines, China, Thailand, Malaysia, Fiji, Indonesia, Kiribati. Low Income: Solomon Islands, Myanmar, Papua New Guinea.

World crisis volatility, which captures the frequency of major crises (Box 1), has also declined from an average of more than 4 percent of total volatility at the end of the 1970s, to less than 1 percent at the beginning of the new century (Figure 1). However, the decline has been unevenly distributed: during the period considered, OECD countries have almost lived without crisis volatility, and in China crisis volatility seems to be a matter of the past (i.e. the 1960s and 1970s); in contrast, in the Pacific islands major crises are a recurrent problem happening in almost every decade (e.g. Solomon Islands, New Caledonia, Papua New Guinea and Fiji); and for a third group of countries it is a new phenomenon, closely related to the 1997 financial crisis (e.g. Indonesia, Singapore and Malaysia).

Box 1: What is Crisis Volatility?

We define "crisis volatility" as the portion of the standard deviation of per capita GDP growth that corresponds to downward deviations below a certain threshold (in our case, the world average standard deviation of output growth; see Figure 6). Crisis volatility is designed to capture major drops in output growth, in contrast with the standard deviation of output growth that also captures small variations. To put it differently, while the standard deviation of output growth (i.e. "volatility") may capture mostly high frequency variations of limited magnitude, the crisis volatility only captures major output drops (for more details see also Hnatkovska and Loayza, 2004).

Figure 6: Computing crisis volatility for Indonesia



Sources: author's own calculations using WDI data. Crisis volatility measures the portion of the standard deviation of per capita GDP growth that corresponds to downward deviations below the world average.

4 MACROECONOMIC VOLATILITY: DETERMINANTS

Most of the decline in output growth volatility can be explained by improved domestic structural features, more stable macroeconomic policies and, until the current financial crisis hit, a lower frequency of external and exogenous shocks. In particular, the literature studying output growth volatility has identified three main sources of volatility: (i) domestic structural features that affect the ability of the economy to absorb shocks; (ii) domestic shocks generated by self-inflicted policy mistakes and weak institutions; and (ii) external shocks such as "sudden stops" of capital inflows, large changes in the international terms of trade, and volatility of main trading partners. Next, we review these factors in detail and their trends in East Asia.

Improved Domestic Structural Features

Domestic structural features, such as institutions, the sophistication and depth of financial markets, technology and business practices, not only affect countries' ability to absorb shocks, but can also induce or magnify them. Deaton and Miller (1996), Hoffmaister, Roldós, and Wickham (1998), and Raddatz (2005, 2007), among others, all find that internal conditions and domestically induced shocks explain a large share of output fluctuations in poor countries. Improved institutions, deeper financial markets, and more stable macroeconomic policies have all played an important role in reducing volatility in East Asia and all over the world.

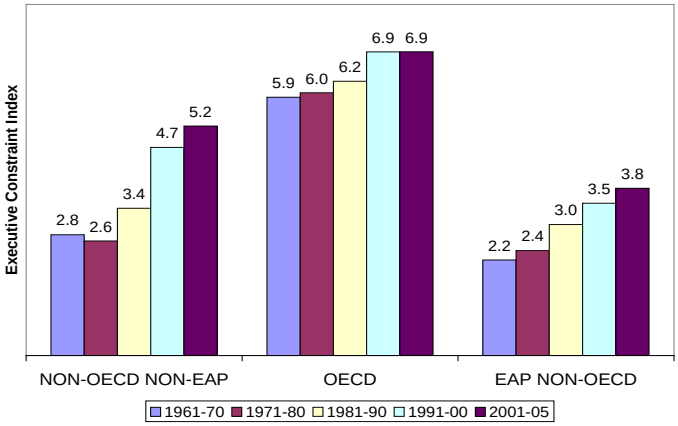
Improved Institutions

Greater institutional quality tends to be associated with increased capacity of adjusting to major economic shocks, and lower output growth volatility. Acemoglu *et al.* (2003), for instance, document a strong relationship between the quality of institutions and volatility, with countries that inherited worse institutions having a higher probability of suffering high volatility and economic crises. They motivate the findings by suggesting that societies with better institutional quality are expected to experience less internal conflicts, hence governments are able to pursue more enduring and less volatile policies.

Since the 1960s East Asian countries have significantly improved overall institutional quality, which remains nonetheless well below the OECD average (Figure 7). There exist various datasets providing quantitative measures of institutional quality. The one used in this study is the Polity IV (2004), which looks at the quality of checks and balances in place on the executive branch of the government. It shows that, on average, non-OECD East Asia improved its institutional quality score from 2.2 in the 1960s, to 3.8 nowadays. Although this represents a significant improvement, overall institutional quality remains fairly low (the best institutional quality in the Polity IV dataset is 7), and even nowadays remains lower than institutional quality of OECD countries in the sixties. Moreover, most of the progress

happened in the 1980s, while from the nineties onwards few improvements have been achieved.

Figure 7: Institutional quality



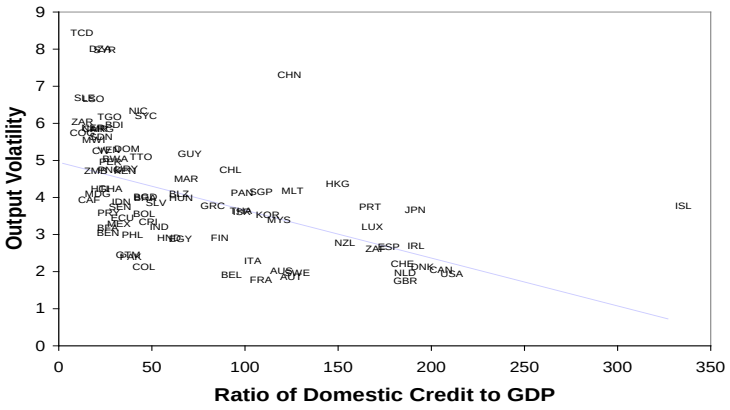
Sources: author's calculations using Polity IV (2004) data. The variable is the unweighted average for the region.

Increased Sophistication and Depth of Financial Markets

More sophisticated and developed financial markets improve the economy's capability to reallocate resources where needed in case of shocks, and therefore dampen output growth volatility. More developed financial markets also have a direct beneficial effect on consumers by allowing greater smoothing of consumption. Figure 8 presents a scatter plot of output growth volatility versus financial depth, measured as the ratio of private sector domestic credit to GDP. It shows a clear relationship between the depth of financial markets, and output growth volatility. Using more sophisticated econometric techniques, Loayza and Raddatz (2006), among others, find that domestic financial depth has an important role in stabilizing the economy, and can reduce the impact of shocks by up to 1.5 percentage points.

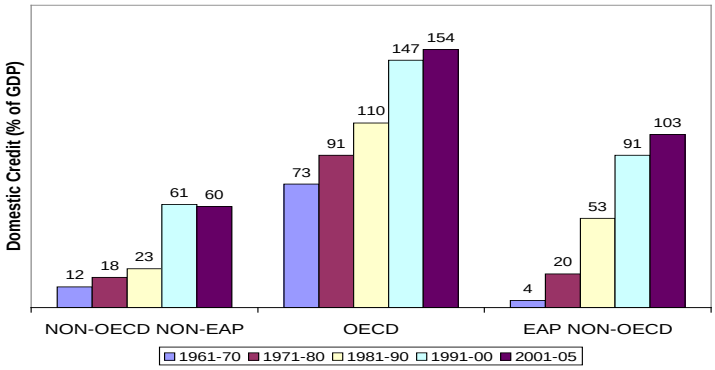
Financial markets have significantly deepened in both OECD and developing countries, and East Asia followed the trend (Figure 9). In non-OECD East Asia, domestic credit as a percentage of GDP rose from less than 50 percent in the 1970s to more than 100 in 2006, and now stands significantly higher than in other non-OECD countries. Improvements have however been heterogeneous, with some countries developing their financial markets at a much higher pace than others.

Figure 8: Output growth volatility vs. Financial Depth



Sources: author's calculations using WDI data. Output Volatility is the average standard deviation of GDP per capita growth for the years 1960-2006.

Figure 9: Private sector domestic credit to GDP



Sources: author's calculations using WDI data. Domestic Credit to GDP is the unweighted average for the group.

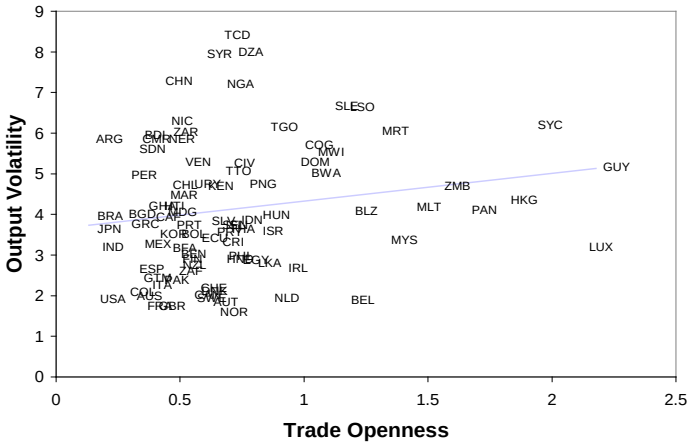
Trade Openness

Traditionally, the literature has identified trade openness as an important factor affecting volatility (Figure 10).[8] Trade openness can lead to higher volatility through several channels: it increases, for instance, concentration and specialization in production through dynamic comparative advantage, so that countries suffer to a greater extent when international prices

[8] While the positive association between trade openness and volatility has been repeatedly found, there is an ongoing empirical debate regarding the connection between financial openness and output growth volatility (see Box 2).

of the goods they produce fluctuate; moreover, larger trade openness also magnifies the output impact of external shocks, particularly the negative ones.[9]

Figure 10: Trade openness and output growth volatility



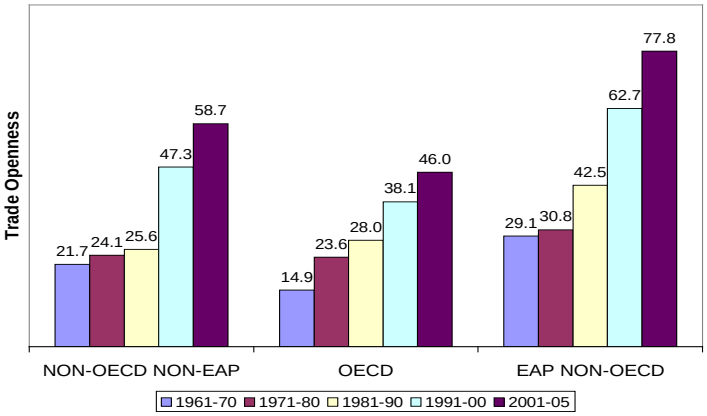
Sources: author's own calculations using WDI data. Trade openness is measured as the ratio of total trade to GDP for the year 2005.

The impact of trade openness on volatility is particularly large for low and middle-income countries. O'Donnell (2001), for instance, finds that the positive link between trade openness and volatility holds for non-OECD countries, but that the effect is reversed for OECD countries, which tend to have a more diversified production structure. A similar result is establish by Calderón *et al.* (2008), who find that trade openness increases volatility, but show that the result is only relevant for low-income countries. The non-linearity of the relationship between trade openness and volatility can explain why some studies find the opposite result, i.e. that trade openness reduces output volatility (Cavallo, 2005), in particular in high-income countries that have diversified production and where trade openness may act as a shock absorber (Martin and Rey, 2006; Cavallo and Frankel, 2004).

In the last decades East Asian countries have faced a striking increase in trade openness. The average trade volume for non-OECD East Asia is more than one and a half the OECD trade volume (78 versus 45 percent of GDP), and is 20 percent higher than the average trade volume of other non-OECD countries (Figure 11). While this high trade volume strongly contributes to spur East Asian growth, it also makes East Asian countries more vulnerable to external shocks.

[9] See, among others, Easterly, Islam, and Stiglitz (2000), O'Donnell (2001), Kose *et al.* (2003), Cavallo (2005), Giovanni and Levchenko (2006), Loayza and Raddatz (2006), and Calderón *et al.* (2008).

Figure 11: Openness to trade



Sources: author's own calculations using WDI data. Trade openness is the group's average (unweighted) of the ratio of total trade to GDP for the year 2005.

Improved Macroeconomic Policies

One of the most relevant sources of domestic shocks is poor management of fiscal and monetary policies. Erratic macroeconomic policies, leading to volatile public consumption growth and inflation volatility, have been repeatedly proven to be a major source of output volatility.

Several econometric studies find that a more stable fiscal policy lowers output fluctuations. Among others, Fatás and Mihov (2006) and Loayza *et al*. (2006) find a positive causal link between fiscal volatility and output growth volatility, and argue that a more stable fiscal policy can help diminish, or at least not amplify, output fluctuations. Accordingly, East Asia displays a markedly high correlation between the volatility of fiscal policy and output growth volatility (0.89; see Figure 13), and econometric evidence shows that significant part of that correlation stems from the causal link from volatile fiscal policies to output growth volatility (see next section). It is worth observing that what causes increased output growth volatility is likely to be the *pro-cyclicality* of fiscal policies. Instead of being a-cyclical or counter-cyclical (assisting people by means of higher spending in times of crises), Gavin and Perotti (1997) and others have shown that in most developing countries fiscal policy is generally pro-cyclical (that is, expanding in booms and contracting in recessions), aggravating both output and consumption volatility, and Talvi and Végh (2005) find that the correlation between the cyclical component of government consumption and GDP is positive for every single of 36 developing countries in their sample (with an average of 0.53), among which are Indonesia, Malaysia, Singapore and Thailand (see also Ilzetzki and Vegh, 2009).

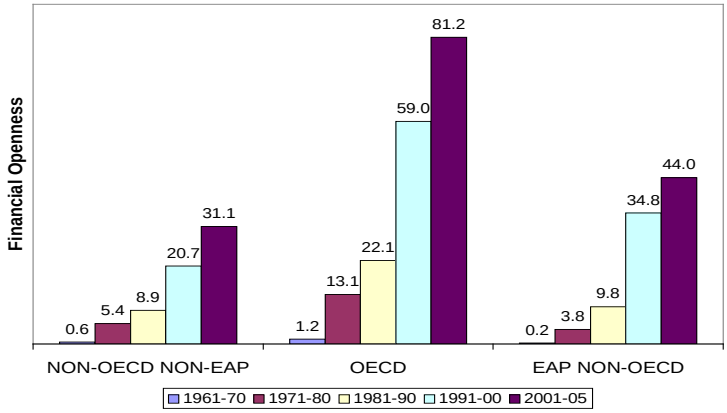
The volatility of fiscal policy in non-OECD East Asian countries has decreased by more than half between the 1970s and 2000s (from a quite high 6.89 percent in the 1970s, to 2.91 percent in the 2000s). It is now close to the non-OECD world average (2.88 percent), but still remains far above the OECD average (1 percent). Improvements in fiscal policies have been observed in all groups of countries (i.e. high, middle, and low-income countries).

Box 2: What about financial openness?

Economic models have traditionally identified financial markets as the most important shock absorber because they help diversifying macroeconomic risk and shifting resources where they are most needed. Evidence remains however inconclusive. While, among others, O'Donnell (2001), Loayza and Raddatz (2007), and Calderon *et al*. (2007) find evidence that financial openness helps countries reduce their growth volatility, Easterly, Islam, and Stiglitz (2000) do not find a significant impact of financial openness on output growth volatility.

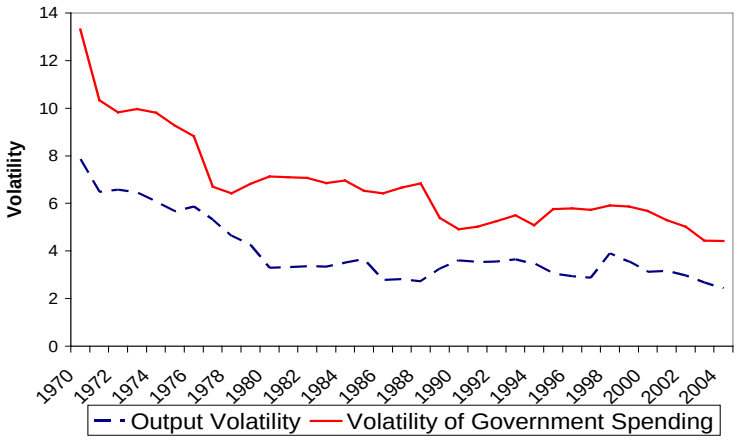
Our estimations lean towards a beneficial impact, as they find that more openness to financial markets reduces output growth volatility. Our data show that East Asian countries have improved their financial openness although they remain below OECD levels (Figure 12), and that such an improvement has contributed to lower output growth volatility by an average of 7.6 percent.

Figure 12: Financial openness in the world



Sources: author's own calculations using Lane and Millesi-Ferretti (2007). Financial openness is measured as the unweighted group's average of the sum of Assets and Liabilities as a percentage of GDP.

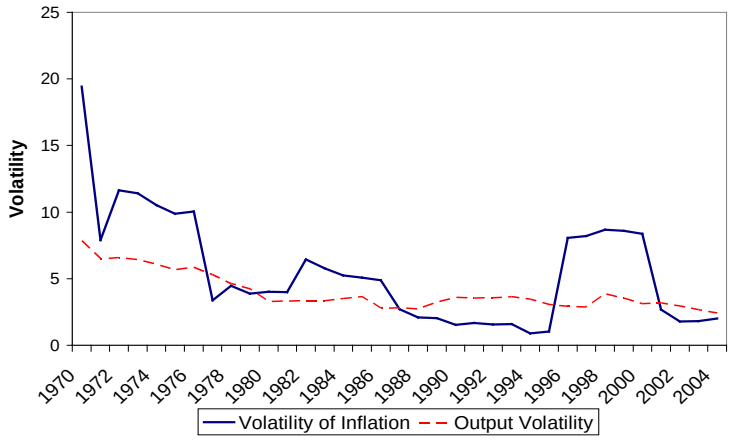
Figure 13: Output growth volatility and volatility of Government spending in non-OECD East Asia



Sources: author's own calculations using WDI data. Volatility of Government spending is measured as the weighted average standard deviation of detrended government consumption growth using a ten year window.

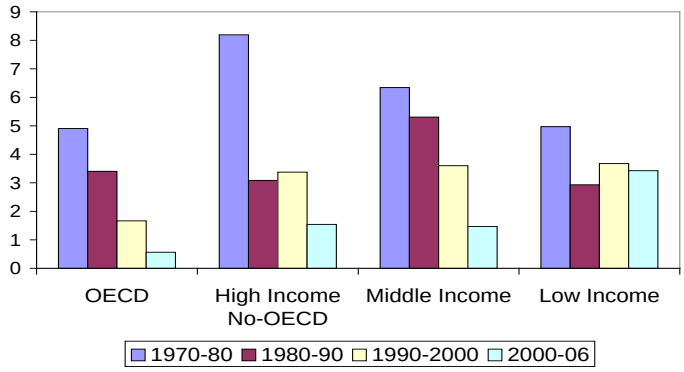
Improved monetary policies have also played a significant role in stabilizing output fluctuations all over the world. Volatility of inflation and output growth volatility have a strong tendency to move together (Blanchard and Simon, 2001), and unsound monetary policy can strongly amplify or dampen fluctuations: for instance, the 1970s were both years of high output and inflation volatility, and of poorly performing monetary policies (Romer and Romer, 2002; Bernanke, 2004). In East Asia the association between volatility of inflation and output growth volatility is quite high (0.75), and the significant decrease in inflation volatility between the 1980s and the 2000s has contributed to lowering output growth volatility (Figure 14): at almost 20 percent, volatility of inflation in non-OECD East Asian countries was far above the world average in the 1970s, but thanks to sound monetary policies it decreased rapidly close to OECD levels by the end of the 1970s until the mid nineties, where a spike can be observed as a consequence of the 1997/98 financial crisis. Gains have been nonetheless more pronounced for high and middle income countries, while low income countries did not manage to reduce as much volatility of inflation (Figure 15).

Figure 14: Output growth volatility and volatility of inflation in non-OECD East Asia



Sources: author's own calculations using WDI data. Volatility of inflation is measured as weighted average of the standard deviation of CPI growth using a five year window.

Figure 15: Volatility of inflation in East Asia (by income level)



OECD: Korea, Rep., New Zealand, Australia, Japan. High Income non-OECD: French Polynesia, New Caledonia, Singapore, Hong Kong. Middle Income: Philippines, China, Thailand, Malaysia, Fiji, Indonesia, Kiribati.

Lower Frequency of External and Exogenous Shocks

While countries have some leverage in reducing the frequency and magnitude of internal shocks, they are also subject to external shocks upon which they have little control – whose frequency nonetheless reduced in the last decade. These external shocks, such as terms of trade shocks, fluctuations in international interest rates, and aid volatility, also contribute considerably to the volatility of output growth, particularly in developing countries (see, for

instance, Mendoza, 1995, and Calvo, 1998). The frequency of these external shocks lowered in the last decade, at times significantly, having a beneficial impact on output growth volatility.[10] Next, we review these shocks.

Volatility of Foreign Growth

With the world becoming more integrated and open to trade, economies have been increasingly influenced by growth of their trading partners. Growth rate of trading partners has a significant effect on the growth performance of an open economy. Arora and Vamvakidis (2005), among others, find that a 1percent increase in economic growth of the countries' trading partners leads to higher domestic growth by 0.8 percentage points. By the same token, growth volatility of trading partners ought to influence output growth volatility, a link documented by Calderón *et al* (2006). While the world decrease in output growth volatility in the last decades has benefited East Asian countries, it should therefore come as no surprise that their high openness to trade has kept them vulnerable to external fluctuations that can worsen volatility during "bad" times, such as the current financial crisis.

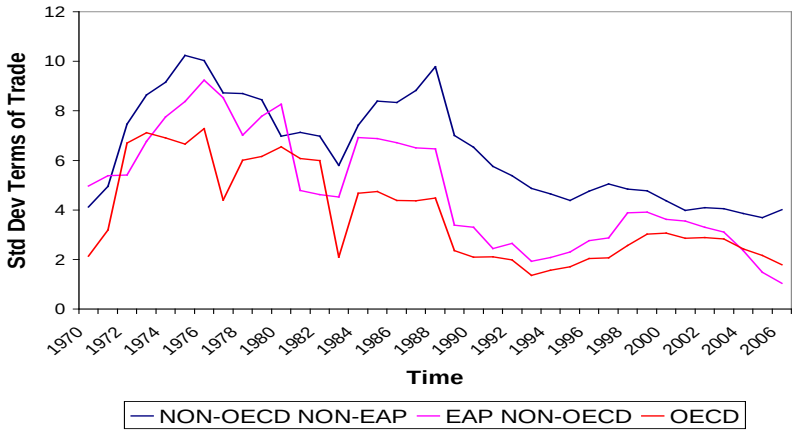
Volatility of terms of trade

Terms of trade shocks affect in particular output volatility of small open economies, although the magnitude to which they do so is subject to debate as it often depends on the methodology used to estimate it.[11] Magnitude notwithstanding, the long-term observed decrease in the volatility of terms of trade growth (Figure 16) contributed to lowering East Asia's output growth volatility, but the recent fluctuations in commodity prices are likely to have reversed that trend.

[10] Stock and Watson (2002), for instance, analyzing the experience of the G7 countries, find that with the exception of Japan the widespread reduction in volatility is in large part associated with a reduction in the magnitude of common international shocks.

[11] Calibrations, such as the ones by Mendoza (1995) and Kose (2002), find that terms of trade disturbances can explain from 56 to 88 percent of aggregate output fluctuations. These are however simulations that do not consider the correlation of terms of trade shocks with other variables. On the other end, studies based on vector auto-regressions (VAR) find a much smaller impact, varying from 6 to 15 percent (see, for instance, Ahmed and Murthy, 1994, Hoffmaister and Roldós 1997, and Hoffmaister, Roldós and Wickham, 1998).

Figure 16: Volatility of terms of trade growth

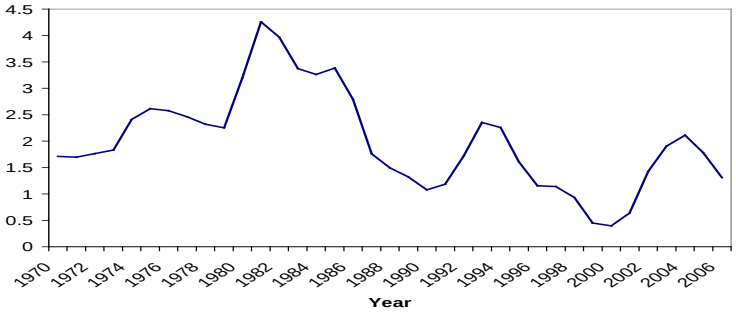


Sources: author's own calculations using WDI data. Volatility is measured as the standard deviation of terms of trade growth using a five year window.

Sudden Stops and Interest Rate Shocks

Shocks such as sudden stops where investors rapidly pull their money out of the country affect the terms at which companies and households can get access to credit, increasing uncertainty and causing macroeconomic volatility. In emerging markets sudden stops in financial flows are the most damaging external shock (Becker and Mauro, 2006), although, overall, internal shocks appear to have a much larger impact on volatility than external ones. Large interest rate shocks can also lead firms towards distress or bankruptcy. In addition to making credit, and thus investment, more expensive, adverse interest rate shocks can reduce the tolerance of financial institutions towards risk, excluding groups of borrowers from borrowing, and intensifying output growth volatility. Since firms are interrelated by complex credit relationships, bankruptcy of one firm can also generate "bankruptcy chains" with bad adverse effects (Easterly, Islam and Stiglitz, 2000). The volatility of international interest rates has however fallen progressively since its 1970s peak (Figure 17). The rolling 5-year standard deviation of monthly Federal funds effective rate has fallen progressively since its 1970s peak. Nonetheless, between 2000 and 2004 it experienced a surge of more than 2 percent, from which it has not yet recovered.

Figure 17: Volatility of international Interest Rates



Source: author's own calculations using data from the Federal Reserve Statistical Release. Volatility is measured as the standard deviation of monthly Federal funds effective rate using a five year rolling window.

5 REDUCING EAST ASIA'S VULNERABILITY TO EXTERNAL SHOCKS

The significant drop in growth experienced by most East Asian countries in the face of the financial crisis, joint with a more volatile external environment, are bound to increase output growth volatility in the medium term.[12] Based on cross-country regression estimates this section looks at which factors have contributed to lower output growth volatility in East Asia, and draws lessons about factors that could help mitigating the impact of the crisis by lowering volatility further.

Which Factors Contributed to the Long-term Decline in Volatility?

The previous section reviewed individually channels that have been proven to affect output growth volatility, but failed to analyze the importance of each factor in East Asia's long-term decline in volatility. In this section we address this issue by means of cross-country regression estimates. Our estimations are based on cross-country dynamic panel General Method of Moments (GMM) regressions, as well as Ordinary Least Squares (OLS) as a robustness check. Results reported in this section are from Column 2 of Table A1 in the Appendix. Although not a perfect fit, our estimations do a fair job in forecasting the decrease in output growth volatility. The biggest gap between our model and the data is China: between the 1980s and 2000-05, China experienced a decrease in output growth volatility of more than 60 percent, whereas our model predicts a decrease of slightly more that 40 percent.

In accordance with the reviewed literature, our regressions show that an increasingly stable international economic outlook contributed significantly to the overall decline in volatility. We estimate that higher stability in trading partners' rate of growth and lower volatility of terms of trade shocks are responsible for more than fifteen percent of the decrease in output growth volatility (Figure 20): the long-term decline in output growth volatility of trading partners countries (weighted by trade volumes) helps explaining more than 7 percent of the decrease in volatility in East Asia between the 1980s and 2005, and the overall decrease in volatility of terms of trade reduced further output growth volatility by 3.9 percent (in non-OECD East Asian countries, terms of trade growth volatility has decreased from 6.8 percent in the 1970s to 3.3 in the 2000s, and before the crisis was lower than average volatility in OECD countries: see Figure 14).

Domestic factors that lowered volatility include improved institutional quality, more stable monetary policies, and better fiscal management. Efforts made to enhance institutional quality paid off by increasing overall stability of GDP growth (Figure 18). Large reductions have also been achieved thanks to more stable monetary policies and better fiscal

[12] As computing volatility requires observations over several years, the impact of the current financial crisis will be precisely known in a few years from now only.

management. In some countries such as Thailand and the Philippines, lower and more stable inflation followed the adoption of inflation targeting (adopted in the second quarter of 2000 and 2002, respectively),[13] which helped building credibility and anchoring inflation expectations more rapidly and durably.[14] Overall, we estimate that in middle-income countries lower volatility of inflation decreased output growth volatility by more than 8 percent (Figure 18). The complement of more stable monetary policies has been sound and stable fiscal policies, which generated a decrease in output growth volatility in almost every country. For example, in 2001 Indonesia started a plan of fiscal consolidations and a restructuring of the financial markets, and in China a proactive fiscal policy was adopted in 1998 to counteract the negative impact of the 1997 financial crisis.[15] These efforts have paid off: our estimations find that the overall decrease in volatility of government spending from its 1970s level (6.89 percent) to the 2000-2005 levels (2.91 percent) has helped reduce overall output growth volatility by 5.2 percent.[16]

Finally, our estimations confirm that one of the main sources of vulnerability in East Asia remains its high openness to trade. East Asian countries are markedly more open to trade than OECD countries. The average trade volume for non-OECD East Asia is more than one and the half the OECD trade volume (78 versus 45 percent of GDP), and is 20 percent higher than the average trade volume of other non-OECD countries (Figure 11). While this high trade volume strongly contributes spurring East Asian growth, it also makes East Asian countries more vulnerable to external shocks: we estimate that if trade volumes would have remained at their 1980s levels, output growth volatility would be about 9 percent lower (Figure 18).

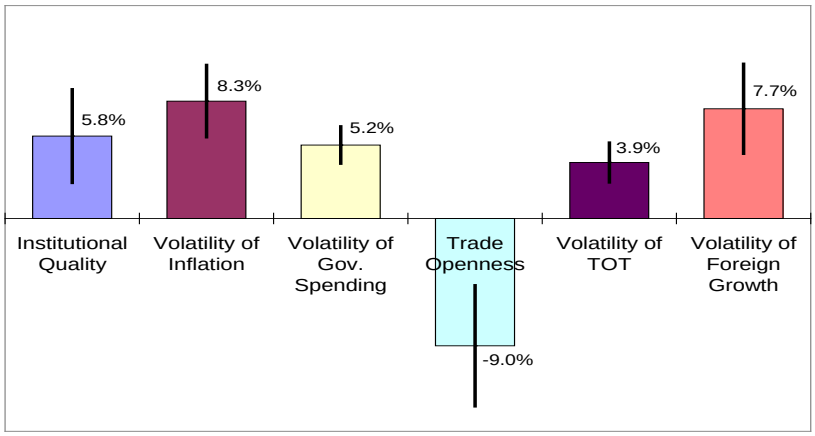
[13] The Bank of Thailand formally adopted inflation targeting in May 2000 (see Charoenseang and Manakit (2007) for more details on the effect of the change in monetary policy in Thailand, and Ito and Hayashi (2004) for an analysis of Inflation Targeting in Asia).

[14] There are several papers in support of this argument, for a review see Mishkin and Schmidt-Hebbel (2007).

[15] See Goodfriend and Prasad (2005) and Boediono (2005) for details on reforms in China's monetary and fiscal policy and the stabilization plan in Indonesia.

[16] As previously mentioned, existing literature also finds that increased depth of financial markets has contributed to the decline in volatility. We refrain however from estimating the impact as in our regressions financial depth carries a statistically insignificant coefficient.

Figure 18: Estimated contributions to the decrease in volatility: middle income EAP in 2000-05 vs. 1980s

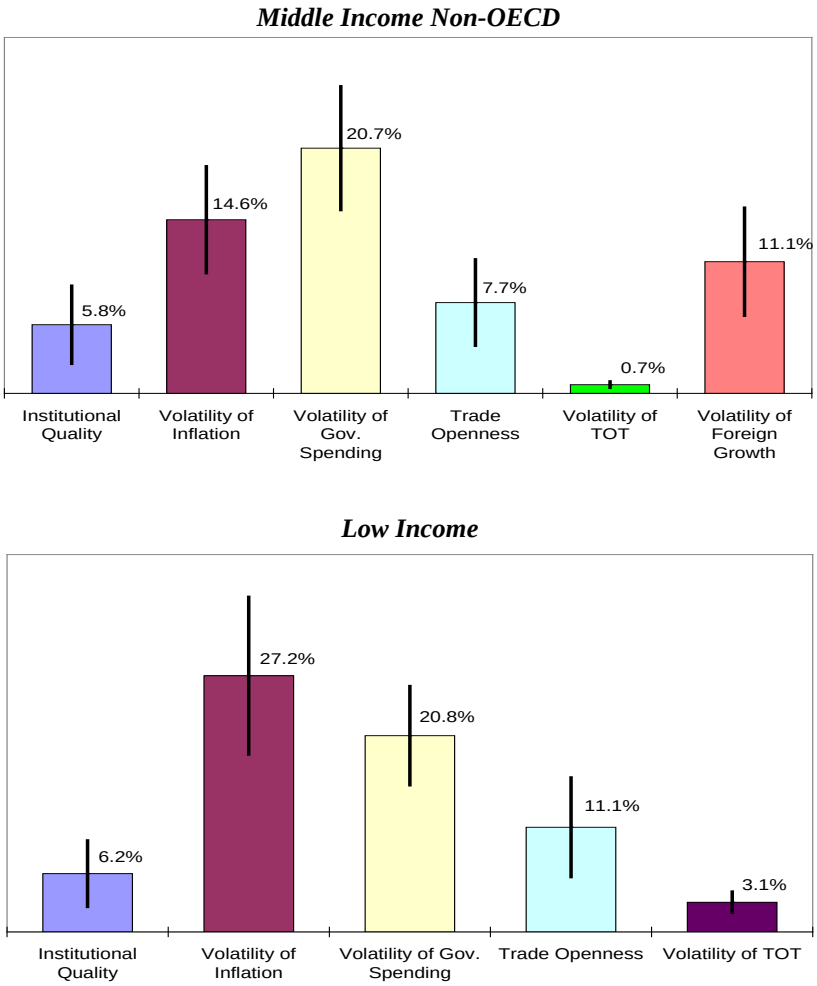


Source: Author's own calculations using data from WDI, IMF and Polity IV. For each variable, EAP is the average of China, Indonesia, Thailand, Malaysia and the Philippines.

Mitigating Upward Pressures on Volatility from the Financial Crisis

While trade openness majorly contributed to the East Asian economic success, it created at the same time a channel through which external volatility gets transmitted (Table A1). In the face of the financial crisis, East Asian countries should act therefore on the domestic front and improve domestic factors that have proven to mitigate volatility. Our regression results suggest that improvements in the quality of institutions up to the average level of OECD countries would reduce volatility by an additional 6 percentage points in both low and middle-income countries (Figure 19). Further improvements in monetary and fiscal policies could also help: in middle-income countries, bringing inflation volatility to median OECD levels could reduce output growth volatility by a further 14.6 percent, and by bringing volatility of government spending to median OECD levels (0.99 percent, i.e. Germany for the period 2000-2005) output growth volatility could be reduced by an additional 20.7 percent (Figure 19). Interestingly, low-income countries present a similar pattern, with improvements in monetary and fiscal policies achieving the highest impact. These estimates are indicative as they represent improvements of fictitious countries with average characteristics, but suggest which areas, at the regional level, could achieve the highest reduction in volatility.

Figure 19: Estimated reduction in volatility if determinants were brought at OECD levels

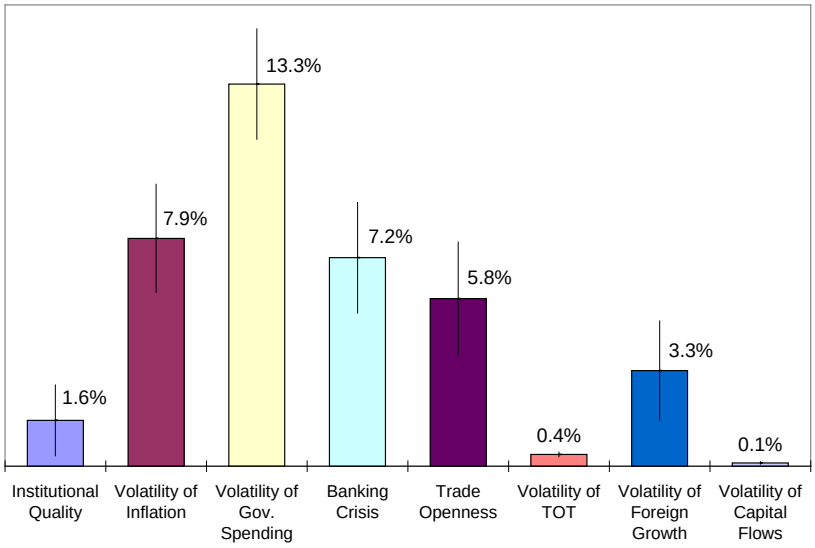


Middle income Non-OECD: average of China, Indonesia, Thailand, Malaysia and the Philippines vs. average OECD levels in 2000-05. Low income non-OECD: average of Lao PDR, Myanmar, Papua New Guinea, Solomon Islands, and Vietnam. The bars represent the estimates' standard deviation. Source: Author's own calculations using data from WDI, IMF and Polity IV.

Determinants that reduce overall volatility are also found to reduce the likelihood of major crises. Our estimations show that improved monetary and fiscal policies, for instance, reduce both "regular" and crisis volatility (Table A.1), hence further improvements would likely help preventing the likelihood of transmission of major crises events. In addition, it also appears that for crisis volatility improvements in the regulation and supervision of the Banking sector would reduce the likelihood of a major crisis (Figure 20), something not observed for "regular" volatility. Given the nature of the current crisis, and strains in the Banking sector that some countries such as Cambodia are currently facing, it is vital to rapidly improve prudential supervision and create fast response plans for handling banking

problems. The central bank role as lender of last resort coordinated with bank supervision and deposit insurance are key elements for averting bank runs. In addition, improved financial depth would also allow a better allocation of resources where and when needed, generating a beneficial impact on volatility.

Figure 20: Estimated reduction in Crisis Volatility if determinants were brought at OECD levels (middle income East Asia)



Average of China, Indonesia, Thailand, Malaysia and the Philippines vs. average OECD levels in 2000-05. The bars represent the estimates' standard deviation. Source: Author's own calculations using data from WDI, IMF and Polity IV.

6 CONCLUSIONS: FACING THE PRESENT CHALLENGES

While East Asian countries successfully managed to reduce output growth volatility in the past decades, the ongoing crisis is putting renewed pressure on volatility. The more volatile international environment is having strong repercussions on domestic macroeconomic stability, and is unlikely to reverse soon to pre-crisis levels. The majority of forecasts predict lower growth and higher volatility in most high-income countries, which will have a significant impact on the economic performance of East Asian economies.

The potential impact of the financial crisis is particularly relevant for East Asian countries because of their higher openness to trade and less developed financial markets. The expansion of trade through domestic liberalization under the auspices of the GATT and WTO has been remarkable in East Asia, and while the process has been a key driver of economic growth, it also makes East Asia more vulnerable to external shocks.

To cope with these events and help reduce output growth volatility, there needs to be improvements in domestic structural factors that reduce volatility. The paper identified three main domestic sources of volatility that could be further improved: financial stability, institutional quality, and monetary and fiscal policies. First, advancements could be made to improve financial stability. It is urgent to improve prudential supervision and create fast response plans for handling banking problems. The central bank role as lender of last resort coordinated with bank supervision and deposit insurance are key elements for averting bank runs. Moreover, improved financial depth would also allow a better allocation of resources where and when needed with a beneficial impact on volatility. Second, in some countries the quality of institutions could also be improved. It is central that parliaments have strong control over the executive, to prevent it from deviating from medium term plans and to avoid continuous shifts in fiscal policy. Finally, stable monetary and fiscal policies are essential instruments to reduce output growth volatility. In that context, medium-term monetary and fiscal frameworks could be developed to better steer these instruments and provide policy makers with a benchmark and a target for monetary and fiscal policies.[17] If the policy framework is credible it will help fixing inflation expectations and reduce uncertainty about the future, which is crucial to help reduce variability in the economic cycle. In that context, it is imperative that central banks reach and keep independence from the political power – and since it is difficult to achieve good monetary policy under poor fiscal policies, there is a need for active dialogue between monetary and fiscal actors.

[17] Mid-term policy frameworks have been used with great success in Australia and New Zeland, but also in China. Australian monetary policy, for example, was consolidated into a medium-term inflation targeting regime in 1993.

APPENDIX

A. Tables

Table A1: Cycle volatility and crisis volatility
Sample: 80 countries 1966-2005 (5-year period observations)
Dependent variable: Standard deviation of the growth rate of GDP per capita
Estimation Method: OLS and Arellano and Bover (GMM)

	Cyclical Volatility		Crisis Volatility	
	OLS	GMM	OLS	GMM
Institutions (Executive Constraint)	-0.034***	-0.032*	-0.019	-0.028
	(2.75)	(1.76)	(0.96)	(1.51)
Volatility of Inflation	0.137***	0.131***	0.174***	0.185***
	(4.17)	(3.26)	(3.43)	(4.38)
Volatility of Government Spending	0.141***	0.142***	0.095***	0.190***
	(4.39)	(3.97)	(2.68)	(5.48)
# of years under a systematic banking crisis	0.331	0.314	2.483**	3.107***
	(0.49)	(0.67)	(2.29)	(4.36)
Financial Depth	-0.028	-0.039	-0.1	-0.003
	(0.77)	(0.72)	(1.37)	(0.05)
Trade Openness	0.095**	0.203**	0.058	0.454***
	(2.25)	(2.11)	(1.29)	(3.38)
Volatility of Terms of Trade	0.028*	0.049***	0.065***	0.079***
	(1.70)	(2.83)	(4.30)	(5.71)
Standard deviation of Foreign Growth	0.152	0.249**	0.061	0.224**
	(1.46)	(2.44)	(0.46)	(2.27)
Standard deviation of Foreign capital flows	0.094*	-0.016	0.240***	0.142***
to the region	(1.79)	(0.43)	(4.02)	(3.29)
Observations	607	607	607	607
R-squared	0.33		0.27	
Number of Country		80		80
Number of Instruments		56		56
Arellano-Bond test for AR(1)		0.000		0.001
Arellano-Bond test for AR(2)		0.66		0.326
Hansen test of overid. restrictions		0.176		0.666

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A2: Determinants of output growth
Sample: 80 countries 1966-2005 (5-year period observations)
Dependent variable: Growth rate of GDP per capita
Estimation method: OLS and Arellano and Bover (GMM)

	No Volatility		Cyclical Volatility		Crisis Volatility	
	OLS	GMM	OLS	GMM	OLS	GMM
Volatility			-0.565***	-1.237***	-1.476***	-1.546***
			(3.32)	(11.96)	(15.33)	(32.34)
Initial GDP pc (in logs)	-0.676***	-0.582***	-0.676***	-0.782***	-0.639***	-0.919***
	(4.18)	(3.32)	(4.17)	(5.25)	(4.43)	(7.53)
Education	1.607***	2.722***	1.531***	2.858***	1.320***	2.600***
	(6.66)	(6.63)	(6.23)	(7.41)	(6.58)	(11.10)
Financial Depth	0.840***	1.000***	0.764***	0.878***	0.568***	0.802***
	(4.26)	(4.43)	(3.91)	(4.63)	(3.40)	(5.56)
Government Spending (%GDP)	-0.764**	-3.082***	-0.687**	-2.691***	-0.776***	-1.666***
	(2.49)	(5.64)	(2.26)	(4.79)	(3.01)	(3.39)
Inflation	-0.019***	-0.015***	-0.017***	-0.016***	-0.004	-0.001
	(5.59)	(6.71)	(4.88)	(6.98)	(1.57)	(0.30)
Trade Openness	0.134	1.313***	0.199	1.036**	0.305**	1.150***
	(0.78)	(2.69)	(1.16)	(2.20)	(1.99)	(3.48)
Growth rate of Terms of Trade	0.033	0.032**	0.034	0.028**	0.039**	0.033***
	(1.24)	(2.41)	(1.33)	(2.34)	(1.99)	(4.34)
Growth rate of Main Trading Partners	0.347	0.451	0.287	-0.063	0.152	0.107
	(1.02)	(1.56)	(0.87)	(0.26)	(0.52)	(0.55)
Capital flows to the region (% of the	0.207***	0.186***	0.173**	0.164***	0.192***	0.191***
region's GDP)	(3.04)	(4.46)	(2.48)	(5.79)	(3.40)	(4.99)
Observations	617	617	617	617	617	617
R-squared	0.32	--	0.33	--	0.51	--
Number of Country # code		80		80		80
Number of Instruments		59		67		67
Arellano-Bond test for AR(1)		0.00		0.00		0.00
Arellano-Bond test for AR(2)		0.933		0.42		0.101
Hansen test of overid. restrictions		0.14		0.35		0.19

Robust t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A3: Average growth and volatility by decade in EAP

Country	Growth					Volatility				
	1961-70	1971-80	1981-90	1991-00	2001-05	1961-70	1971-80	1981-90	1991-00	2001-05
Brunei Darussalam	--	4.97	-4.36	-0.37	-0.22	--	10.92	6.55	2.00	1.47
China	2.41	4.37	7.77	9.28	8.87	13.82	3.87	3.88	2.38	0.91
Fiji	2.35	2.97	-0.33	1.60	1.78	5.21	4.51	6.58	3.57	1.87
Micronesia, Fed. Sts.	--	--	0.45	0.53	-0.13	--	--	1.16	4.51	2.91
Guam	--	--	--	--	--	--	--	--	--	--
Hong Kong, China	7.12	6.73	5.21	2.98	3.73	3.99	5.19	4.24	3.98	3.53
Indonesia	1.88	5.40	4.47	2.91	3.33	4.08	1.29	2.54	6.46	0.72
Cambodia	--	--	--	4.82	7.41	--	--	--	2.61	2.64
Kiribati	--	-2.18	-0.53	2.59	-0.59	--	24.40	7.68	3.70	2.87
Lao PDR	--	--	1.49	3.69	4.55	--	--	5.83	1.38	0.56
Macao, China	--	--	3.79	1.10	10.92	--	--	3.52	4.71	9.67
Marshall Islands	--	--	4.17	-2.39	-0.61	--	--	7.67	5.82	1.94
Myanmar	0.93	2.27	-0.46	5.41	8.05	7.14	2.56	5.32	3.27	4.65
Mongolia	--	--	2.66	-1.23	5.18	--	--	3.06	5.62	2.67
Malaysia	3.47	5.34	3.17	4.57	2.38	1.33	3.07	3.44	5.13	2.54
New Caledonia	8.90	-0.99	3.65	-0.72		11.95	8.08	10.86	2.31	--
Philippines	1.82	3.06	-0.63	0.84	2.33	0.95	1.61	4.89	2.57	1.67
Palau	--	--	--	--	4.15	--	--	--	--	1.17
Papua New Guinea	4.71	0.29	-1.27	2.32	-0.84	2.40	3.97	2.49	7.66	1.70
French Polynesia	0.13	2.07	3.09	0.44	--	8.02	7.08	2.42	2.21	--
Singapore	7.37	7.19	4.99	4.68	2.52	5.46	2.85	3.17	3.91	4.58
Solomon Islands	-0.92	1.93	3.50	-1.20	-0.82	4.36	16.41	6.41	6.24	6.91
Thailand	5.00	4.47	6.31	3.48	4.29	1.92	2.65	3.41	6.13	1.95
Timor-Leste	--	--	--	13.12	-2.92	--	--	--	--	11.21
Tonga	--	--	2.09	2.41	2.23	--	--	3.41	2.89	0.77
Vietnam	--	--	2.26	5.89	6.06	--	--	1.57	1.51	0.63
Vanuatu	--	-13.77	0.38	1.68	-1.51	--	--	7.52	4.16	5.69
Samoa	--		0.75	1.56	3.61	--	--	3.27	3.58	2.01

Source: Author's own calculations using WDI (2007)

Table A4: Summary Statistics

	World					EAP			
Variable	Obs	Mean	SD	Min	Max	Obs	Mean	SD	Min	Max
Volatility of Output Growth	617	0.88	0.72	-1.03	2.87	47	0.81	0.76	-0.89	2.10
Institutional Quality	609	4.63	2.28	1.00	7.00	47	4.20	1.90	1.00	7.00
Volatility of inflation	617	1.30	1.13	-1.66	5.12	47	1.12	0.89	-0.41	3.76
Volatility of Government Spending	617	1.47	1.12	-1.62	4.99	47	1.62	0.70	0.17	3.28
# of Banking Crisis	617	0.02	0.05	0.00	0.18	47	0.04	0.06	0.00	0.18
Domestic Credit (% of GDP)	617	3.38	0.89	-0.02	5.40	47	3.83	0.78	2.20	5.27
Trade Openness	617	3.94	0.63	1.97	5.79	47	4.46	0.59	3.47	5.79
Volatility of TOT	612	1.67	1.55	-12.59	4.23	47	1.55	0.86	-0.70	2.93
Voltility of Foreign Growth	617	0.02	0.49	-1.54	1.04	47	0.10	0.40	-0.56	0.99
Volatility of Capital Flows	617	0.03	0.65	-1.97	1.49	47	-0.13	0.62	-1.04	1.02
Average Growth	617	1.76	2.76	-10.34	11.75	47	3.92	3.19	-3.52	10.95
Initial GDP	617	7.67	1.53	4.44	10.53	47	7.03	1.05	5.23	9.87
Education	617	3.79	0.80	0.11	5.02	47	3.76	0.58	2.44	4.41
Government Spending (% of GDP)	617	2.64	0.38	1.46	3.63	47	2.50	0.32	1.91	3.41
Inflation	617	15.38	31.56	-1.98	361.83	47	6.63	4.19	1.05	17.61
Growth Rate of TOT	617	-0.19	4.59	-18.86	22.03	47	-0.47	3.17	-5.55	11.49
Growth Rate of Main Trading Partners	617	2.38	0.91	-0.55	6.02	47	2.78	1.01	1.28	6.02
Growth rate of Capital Flows	617	3.15	2.07	-1.64	10.34	47	3.33	1.30	1.01	5.66
Crisis Volatility	617	0.42	0.95	0.00	7.55	47	0.26	0.62	0.00	2.63

Sorce: Author's own calculation using data from WDI (2007) and Polity IV.

B. Data and Methodology

We conducted two analogous empirical analyses. The first focuses on growth volatility which is the subject matter of the report, and the second on economic growth. In both cases, the dependent variable is constructed using the annual per capita real GDP growth rate as the main input. For growth volatility, the dependent variable is the *standard deviation* of the growth rate of economic growth over a 5 years time period; for economic growth, the dependent variable is the *average* rate of growth over the same time period.

Data

We work with a pooled data set of cross-country and time-series observations. It consists of 80 countries and, for each of them, at most 8 non-overlapping five-year periods spanning the 1966-2005 period. GDP data are from the World Bank's World Development Indicators (2007). Our variable of institutional quality captures "Constraints on the Executive" as measured by Polity IV. Financial depth is measured as the ratio of domestic credit to GDP. Our measure of macroeconomic management is the standard deviation of the consumer price index (CPI) inflation rate. The volatility of fiscal policy represents the standard deviation of general real government consumption. Finally, trade openness represents the volume of trade (exports and imports) over GDP. All these variables are from the WDI (2007). Data on the volatility of the growth rate of terms of trade; volatility of the growth rates of main trading partners; and volatility of capital flows to the region are from the World Bank (WDI 2007) and Loayza *et al.* (2005).

Methodology [18]

The general regression equation that we estimate (both for volatility and for economic growth) is the following:

$$y_{i,t} = \beta X_{i,t} + \mu_t + \eta_i + \varepsilon_{i,t} \quad \text{(B.1)}$$

Where the subscripts i and t represent country and time period, respectively; y is the dependent variable; X is a set of time- and country-varying explanatory variables that may include a lagged dependent variable, proxies of trade openness, measures of various external shocks, interaction terms, and control variables; μ_t and η_i denote unobserved time- and country-specific effects, respectively; and ε is the error term.

For the sake of simplicity, we shall focus attention on the growth regression – which, as it contains a lagged dependent variable, represents the more complex case. The regression presented above poses some challenges for estimation. The first is the presence of unobserved period- and country-specific effects. While the inclusion of period-specific dummy variables can account for the time effects, the common methods of dealing with country-specific effects (that is, within-group or difference estimators) are inappropriate given the dynamic nature of the regression. The second challenge is that most explanatory variables are likely to be jointly endogenous with economic growth, so we need to control for the biases resulting from simultaneous or reverse causation. The following outlines the econometric methodology we use to control for country-specific effects and joint endogeneity in a dynamic model of panel data.

[18] Adapted from Loayza, Olaberria, and Rigolini (2009).

We use the generalized method of moments (GMM) estimators developed for dynamic models of panel data that were introduced by Holtz-Eakin, Newey, and Rosen (1988), Arellano and Bond (1991), and Arellano and Bover (1995). These estimators are based, first, on differencing regressions or instruments to control for unobserved effects and, second, on using previous observations of explanatory and lagged-dependent variables as instruments (which are called internal instruments). To eliminate the country-specific effect, we take first differences of equation B.1:

$$y_{i,t} - y_{i,t-1} = \alpha\left(y_{i,t-1} - y_{i,t-2}\right) + \beta'\left(X_{i,t} - X_{i,t-1}\right) + \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right) \quad \text{(B.2)}$$

where we now have made explicit the presence of a lagged variable. The use of instruments is required to deal with the likely endogeneity of the explanatory variables and the problem that, by construction, the new error term, $\varepsilon_{i,t} - \varepsilon_{i,t-1}$, is correlated with the lagged dependent variable, $y_{i,t-1} - y_{i,t-2}$. The instruments take advantage of the panel nature of the data set in that they consist of previous observations of the explanatory and lagged-dependent variables. Conceptually, this assumes that shocks to economic growth (that is, the regression error term) be unpredictable given past values of the explanatory variables. The method does allow, however, for current and future values of the explanatory variables to be affected by growth shocks. It is this type of endogeneity that the method is devised to handle.

Under the assumptions that the error term, ε, is not serially correlated and that the explanatory variables are weakly exogenous (that is, the explanatory variables are assumed to be uncorrelated with future realizations of the error term), our application of the GMM dynamic panel estimator uses the following moment conditions:

$$E\left[\, y_{i,t-2} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \quad \text{(B.3)}$$

$$E\left[\, X_{i,t-2} \cdot \left(\varepsilon_{i,t} - \varepsilon_{i,t-1}\right)\right] = 0 \quad \text{(B.4)}$$

for $t = 3,\ldots, T$ (note that we limit the set of instruments to one lag only, while the set of possible moment conditions includes all available lags. We do it to avoid overfitting bias. We return to this issue below). The GMM estimator based on the conditions in B.3 and B.4 is known as the difference estimator. Notwithstanding its advantages with respect to simpler panel data estimators, the difference estimator has important statistical shortcomings. Blundell and Bond (1998) and Alonso-Borrego and Arellano (1999) show that when the explanatory variables are persistent over time, lagged levels of these variables are weak instruments for the regression equation in differences. Instrument weakness influences the asymptotic and small-sample performance of the difference estimator toward inefficient and biased coefficient estimates, respectively.[19]

To reduce the potential biases and imprecision associated with the difference estimator, we use an estimator that combines the regression equation in differences and the regression equation in levels into one system (developed in Arellano and Bover, 1995, and Blundell and Bond, 1998). For the equation in differences, the instruments are those presented above. For the equation in levels

[19] An additional problem with the simple difference estimator involves measurement error: differencing may exacerbate the bias stemming from errors in variables by decreasing the signal-to-noise ratio (see Griliches and Hausman, 1986).

(equation B.2), the instruments are given by the lagged differences of the explanatory variables.[20] These are appropriate instruments under the assumption that the correlation between the explanatory variables and the country-specific effect is the same for all time periods.

Note that we use only a limited set of moment conditions. In theory the potential set of instruments spans all sufficiently lagged observations and, thus, grows with the number of time periods, *T*. However, when the sample size in the cross-sectional dimension is limited, it is recommended to use a smaller set of moment conditions in order to avoid over-fitting bias (see Arellano and Bond 1998; for a detailed discussion of over-fitting bias in the context of panel-data GMM estimation, see Roodman 2007). This is our case, and therefore we use two steps to limit the moment conditions. First, as described in detail above, we use as instruments only the *first appropriate lag* of each endogenous explanatory variable. Second, we use a common variance-covariance of moment conditions across periods. This results from substituting the assumption that the average (across periods) of moment conditions for a particular instrument be equal to zero for the assumption, conventional but more restrictive, that each of the period moment conditions be equal to zero.[21] At the cost of reduced efficiency, our two steps decrease over-fitting bias in the presence of small samples by accommodating cases when the unrestricted variance-covariance is too large for estimation and inversion given both a large number of explanatory variables and the presence of several time-series periods.

The consistency of the GMM estimators depends on whether lagged values of the explanatory variables are valid instruments in the growth regression. We address this issue by considering two specification tests. The first is the Hansen test of overidentifying restrictions, which tests the validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. Failure to reject the null hypothesis gives support to the model. The second test examines whether the original error term (that is, $\varepsilon_{i,t}$ in equation B.2) is serially correlated. The model is, therefore, supported when the null hypothesis is not rejected. In the system specification, we test in fact whether the first-differenced error term (that is, the residual of the equation in differences) is second-order serially correlated. First-order serial correlation of the differenced error term is expected even if the original error term (in levels) is uncorrelated, unless the latter follows a random walk. Second-order serial correlation of the differenced residual indicates that the original error term is serially correlated and follows a moving average process of at least order one.

[20] The timing of the instruments is analogous to that used for the difference regression: for the variables measured as period averages, the instruments correspond to the difference between *t-1* and *t-2*; and for the variables measured at the start of the period, the instruments correspond to the difference between *t* and *t-1*.

[21] This uses the "collapse" option of xtabond2 for STATA.

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