Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 646

Noviembre 2011

THE IMPACT OF UNCERTAINTY SHOCKS IN EMERGING ECONOMIES

Yan Carrière–Swallow

Luis Felipe Céspedes

La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: http://www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de $500 si es dentro de Chile y US$12 si es para fuera de Chile. Las solicitudes se pueden hacer por fax: (56-2) 6702231 o a través de correo electrónico: bcch@bcentral.cl.

Working Papers in PDF format can be downloaded free of charge from: http://www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for orders inside Chile the charge is Ch$500.) Orders can be placed by fax: (56-2) 6702231 or e-mail: bcch@bcentral.cl.

BANCO CENTRAL DE CHILE

CENTRAL BANK OF CHILE

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
Agustinas 1180, Santiago, Chile
Teléfono: (56-2) 3882475; Fax: (56-2) 3882231

Documento de Trabajo N° 646 | **Working Paper N° 646**

THE IMPACT OF UNCERTAINTY SHOCKS IN EMERGING ECONOMIES

Yan Carrière–Swallow
Banco Central de Chile

Luis Felipe Céspedes
Universidad Adolfo Ibáñez

Abstract

A recent strand of research proposes that sudden jumps in uncertainty generate rapid drops and recoveries in real macroeconomic variables that drive the business cycle. Using an empirical model, we find substantial heterogeneity in the reactions to these shocks across countries. In comparison to the U.S. and other developed countries, emerging economies suffer much more severe falls in investment and private consumption following an exogenous uncertainty shock, take significantly longer to recover, and do not experience a subsequent overshoot in activity. We provide evidence that the dynamics of investment and consumption are correlated with the depth of financial markets. Once we control for the potential role of credit constraints, we find that investment and consumption dynamics in emerging economies are similar to those in developed economies. In this context, monetary and fiscal policy actions that alleviate the impact of credit constraints facing firms and households may reduce the impact of uncertainty shocks in these economies.

Resumen

La literatura reciente propone que un aumento repentino del nivel de incertidumbre genera caídas y recuperaciones rápidas en variables macroeconómicas. Estimando un modelo empírico, encontramos heterogeneidad entre las reacciones de distintos países frente a estos shocks. Frente a un aumento repentino de la incertidumbre, las economías emergentes sufren caídas mayores en inversión y consumo privado que los países desarrollados, se demoran más en recuperarse, y no experimenten un sobrerreacción posterior en la actividad. Encontramos evidencia de que la dinámica de la inversión y el consumo está correlacionada con la profundidad del mercado financiero local. Cuando controlamos por el potencial rol del canal del crédito, encontramos que la dinámica de la inversión y el consumo en los mercados emergentes es parecida a la de los países desarrollados. Dados nuestros resultados, una intervención monetaria o fiscal dirigida a contrarrestar el impacto de las restricciones del crédito que enfrenten los agentes económicos podrían reducir el impacto de la incertidumbre global sobre las economías emergentes.

We thank Javier García-Cicco, César Carrera, Sebastián Claro and seminar participants at the Central Reserve Bank of Peru and Central Bank of Chile for insightful comments. All remaining errors are our own. The views expressed in this paper are those of the authors and do not represent those of the Central Bank of Chile or its board members.

1 Introduction

Sudden changes to the level of aggregate uncertainty facing economic agents has been shown to be an important shock driving the U.S. business cycle. Using a simple reduced-form VAR, Bloom (2009) estimates that U.S. industrial production is reduced by approximately 1 percent in response to an uncertainty shock. The initial drop is followed by a swift recovery and subsequent overshoot in production that surpasses its trend by approximately one percent. Gourio, Siemer and Verdelhan (2010) find that similar dynamics are observed in a group of high-income OECD countries following spikes in global uncertainty. The main purpose of this paper is to examine to what extent these findings generalize to a broader group of countries.

In this paper we address whether the rapid drop and rebound of macroeconomic variables in response to uncertainty shocks in developed economies is also a regularity for emerging market economies. In particular, we compare the behavior of investment and private consumption in response to global uncertainty shocks in developed and emerging economies using an open-economy VAR approach. Our global uncertainty shock corresponds to strong increases in U.S. stock market volatility, and we also employ a measure of local uncertainty shocks for a smaller group of emerging economies in order to check the robustness of our findings.

The evidence we present for a large group of developed economies is consistent with the literature.[1] In particular, there is a rapid drop and rebound in investment following an uncertainty shock, while private consumption remains almost unchanged. These dynamics are consistent with the predictions of a model with fixed investment costs that generate a real-option value of waiting under uncertainty as stressed by Bloom (2009). In contrast, the evidence we present for emerging markets indicates that these economies suffer a much more severe fall in investment and that this fall is considerably more persistent. We also observe a significant fall in private consumption following global uncertainty shocks, in contrast to developed economies where consumption does not deviate from its trend throughout the event.

It has been proposed that uncertainty generates reductions in real activity since at least Keynes (1937), who suggested that investment is the most volatile component of aggregate demand precisely because it relies most heavily on opinions about future events, which are necessarily ill-informed. Building on work by Weisbrod (1964) and Arrow and Fischer (1974), Bernanke (1983) formalized the idea that, when projects are irreversible and information is made available over time, the presence of uncertainty about future returns generates an

[1] See Bloom (2009) for evidence estimated for the U.S., and Gourio, Siemer and Verdelhan (2010) for a group of five OECD countries.

option value of waiting that lowers the rate of current investment, even when agents are risk-neutral.[2] Recent work on the topic has made progress on modelling the effects of uncertainty, on verifying the predictions of the theoretical models with their empirical counterparts, and on estimating the economic significance of the mechanism.

In models of investment with fixed adjustment costs, such as Bloom (2009), the region of inaction – in which firms find it optimal not to adjust their input levels – varies according to the level of time-varying uncertainty. In periods of high uncertainty, more firms choose to "wait-and-see", putting their investments on hold voluntarily. When uncertainty dissipates and business conditions can be better ascertained, firms who postponed their factor adjustments find themselves far from their optimal levels of capital and labor, and thus carry out the corresponding adjustment to relieve their pent-up factor demand. This generates a rapid recovery and overshoot from the original trend levels of macro variables. This modelling approach predicts that a given fiscal or monetary policy intervention will have less impact during periods of high uncertainty.

A number of candidate explanations are available to account for the heterogeneity in responses we observe across countries, which lead to very different policy prescriptions in the face of uncertainty shocks. While the model described above could be calibrated according to local depreciation and discount rates, the evidence from emerging market economies suggests that other factors may need to be taken into account to fully characterize the response of real activity to uncertainty shocks. These may include credit constraints for firms and households that arise due to characteristics of local financial markets. We explore several alternative mechanisms using a cross-sectional approach in order to shed light on the heterogeneity in response dynamics, but do not offer conclusive evidence in this paper. We document that the amplitude of the fall in investment and private consumption for the group of countries in our sample is correlated with GDP-per-capita, the depth of local financial markets, an index of business-related institutional quality, and the degree of financial dollarization.

Based on our findings, we conduct a counterfactual exercise to gauge the magnifying role of the credit channel. We find that the contraction in credit loans in emerging markets following uncertainty shocks can account for approximately one-third of the drop in investment. Interestingly, the persistence of the drop in investment and the lack of a subsequent overshoot are both explained in large part by the persistent drop in credit. In other words, when we shut off the endogenous response of credit to the uncertainty shock, we observe that investment and consumption dynamics in emerging market economies are similar to those in developed economies.

The paper is organized as follows. In section 2 we present the data used in the paper and

[2]See Pindyck (1991) and Dixit (1992) for an overview of the implications of irreversibility on investment under uncertainty.

discuss our definition of a global uncertainty shock. In section 3 we describe our methodological approach, and state the econometric model we will estimate. In section 4 we present the results of our estimations, examine the heterogeneity in the response functions across countries using plausibly relevant variables, and discuss the policy implications of each interpretation. We then conduct sensitivity analysis using a measure of local uncertainty to ensure that our results are not driven by the use of a global indicator of uncertainty. Section 5 concludes.

2 Data

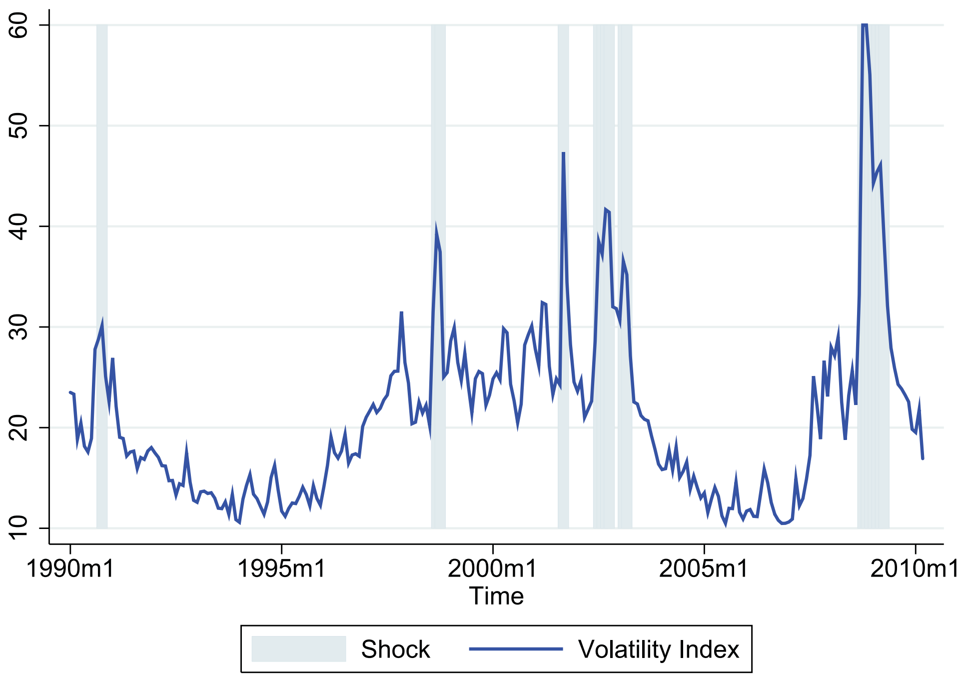
While the idea that uncertainty is an important determinant of the business cycle has been acknowledged since Keynes (1937), its incorporation into modern models of the business cycle was delayed due to its intangible nature. There has been disagreement as to what, exactly, "uncertainty" corresponds to, and what its empirical counterpart should be. In an important contribution, Bloom (2009) showed that measures of stock-market volatility are strongly correlated with other measures of both micro- and macro-level uncertainty, including bond spreads, disagreement among professional forecasters, and the distributions of firm profits and industry productivity growth.[3] This has motivated the use of volatility in stock market options as a measure of implied aggregate uncertainty.

In measuring uncertainty for a panel of countries, it is unclear whether the relevant measure is a local indicator of volatility, or a common global shock that would affect all economies exogenously. Gourio, Siemer and Verdelhan (2010) find that country-level risk indices constructed using local financial indicators are highly correlated across countries. Given this extensive co-movement, they use the mean of their country-level indices as a common measure of global uncertainty in their analysis.

Since reliable high-frequency domestic series are not always available for emerging market countries, a measure built using averages of these domestic series would be susceptible to changes in the sample of countries included. It is also debatable to what extent stock market indices are an adequate measure of local business conditions in an emerging economy, especially during the 1990s when market capitalization was low relative to GDP and very few firms sought financing in local stock markets. For this reason, we choose to use a single series to identify global shocks in our core analysis, and conduct a sensitivity exercise in section 4.4 to test whether our results are robust to using uncertainty series built with domestic financial variables for emerging markets.

[3]Bloom, Bond and Van Reenen (2007) had previously shown that share return volatility is correlated with firm-level uncertainty in the United Kingdom.

Figure 1: U.S. Volatility Index and Global Uncertainty Shocks



Source: Authors' calculations using methodology from Bloom (2009) and data from Bloomberg.

We begin by constructing a volatility index equal to the annualized standard deviation of daily returns in the S&P 500 30-day future options market over a calendar month, defined as x_t. We then implement the identification methodology presented in Bloom (2009), identifying global uncertainty shocks as periods of high volatility in the series x_t, which is graphed for our analysis period in figure 1.

Uncertainty shocks are identified as observations that are 1.65 standard deviations above the Hodrick-Prescott trend value of the index, and correspond to the areas shaded in light blue. Six events that fit this criteria are identified in our sample period, and each can be clearly associated with an important geopolitical or financial event that can be considered exogenous to local macroeconomic fundamentals.[4] The persistently high volatility following

[4]Interestingly, many of the events identified as uncertainty shocks using this criteria coincide with those listed in Caballero and Krishnamurthy (2008) as episodes of increased Knightian uncertainty that generate a flight to quality.

the 2008 financial crisis has increased the standard deviation of the series as a whole, such that not all events reported by Bloom (2009) are identified as shock episodes even though we employ the same identification criteria. In particular, the 1997 Asian financial crisis is no longer considered a global uncertainty shock in our analysis.

The events are weighted according to the magnitude of the volatility shock, making the results comparable across countries even though the events under consideration differ according to the length of each sample. When volatility remains high for more than one quarter, as is the case in the Worldcom/Enron scandals of 2002 and the global financial crisis of 2008–09, the vol_t^* variable maintains a positive value until volatility drops below the threshold. Explicitly, we define the global uncertainty shock series as the following split function:

$$vol_t^* = \begin{cases} 0 & \text{if } x_t < \text{threshold}, \\ x_t & \text{if } x_t >= \text{threshold}. \end{cases}$$

The quarterly series is then constructed as the arithmetic mean across underlying months.

Local macroeconomic variables are from the quarterly national accounts reported by the Organization for Economic Cooperation and Development, the International Monetary Fund's *International Financial Statistics*, and in some cases are supplemented by information from national central banks. Series reported in volumes are used when available, and we deflate nominal series using the national consumer price index to obtain constant-price series in the remaining cases. All series are seasonally adjusted using the X-12-ARIMA routine provided by the U.S. Census Bureau, and detrended using the Hodrick-Prescott filter.[5]

The full list of countries included in our analysis is displayed in table 1. All the countries in our core sample have complete data for the period of 1990:1 to 2010:1. We use a common sample period to ensure that results are comparable across countries, since the shock we are considering is common to all countries and the structure of the international financial system has changed substantially over time. Countries in the extended sample, for which we have data starting between 1991:1 and 1997:1, are included later as robustness checks and in the cross-section correlation exercises.

[5]While most series appear stationary in first-differences, this transformation is particularly important in the estimation of the model for countries that have undergone periods of very high inflation, such as Argentina, Mexico and Peru.

Table 1: Sample of Countries

Developed		*Emerging*	
Core sample (1990:1 to 2010:1)			
Australia	Japan	Chile	
Austria	Netherlands	Hong Kong	
Canada	New Zealand	Mexico	
Denmark	Norway	Philippines	
Finland	Switzerland	South Africa	
France	United Kingdom	South Korea	
Italy	United States	Turkey	
Extended sample (199 to 2010:1)*			
Belgium		Argentina	Indonesia
Germany		Brazil	Israel
Portugal		Colombia	Malaysia
Russia		Croatia	Peru
Spain		Czech Republic	Poland
Sweden		Estonia	Thailand
		Hungary	
Total developed:	20		
Total emerging:	20		
Sample size:	40		

3 Empirical specification

We use a standard specification for the reduced-form vector autoregression that incorporates exogenous shocks, prices and real variables. The full set of variables included in the VAR for each country are: the cyclical component of the S&P-500 index, $\tilde{sp}_t^*$; the weighted uncertainty shock indicator, vol_t^*; the cyclical deviation of consumer price inflation, $\tilde{\pi}_t$; and the cyclical deviations of real investment and consumption. Two lags of each variable are included, and all data are at a quarterly frequency.

The reduced-form VAR model we estimate can be written as:

$$\tilde{sp}^*_t = \rho_1 \tilde{sp}^*_{t-1} + \rho_2 \tilde{sp}^*_{t-2} + \rho_3 vol^*_{t-1} + \rho_4 vol^*_{t-2} + \varepsilon^{sp^*}_t \tag{1}$$

$$vol^*_t = \delta_1 vol^*_{t-1} + \delta_2 vol^*_{t-2} + \varepsilon^{vol^*}_t \tag{2}$$

$$\tilde{\pi}_t = \boldsymbol{\beta}_3(L + L^2)\mathbf{Z}_t + \boldsymbol{\gamma}_3(L + L^2)\mathbf{X}_t + \varepsilon^{\pi}_t \tag{3}$$

$$\tilde{I}_t = \boldsymbol{\beta}_4(L + L^2)\mathbf{Z}_t + \boldsymbol{\gamma}_4(L + L^2)\mathbf{X}_t + \varepsilon^{I}_t \tag{4}$$

$$\tilde{C}_t = \boldsymbol{\beta}_5(L + L^2)\mathbf{Z}_t + \boldsymbol{\gamma}_5(L + L^2)\mathbf{X}_t + \varepsilon^{C}_t \tag{5}$$

where $\boldsymbol{\beta}_3, ..., \boldsymbol{\beta}_5, \boldsymbol{\gamma}_3, ..., \boldsymbol{\gamma}_5$ are vectors of parameters, $\mathbf{Z}_t = \{\tilde{sp}^*_t, vol^*_t\}$ is a vector of exogenous shocks, and $\mathbf{X}_t = \{\tilde{\pi}_t, \tilde{I}_t, \tilde{C}_t\}$ is a vector of endogenous variables.

The inclusion of the stock market index is meant to control for first-moment shocks to returns, such that our analysis of shocks to $\varepsilon^{vol^*}_t$ can be interpreted as the impact of the uncertainty shocks alone. The first two variables are exogenous to the local economy, as would be the case for a small open economy. For our estimation of the United States, we relax equation (1) and allow the stock market to be affected by lags of the endogenous vector $\mathbf{X}_t$.

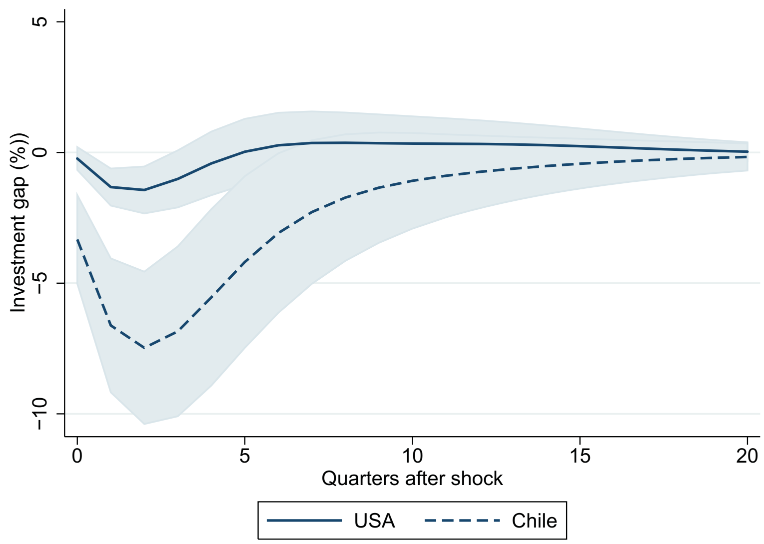
The VAR model given by equations (1) through (5) is estimated by maximum likelihood for each of the countries in our sample. We then compute the impulse-response matrix $\mathbf{\Phi}_i$ and its orthogonalized counterpart $\mathbf{\Theta}_i$ using a Cholesky decomposition of the matrix $\hat{\mathbf{\Sigma}}$, which contains estimates of the contemporaneous covariance between the reduced-form error terms. In the familiar notation employed by Lütkepohl (2006), the orthogonalized impulse-response functions are given by

$$\mathbf{\Theta}_i = \mathbf{\Phi}_i \cdot \mathbf{P}, \quad \text{where} \quad \hat{\mathbf{\Sigma}} = \mathbf{P}\mathbf{P}'.$$

The ordering of variables in the recursive structure is the same as reported in equations (1) through (5). As in Bloom (2009), our main identifying assumption is that, once we have controlled for stock market levels, the uncertainty shocks are completely exogenous to the rest of the variables. As discussed in section 2, the series corresponds to spikes in the volatility of daily stock market returns of the S&P 500 index. While it may be argued that the continuous volatility series depends on stock market levels, and thus on other measures of economic activity, the shocks to this series shown in figure 1 can often be associated with important geopolitical events, and are thus exogenous even to the U.S. economy.

The magnitude of the shock to $\varepsilon^{vol^*}_t$ is equal to the mean value of x_t over all episodes in our sample. The response functions have been normalized to percentage units such that the plots in figures 2, 3 and 5 can be interpreted as the response variable's deviation from trend in percentage points following a volatility shock of average magnitude.

Figure 2: Response of Investment to an Orthogonalized Global Uncertainty Shock



4 Results

4.1 Main findings

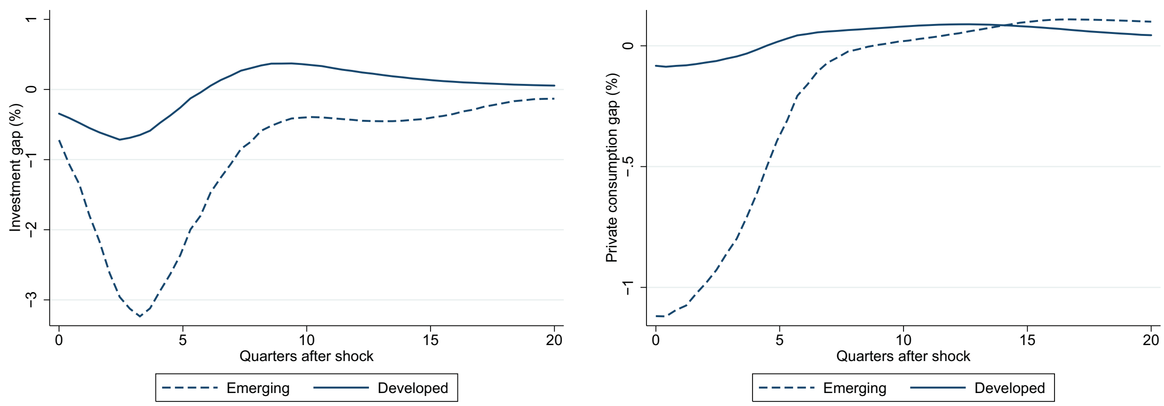
We estimate the model separately for each of the countries listed in table 1. Figure 2 displays the orthogonalized impulse response functions for investment in Chile and the United States following a shock to global uncertainty, with one-standard-deviation confidence intervals shaded in blue. While the U.S. reaction is consistent with the results in Bloom (2009) and Gourio, Siemer and Verdelhan (2010) – displaying a rapid drop, rebound, and overshoot – the Chilean case displays strikingly different characteristics. First, the amplitude of the drop in investment is three times as large. Second, investment takes considerably longer to return to its trend level, indicating that the effect of the uncertainty shock is more persistent. Third, the response of investment in emerging markets displays no subsequent overshoot.

To generalize our findings, we group the countries by their World Bank income classification at the beginning of the sample period (1990), where the "developed" group corresponds to high-income countries and the "emerging" group to countries with low- and middle-income designations (World Bank, 1990). Figure 3 plots the median impulse response functions for the group of emerging market economies and for the group of developed countries.[6] Panel

[6] The value of the median IRF in step i is defined as the median across all IRFs in step i, and does not

Figure 3: Response of Investment and Private Consumption to an Orthogonalized Global Uncertainty Shock

(a) Investment   (b) Private Consumption



A reports the response of investment. The response for developed countries is consistent with the response estimated for the United States, displaying a rapid drop and rebound in investment. The group of emerging economies suffers a much more severe fall in investment following the global uncertainty shock, the median gap falling by three times the fall experienced in developed economies. This result is consistent with Lane's (2003) finding that the business cycle in emerging markets is considerably more volatile than in wealthier countries. We also observe considerable heterogeneity in the persistence of the shock across countries. On average, emerging markets take substantially longer to recover to their pre-shock trend, and display no subsequent volatility overshoot.

Panel B shows the response functions for private consumption. While consumers in developed countries are able to smooth their consumption and thus avoid a drop in utility due to the uncertainty shock, private consumption in emerging markets falls substantially and persistently. Possible explanations for this difference are a constraint on consumer access to financial markets, or to differences in the social safety nets in place in each country. The drop in private consumption is consistent with Bernanke (1983), who argues that consumption in durable goods should fall along with business fixed investment during periods of high uncertainty, since it is subject to a similar degree of irreversibility that would lead agents

correspond to the IRF of a single representative country. For this reason, aggregate IRFs are shown without confidence intervals. Medians are used as our measure of central tendency to ensure that results are not influenced by the presence of outliers.

to postpone their purchasing decisions until uncertainty had subsided.[7] The fall in private consumption observed in emerging economies signals that consumers are likely suffering a transitory loss of welfare as a result of the uncertainty shock.

4.2 Potential explanatory channels and their policy implications

In models that feature fixed adjustment costs and an option-value of waiting mechanism, firms reduce their investment voluntarily during a period of increased uncertainty as their region of optimal inaction widens. The contraction is independent of changes in the expected value of future demand, and takes place even when firms are risk neutral. An implication, which has been explored since Dixit (1992), is that firms are less responsive to a given change in demand or cost conditions during periods of high uncertainty. Bloom, Bond and Van Reenen (2007) employ a panel of British firm-level data to estimate the degree to which aggregate and idiosyncratic uncertainty reduce the responsiveness of investment to demand shocks. They find that firms in the fourth quartile of uncertainty are half as responsive as those in the first quartile, suggesting that the effect of uncertainty is of first-order importance to the firm's investment decision. This leads to the conclusion that both monetary and fiscal policy interventions are ineffective at maintaining rates of investment during episodes of high uncertainty.

But can this class of models be calibrated to generate the observed heterogeneity across countries that we have reported above? The value of waiting is influenced by the size of the fixed cost associated with investing – or, equivalently, the degree of irreversibility of capital – faced by firms, which is likely to vary across countries. Pindyck (1991) discusses how the degree of irreversibility in an economy is determined in part by the market environment, such as regulations on capital mobility and the risk of expropriation. The sunk costs associated with filing lengthy paperwork and overcoming bureaucracy also increase the irreversibility of projects. Countries with regulatory frameworks that make investments less reversible should thus generate larger real-option values to waiting during periods of uncertainty, and thus suffer deeper recessions.

Another parameter that determines the value of waiting in the model is the stochastic discount factor that firms use to discount future profits. When the future is heavily discounted, the value of putting off current projects in order to wait for stability to return goes down, and firms will be more likely to go ahead with projects despite high levels of uncertainty. Cross-country differences in discount rates could thus account for some of the

[7] Carrière-Swallow and Medel (2011) carry out a sectorial analysis for Chile and confirm that the fall in private consumption following an uncertainty shock is due to a very large fall in consumption of durable goods.

variability in amplitude.[8]

While these parameters can help describe the heterogeneity in amplitude, they cannot directly account for the slow rate of recovery or for the absence of an overshoot in the medium-run. The real-options mechanism generates a fall in investment in response to increased uncertainty by widening the region of inaction, and subsequent recovery to trend once the uncertainty returns to normal levels. In Bloom (2009), the overshoot estimated for the U.S. economy is modelled using a separate mechanism. The increased volatility following the uncertainty shock, when combined with a positive rate of depreciation, skews the distribution of firms in capital-to-productivity space, creating a glut of firms on the edge of their inaction regions that initiate investment projects once the level of uncertainty has fallen back to normal levels. This "volatility overshoot" generates a positive response in the medium-term, and once uncertainty has fallen sufficiently, is enough to generate the overshoot in the reaction function. The shape of the impulse response function for emerging markets is similar to that reported by Bloom in his decomposition exercise as the result of the uncertainty channel alone, suggesting that volatility effects might not have the same effect in emerging markets.

In order to examine the differences in the investment reaction across countries, we compute for each country the amplitude and duration of each impulse-response function for the investment gap equation (4) following an orthogonalized shock to $\varepsilon_t^{vol^*}$. Then, we correlate these variables with potentially relevant country characteristics. We define duration as the number of quarters it takes to close the investment gap following the shock.[9] Amplitude is defined as the most negative value of the inflation gap following the shock. For this exploratory exercise, we estimate the model for the extended sample of countries – including those with data start dates up to 1997:1 – in order to increase the number of data points.

Figure 4a shows the negative correlation between the amplitude of the fall in investment and a country's GDP-per-capita in 1990, generalizing the finding that wealthier countries suffer smaller falls in investment following these events.[10] Figure 4b plots the amplitude of the fall in investment versus the World Bank's *Doing Business* index of institutional quality, which measures the degree to which a country's regulatory framework is friendly

[8]A real depreciation may increase the amplitude of the fall in investment due to the fact that the import content of investment is high in some emerging economies, as documented by Burstein, Neves and Rebelo (2004).

[9]Since some series converge to zero very slowly but spend many periods at values that are statistically indistinguishable from zero, we consider the gap closed once it has reached an arbitrary threshold of 20% of its amplitude.

[10]See appendix A for corresponding figures showing correlations with the amplitude of the fall in private consumption.

to businesses.[11] We consider this variable to be a proxy for the fixed costs or investment irreversibility in each country, and indeed find that countries with lower-quality institutions experience deeper falls in investment following global uncertainty shocks.

In this analysis we have estimated the responses of investment and private consumption across countries to a common uncertainty shock. While difficult to measure, it is possible that the same episode of high global uncertainty may be amplified by local policy, such that the level of uncertainty actually perceived by economic agents differs between countries. Pindyck (1991) warns that "if a goal of macro-economic policy is to stimulate investment, stability and credibility may be more important than the particular levels of tax rates or interest rates." Baker, Bloom and Davis (2011) construct an index of U.S. policy uncertainty using Google News data on media coverage of related keywords, and estimate that shocks to this index have first-order effects on investment behavior. The sharp falls we observe in EMEs may be caused by the magnification of global uncertainty shocks due to a local environment of elevated policy uncertainty. The sensitivity exercise performed by Bloom (2009) suggests that the magnitude of the uncertainty shock could account for the amplitude of the fall in investment, but would also be accompanied by an equally magnified overshoot, which is not observed in our estimations.[12]

Unfortunately, the parameters required to improve country-level fit in the adjustment costs model are difficult to measure, making it difficult to establish to what extent the impact of the uncertainty shocks are being generated by voluntary reductions in firm investment, or by some other mechanism.

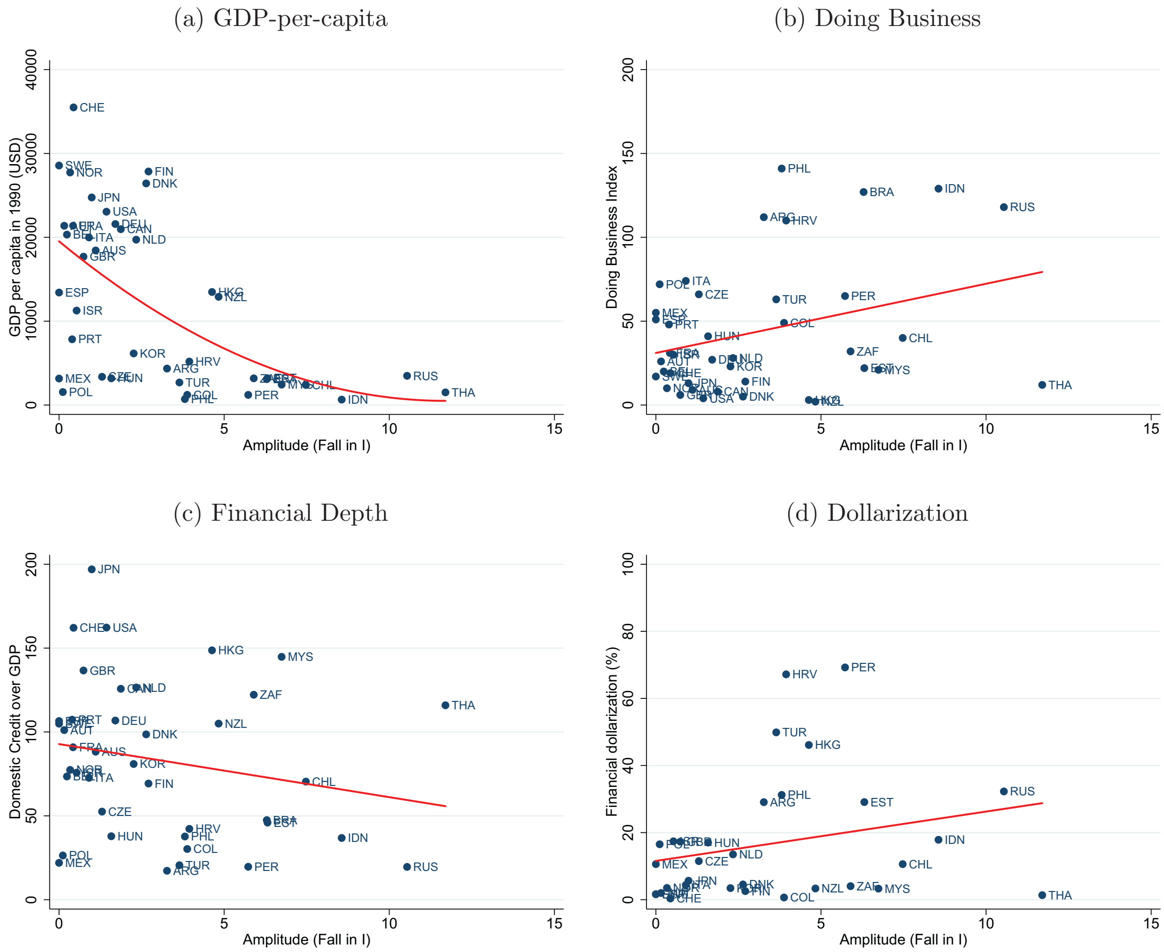
An alternative explanation that could account for the differences in the evolution of investment after an uncertainty shock is the presence of financial frictions. The correlations presented in figure 4 indicate that there is some correlation between the amplitude and certain variables used in the literature to account for credit constraints. As the economy enters a period of high uncertainty, firms may find it more difficult to obtain financing for their projects if (i) banks and other financial intermediaries find it more difficult to gauge the degree of risk involved in the project, (ii) banks are unable to obtain external financing due to a shortage of liquidity or flight-to-quality episode as described by Calvo and Mendoza (2000), or (iii) firms suffer a drop in their balance sheet – perhaps due to a currency mismatch and sudden depreciation – which reduces the collateral available to post against new loans. The fall in the collateral value and/or the deterioration in the firms' balance sheets increase the negative effect of the uncertainty shock in the economy both in terms of the initial fall but also in terms of the persistence of the drop in investment.

An extensive literature has explored the link between emerging market recessions and the

[11] Note that a lower score indicates better institutional quality.

[12] See Bloom (2009), p. 672 for a discussion of this sensitivity exercise.

Figure 4: Cross-sectional correlation with amplitude of fall in investment



functioning of financial markets. Claessens, Kose and Terrones (2011) carry out a comprehensive business-cycle analysis of recessions and recoveries for a sample of 45 countries. One of their findings is that recessions in emerging market countries are more often accompanied by financial market disruptions than is the case in developed economies. Aizenman and Powell (2003) show that a weak legal system combined with high information verification costs generates large, first-order effects of volatility on production, employment and welfare.

A firm credit constraint could affect (i) the extensive margin, by reducing firms' ability to maintain operations while postponing profitable projects during the period of uncertainty, and (ii) the speed at which firms can satiate pent-up demand once the shock has dissipated, and thus the duration of the episode. Figure 4c plots the amplitude of the fall in investment versus a measure of a country's financial depth for the extended sample of countries. As a proxy of a country's financial depth, we use the mean ratio of private credit to GDP over the full length of the period under analysis. We find that countries with shallower financial markets experience deeper falls in investment following global uncertainty shocks.

Céspedes, Chang and Velasco (2004) point out that financial frictions in emerging markets, and their interaction with dollarization of liabilities, present an important shock-amplification mechanism that magnifies the business cycle in these countries. Figure 4d plots amplitude versus the degree of dollarization of the country's outstanding debt, as reported by Levy Yeyati (2006). Here we find that countries indebted in dollars suffer deeper falls in investment following uncertainty shocks, suggesting that transmission of global uncertainty through exposed creditors, or the balance sheet effects caused by currency devaluations, may cause an external credit crunch.

If financial frictions are in fact responsible for a substantial portion of the impact of uncertainty on investment, the policy implications are quite different to viewing the downturn as exclusively a voluntary optimal decision to delay investment. If firms in fact desire to invest, but are unable to obtain financing due to imperfections in the financial market, then liquidity operations by the monetary authority could potentially reduce the amplitude of the fall and increase the speed of recovery once uncertainty has dissipated.

Interestingly, the duration of the drop in investment is not correlated with any of our four explanatory candidates. This may not be surprising as we are considering a limited set of variables to explain the heterogeneity in our simple exercise, and a combination of these and other structural characteristics are likely responsible for the duration of recoveries.

4.3 The credit channel

As discussed above, a possible amplification mechanism (and potentially a source of persistence) for the uncertainty shock is the credit channel. To measure the importance of this channel, we carry out a counterfactual exercise to answer the question "What would have been the impact of the uncertainty shock in emerging markets, if there had been no change in the flow of credit?" To do so, we employ the methodology proposed by Bernanke, Gertler and Watson (1997) to identify the direct impact of exogenous shocks to the price of oil in the presence of an endogenous monetary policy response.

We augment the VAR specification with an additional equation to model the dynamic of the country's loans by banks, which is assumed to be subject to the external volatility shock and endogenously determined along with other local macro variables. The augmented system is thus:

$$
\begin{aligned}
\tilde{sp}_t^* &= \rho_1 \tilde{sp}_{t-1}^* + \rho_2 \tilde{sp}_{t-2}^* + \rho_3 vol_{t-1}^* + \rho_4 vol_{t-2}^* + \varepsilon_t^{sp^*} \\
vol_t^* &= \delta_1 vol_{t-1}^* + \delta_2 vol_{t-2}^* + \varepsilon_t^{vol^*} \\
\tilde{B}_t &= \boldsymbol{\beta}_3 (L + L^2) \mathbf{Z}_t + \boldsymbol{\gamma}_3 (L + L^2) \mathbf{X}_t + \varepsilon_t^B \\
\tilde{\pi}_t &= \boldsymbol{\beta}_4 (L + L^2) \mathbf{Z}_t + \boldsymbol{\gamma}_4 (L + L^2) \mathbf{X}_t + \varepsilon_t^\pi \\
\tilde{I}_t &= \boldsymbol{\beta}_5 (L + L^2) \mathbf{Z}_t + \boldsymbol{\gamma}_5 (L + L^2) \mathbf{X}_t + \varepsilon_t^I \\
\tilde{C}_t &= \boldsymbol{\beta}_6 (L + L^2) \mathbf{Z}_t + \boldsymbol{\gamma}_6 (L + L^2) \mathbf{X}_t + \varepsilon_t^C
\end{aligned}
$$

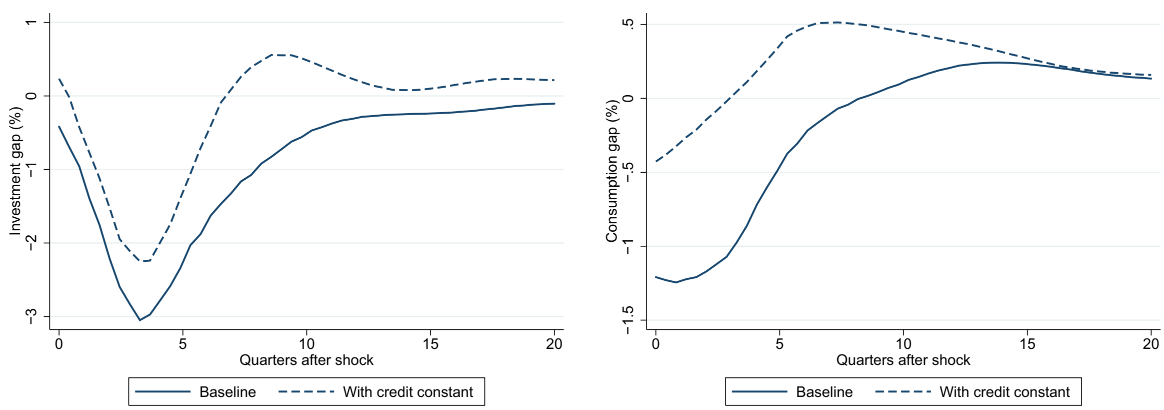
where $\tilde{B}_t$ is the cyclical component of domestic bank loans, and $\mathbf{X}_t = \{\tilde{B}_t, \tilde{\pi}_t, \tilde{I}_t, \tilde{C}_t\}$ is the augmented vector of endogenous variables.

Since long time series for loans are unavailable for many emerging markets, we restrict our analysis to those countries for which a complete series of comparable data are available for our sample period. The countries included in this exercise are Chile, Hong Kong, Mexico, South Africa, South Korea, and Turkey, all of whom have data available from 1990:1-2010:1.

It is clear that a reduction in loans after an uncertainty shock could reflect a fall in loan demand, and is therefore indistinguishable from voluntary wait-and-see behavior. Nevertheless, shutting off the dynamics associated with the loans variable gives us an idea of the quantitative relevance of a potential credit channel and of its effect on investment and consumption dynamics. We begin by estimating the augmented system in reduced form without imposing any additional constraints, and compute impulse-response functions. Our counterfactual is constructed by placing restrictions on the matrix of estimated contemporaneous correlations, $\hat{\boldsymbol{\Sigma}}^R$. By setting all elements in the row and column corresponding to the credit channel to zero, we simulate an environment where credit does not respond contemporaneously to shocks from the other variables in the system. When constructing the restricted impulse-response matrix, $\boldsymbol{\Phi}_i^R$, we set all components of the vectors $\hat{\boldsymbol{\beta}}_3$ and $\hat{\boldsymbol{\gamma}}_3$ to zero, such that the cyclical component of credit does not respond to lagged values of other variables. The counterfactual impulse-response functions are then constructed by multiplying $\boldsymbol{\Phi}_i^R$ by the Cholesky decomposition of $\hat{\boldsymbol{\Sigma}}^R$. By imposing the restrictions after estimating the model, we ensure that the estimations do not suffer from omitted variable bias.

Figure 5: Response of Investment and Private Consumption to an Orthogonalized Global Uncertainty Shock

(a) Investment (b) Private Consumption



The results of the exercise are shown in Figure 5. The baseline results - which are very similar to those reported earlier - are shown by the solid lines, while the counterfactuals are shown by the dashed lines. Controlling for the credit channel accounts for roughly one-third of the drop in investment in emerging markets, and drastically changes the dynamics of the recovery. Not only is the recovery period shortened considerably, but a small overshoot becomes apparent. On the consumption side, the amplitude is cut in half when we control for the fall in credit, and the slow convergence to trend is now a rapid recovery followed by an overshoot of approximately the same magnitude as the initial fall.

These results suggest that the deep, prolonged falls in investment and consumption observed in emerging markets are in large part due to tightening in credit constraints. Once we hold the flow of credit constant, we observe dynamics that are similar to those in developed countries, and which are easier to reconcile with Bloom's (2009) modelling approach. In this context, fiscal and monetary policy actions that soften the credit constraints faced by firms and households may be effective to reduce the negative effects of uncertainty in the economy.

4.4 Sensitivity analysis

Volatility is highly synchronized across OECD countries due to spillovers between integrated financial markets. As Gourio, Siemer and Verdelhan (2010) point out, this justifies the use of a common global uncertainty measure. In emerging markets, however, it is possible that idiosyncratic or regional events may not perfectly correlate with the U.S. series, such that the series we have used so far is inadequate for capturing local market uncertainty. For instance, the Asian Crisis of 1997 and the Tequila Crisis of 1995 had large impacts on real variables in the Far East and Latin America, respectively, but are not identified as relevant events in the U.S. series. It may also be the case that our orthogonalization to U.S. stock market performance is not effectively separating the effect of uncertainty from local first-moment shocks.

To test the sensitivity of our results to this critique, we use national stock market indices to identify local uncertainty shocks by applying the same identification algorithm as described in section 2 for Argentina, Brazil, Chile, Hong Kong, Mexico, Peru, the Philippines, South Korea and Thailand.[13] While the Russian and 2008–09 financial crises are identified in all the local series, the Enron scandal is not identified as an uncertainty shock in any of them. Figure 6 shows the local volatility series and identified shocks in Hong Kong's Han Sen Index and Chile's IPSA index. As expected, the 2007 Asian Crisis figures prominently as a major event in Hong Kong, as does the Tequila Crisis of January 1995 in the Chilean market.

We then estimate a modified version of the VAR model, restructuring the dynamics of the shocks in the vector $\mathbf{Z}_t$ such that the local stock market index is no longer isolated from lagged movements in local macroeconomic activity:

$$\begin{aligned}\tilde{s}_t &= \alpha_1 \tilde{s}_{t-1} + \alpha_2 \tilde{s}_{t-2} + \alpha_3 vol_{t-1} + \alpha_4 vol_{t-2} + \boldsymbol{\gamma}_7 (L + L^2)\mathbf{X}_t + \varepsilon_t^s \\ vol_t &= \phi_1 vol_{t-1} + \phi_2 vol_{t-2} + \varepsilon_t^{vol_t}\end{aligned}$$

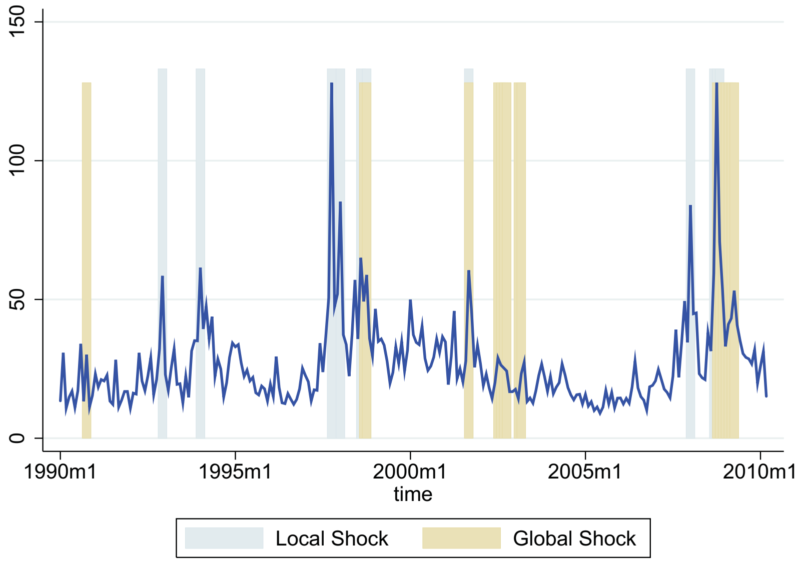
The remaining block of endogenous variables is unchanged from equations (3) through (5). Figure 7 shows the median impulse-response function for the investment gap in the sample of countries listed above, alongside the same function estimated using the global uncertainty series and the VAR model specified in equations (1) through (5). The dynamics are roughly similar, suggesting that the use of a global series may be sufficient for capturing uncertainty shocks in emerging markets.

We also estimate the model using local shocks identified using a local volatility series that has been orthogonalized to remove movements in global uncertainty, using the residuals from a linear regression of vol_t on vol_t^*. For the group of countries considered in this subsection, the results are nearly identical to those reported in figure 7. This exercise confirms that emerging market dynamics following local uncertainty shocks are comparable to those following global uncertainty shocks.

[13] Since daily market data are not available for the full 1990:1-2010:1 period, sample start dates vary.

Figure 6: Equity volatility in Hong Kong and Chile

(a) Hong Kong - Han Sen index



(b) Chile - IPSA index

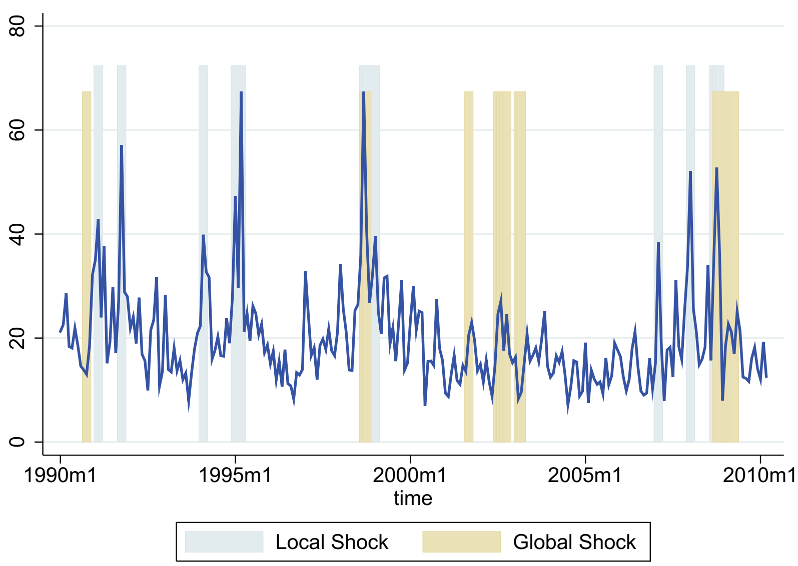
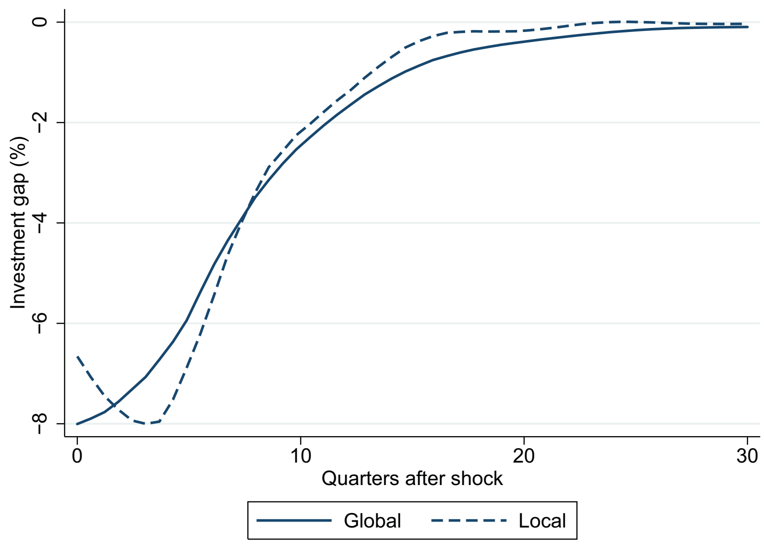


Figure 7: Investment Gap Following Global and Local Uncertainty Shocks



5 Conclusion

We have examined to what extent the stylized facts reported in the recent literature on uncertainty shocks are applicable to a heterogenous group of countries. We identify three findings about the impact of a global uncertainty shock: (i) emerging market countries suffer a median fall in investment approximately three times as large as that found in developed countries; (ii) there is considerable heterogeneity in recovery times between countries but, on average, the recovery time to such a shock is longer for emerging markets; and (iii) emerging markets, unlike their developed counterparts, experience a strong fall in private consumption following the uncertainty shock. In particular, whereas in developed economies there is no significant reaction of private consumption to uncertainty shocks, in emerging economies there is a large and persistent drop of this variable.

We explore alternative explanations and discuss their policy implications, but our empirical strategy is not equipped to identify the relative importance of each channel in generating the cross-country heterogeneity. Certain structural parameters in a real-option value model can be adjusted to account for the cross-country differences, such as the stochastic discount factor and the degree of irreversibility of investment. However, identifying these deep parameters empirically is difficult and reproducing the degree of heterogeneity we have estimated would thus involve substantial calibration, with questionable implications for policy.

We present preliminary evidence that the amplitude of the drop in investment is correlated with the quality of business institutions, the depth of the local financial sector, and the degree of financial dollarization. These empirical findings suggest that financial frictions may have important interactions with the transmission of global uncertainty shocks, which has implications for the modelling strategy that should be employed to study these events. We then carry out a counterfactual exercise to examine the importance of the credit channel, and find that contraction in credit loans in emerging markets following uncertainty shocks can account for approximately one-third of the drop in investment. Interestingly, the persistence of the drop in investment and the lack of a subsequent overshoot are both explained in large part by the persistent drop in credit. This suggests that the real options modelling strategy employed in the literature may be appropriate for modelling the effect of uncertainty in emerging markets if a credit channel is included.

Disentangling the importance of each of the channels considered in this paper is of primary relevance to policymakers. The real-option literature of investment under irreversibility and uncertainty concludes that monetary and fiscal policy have very limited effectiveness during periods of uncertainty. At most, policy should be implemented decisively in order to avoid aggravating the situation by introducing policy uncertainty. However, if the amplifications of a credit friction serve to amplify the fall in investment and stall the recovery, then there may be an important role for fiscal and monetary authorities to increase demand, lower the cost of financing, and provide liquidity to firms that would seek to invest once uncertainty has returned to normal levels. In the long run, institutional reforms that serve to reduce the irreversibility of capital investments, such as capital controls and expropriations, and frameworks that reduce the discretion of fiscal and monetary policymakers, can create a business environment less prone to "wait-and-see" behavior following global uncertainty shocks.

References

[1] Aizenman, J. and A. Powell. 2003. "Volatility and Financial Intermediation." *Journal of International Money and Finance* 22: 657-79.

[2] Arrow, K.J. and A.C. Fisher. 1974. "Environmental Preservation, Uncertainty, and Irreversibility." *Quarterly Journal of Economics* 88(2): 312-9.

[3] Baker, S.R., N. Bloom and S.J. Davis. 2011. "Measuring Economic Policy Uncertainty." Mimeo. Stanford University.

[4] Bernanke, B.S. 1983. "Irreversibility and Cyclical Investment." *Quarterly Journal of Economics* 98(1): 85-106.

[5] Bernanke, B.S., M. Gertler and M. Watson. 1997. "Systemic Monetary Policy and the Effects of Oil Price Shocks." *Brookings Papers on Economic Activity* 1: 91-157.

[6] Bloom, N., S. Bond and J. Van Reenen. 2007. " Uncertainty and Investment Dynamics." *Review of Economic Studies* 74: 391-415.

[7] Bloom, N. 2009. "The Impact of Uncertainty Shocks." *Econometrica* 77(3): 623-85.

[8] Burstein, A., J.C. Neves and S. Rebelo. 2004. "Investment Prices and the Real Exchange Rate." *Journal of the European Economic Association* 2(2-3): 302-9.

[9] Caballero, R. and A. Krishnamurthy. 2008. "Collective Risk Management in a Flight to Quality Episode." *Journal of Finance* 63(5): 2195-230.

[10] Calvo, G.A. and E.G. Mendoza. 2000. "Rational Contagion and the Globalization of Securities Market." *Journal of International Economics* 51(1): 79-113.

[11] Carrière-Swallow, Y. and C. Medel. 2011. "Incertidumbre Global sobre la Economía Chilena." Working Paper 647. Central Bank of Chile.

[12] Céspedes, L.F., R. Chang and A. Velasco. 2004. "Balance Sheets and Exchange Rate Policy." *American Economic Review* 94(4): 1183-93.

[13] Claessens, S., M.A. Kose and M.E. Terrones. 2011. "Recessions and Financial Disruptions in Emerging Markets: A Bird's Eye View." In *Monetary Policy under Financial Turbulence*, edited by L.F. Céspedes, R. Chang and D. Saravia. Santiago: Central Bank of Chile.

[14] Dixit, A. 1992. "Investment and Hysteresis." *Journal of Economic Perspectives* 6(1): 107-32.

[15] Gourio, F., M. Siemer and A. Verdelhan. 2010. "International Risk Cycles." Mimeo. Boston University.

[16] Keynes, J.M. 1937. "The General Theory of Employment." *Quarterly Journal of Economics* 51(2): 209-23.

[17] Lane, P.R. 2003. "Business Cycles and Macroeconomic Policy in Emerging Market Economies." *International Finance* 6(1): 89-108.

[18] Levy Yeyati, E. 2006. "Financial Dollarization: Evaluating the Consequences." *Economic Policy* 21(45): 61-118.

[19] Lütkepohl, H. 2006. *New Introduction to Multiple Time Series Analysis*. Berlin: Springer.

[20] Pindyck, R.S. 1991. "Irreversibility, Uncertainty, and Investment." *Journal of Economic Literature* 29(3): 1110-48.

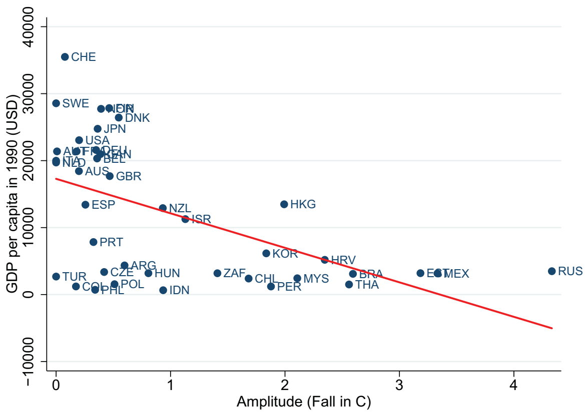
[21] Stock, J.H. and M.W. Watson. 2001. "Vector Autoregressions." *Journal of Economic Perspectives* 15(4): 101-15.

[22] World Bank. 1990. "World Development Report." New York: Oxford University Press.

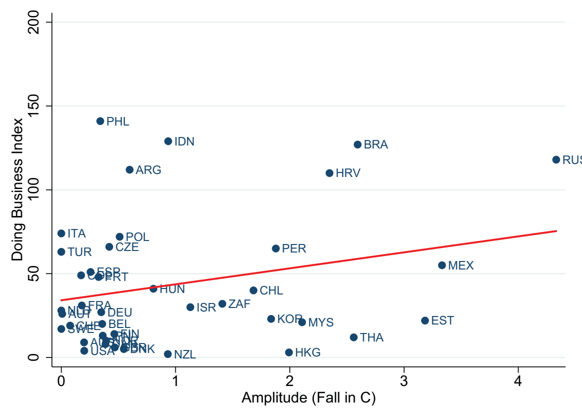
A Additional figures

Figure 8: Correlations with the amplitude of the fall in private consumption

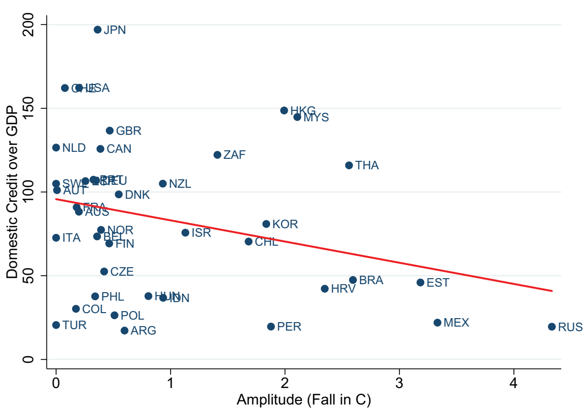
(a) GDP-per-capita



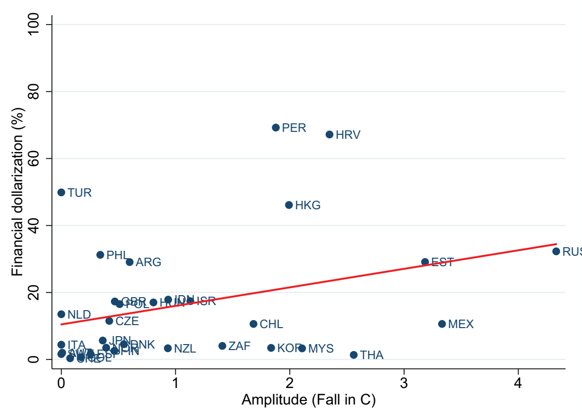
(b) Doing Business



(c) Financial Depth



(d) Dollarization



Documentos de Trabajo
Banco Central de Chile

Working Papers
Central Bank of Chile

NÚMEROS ANTERIORES

PAST ISSUES

La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de $500 si es dentro de Chile y US$12 si es para fuera de Chile. Las solicitudes se pueden hacer por fax: (56-2) 6702231 o a través de correo electrónico: bcch@bcentral.cl.

Working Papers in PDF format can be downloaded free of charge from: www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for orders inside Chile the charge is Ch$500.) Orders can be placed by fax: (56-2) 6702231 or e-mail: bcch@bcentral.cl.

DTBC – 645 Septiembre 2011
Crédito, Exceso de Toma de Riesgo, Costo de Crédito y Ciclo Económico en Chile
Carlos J. García y Andrés Sagner

DTBC – 644 Septiembre 2011
Optimal Fiscal Policy in a Small Open Economy with Limited Commitment
Sofia Bauducco y Francesco Caprioli

DTBC – 643 Septiembre 2011
Contracting Institutions and Economic Growth
Álvaro Aguirre

DTBC – 642 Agosto 2011
Dinámica de Precios en Chile: Evidencia con datos de Supermercados
Gastón Chaumont, Miguel Fuentes, Felipe Labbé y Alberto Naudon

DTBC – 641 Agosto 2011
A Reassessment of Flexible Price Evidence Using Scanner Data: Evidence from an Emerging Economy
Gastón Chaumont, Miguel Fuentes, Felipe Labbé y Alberto Naudon

DTBC – 640 Agosto 2011
Copper, the Real Exchange Rate and Macroeconomic Fluctuations in Chile
José De Gregorio y Felipe Labbé

DTBC – 639 Agosto 2011
Credit Contraction and International Trade: Evidence From Chilean Exporters
Ari Aisen, Roberto Álvarez, Andrés Sagner y Javier Turén

DTBC – 638 Agosto 2011
Investment Dynamics in a DSGE Model With Heterogeneous Firms and Corporate Taxation
Sergio Salgado I.

DTBC – 637 Agosto 2011
Labor Market Dynamics in Chile: the Role of Terms of Trade Shocks
Juan Pablo Medina y Alberto Naudon

DTBC – 636 Agosto 2011
Distribución de la Riqueza, Capital Social y Tasa de Crecimiento
Pablo Filippi

DTBC – 635 Julio 2011
Time – Consistent Bailout Plans
Ernest Pastén

DTBC – 634 Julio 2011
Proyecciones de Inflación con Precios de Frecuencia Mixta: el Caso Chileno
Juan Sebastián Becerra y Carlos Saavedra

DTBC – 633 Junio 2011
Long – Term Interest Rate and Fiscal Policy
Eduardo López, Victor Riquelme y Ercio Muñoz

DTBC – 632 Junio 2011
Computing Population Weights for the EFH Survey
Carlos Madeira

DTBC – 631 Mayo 2011
Aplicaciones del Modelo Binominal para el Análisis de Riesgo
Rodrigo Alfaro, Andrés Sagner y Carmen Silva.