The Fifteenth Dubrovnik Economic Conference

Organized by the Croatian National Bank

Romain Ranciere, Aaron Tornell and Athanasios Vamvakidis

Currency Mismatch and Boom-Busts in Emerging Europe

Hotel "Grand Villa Argentina",
Dubrovnik
June 24 - June 27, 2009

Draft version

Please do not quote

Currency Mismatch and Boom-Busts in Emerging Europe

Romain Rancière IMF
Aaron Tornll UCLA
Athanasios Vamvakidis IMF

PRELIMINARY AND INCOMPLETE

June 16, 2009

1 Introduction

Many countries in emerging Europe have been among the fastest growing countries in the world. However, most of them have been among the hardest hit by the current crisis. We argue in this paper that this boom-bust pattern has many aspects in common with other emerging economies, and that certain credit market imperfections common to emerging economies can help account for these patterns.

The boom in emerging Europe followed the structural reforms and financial liberalization of the 1990s, and has been driven in no small part by the expectation of joining the EU. The reforms opened up the economy to foreign capital inflows and led to "currency mismatches" whereby credit to domestic agents was denominated in foreign currency. Currency mismatch has been at the center of the recent turmoil in emerging Europe.

In this paper we document the degree of currency mismatch across emerging Europe, and the effects it has had on these economies. Also, we present a model to help explain that currency mismatch was optimally chosen by lenders and borrowers given the policy environment they faced. Furthermore, we argue that currency mismatch helped relax financing constraints, and lead to higher investment and growth. Of course financial fragility was a by-product.

In our model a lending boom and currency mismatch are generated by the interaction of two imperfections: contract enforceability problems, and systemic guarantees to bailout lenders in case of crisis. The first imperfection generates borrowing constrains, which are necessary to explain why insolvency risk promotes growth and also why crises can happen. Bailout guarantees provide an implicit subsidy that makes currency mismatch attractive.

In our model, there is a feedback loop that generates a positive correlation of prices and quantities of the nontradables sector. This correlation arises from the interaction of borrowing constraints and currency mismatch, which gives rise to a debt deflation mechanism. As N-sector prices go up, net worth increases in that sector as the real value of debt declines relative to the value of their assets. Higher net worth leads to more credit, which fuels higher demand for nontradables inducing an increase in prices and so on. In the meantime, since the profitability of investment depends on the price of nontradables, financial fragility and insolvency risk can endogeously arise. This opens the possibility of a crisis during which prices, quantities and credit collapse simultaneously. If along this path agents' expectations about this asset price inflation changed, and the demand for nontradables stopped increasing, then many agents would be unable to repay their debts and so generalized bankruptcies would take place. This sudden shift in expectations would start a vicious feedback loop in which price declines lead to lower credit, which leads to lower prices and so on. We believe that the model could provide a better understanding of the recent economic developments

in emerging Europe, and also some insights about the region's post-crisis growth prospects.

The rest of the paper is organized as follows. Section 2 presents an outline. Section 3 presents the model, and Section 4 present the facts of emerging Europe.

2 Outline of the Model

Here, we describe heuristically the mechanism behind currency mismatch and lending booms. Consider a two-sector economy with a tradables (T-) sector and a nontradables (H-) sector. H-sector firms are run by managers who face two credit market imperfections. First, they cannot commit to repay debt (i.e., a manager can divert the funds to himself by incurring a cost). Second, lenders enjoy *systemic bailout guarantees*. It is a stylized fact that governments insure creditors against systemic crises. That is, if a critical mass of borrowers is on the brink of bankruptcy, the government will implement policies to ensure that creditors get repaid (at least in part) and thus avoid an economic meltdown. These policies may come in the form of an easing of monetary policy, the maintenance of an exchange rate peg, or the handing out of checks.

How can borrowing constraints and currency mismatch arise simultaneously in equilibrium? The answer relies on the interaction of contract enforceability problems and systemic bailout guarantees. Enforceability problems generate borrowing constraints because this is the way in which lenders ensure they will be repaid. In order for guarantees not to neutralize the effects of enforceability problems it is necessary that they be systemic, not unconditional. The latter are granted whenever there is a default by an individual borrower, while the former are granted only if a critical mass of borrowers goes bust. Clearly, if all debt were covered by unconditional bailout guarantees, then the enforceability problem would become irrelevant and borrowing constraints would not arise in equilibrium. Since a lender would be bailed out in the case of an idiosyncratic default, he does not have incentives to limit the amount of credit he extends to an individual borrower. In contrast, if the guarantees are systemic, they do not insure lenders against idiosyncratic default by an individual firm. To credibly abstain from stealing, an individual manager must therefore respect a borrowing constraint, so that lenders are repaid in the good state where a bailout does not take place.

If the expected generosity of the guarantee is large enough, borrowers will find it optimal to take on *insolvency risk* via currency mismatch. By doing so they can cash in on the subsidy implicit in the guarantee, as the government will pay the debt obligation in case of insolvency. If the real exchange rate is expected to be sufficiently variable, currency mismatch is a prime vehicle for N-sector agents to take on insolvency risk. By denominating their debt in foreign currency, N-sector agents will pay very low interest rates as someone else will repay creditors in case of a sharp real

depreciation.

Along the equilibrium path there is a self-reinforcing mechanism that generates systemic insolvency risk: On the one hand, if N-sector firms expect the real exchange rate to fluctuate enough, they find it optimal to create a currency mismatch and thereby risk going bankrupt in case of depreciation. If all firms go bankrupt in case of a sharp depreciation, a bailout is triggered and debt repayment is shifted to the taxpayer. This increases ex ante profits. On the other hand, if there is a currency mismatch, a balance sheet effect validates firms' initial expectations of real exchange rate fluctuations.

The dynamic path of this economy delivers a boom-bust cycle. As in the data, model crises are preceded by a real appreciation as well as by a lending boom. The boom features high leverage and risk taking by way of debt denomination by firms in the N-sector. As a result, the economy becomes vulnerable to a self-fulfilling depreciation. In the aftermath of a crisis, the wealth of the N-sector collapses. This generates a credit crunch that affects mainly the N-sector and leads to a fall in the N-to-T output ratio as observed in the data.

3 Model

Here, we formalize the intuitive argument we described in the previous section and show that it is indeed part of an internally consistent story. We first show that the interaction of enforceability problems and bailout guarantees can generate incentives for currency mismatch, which in turn will allow for higher growth and generate boom-bust cycles. The model is based on Schneider and Tornell (2004) and on Ranciere and Tornell (2009).

We consider a simple, dynamic general equilibrium model of an economy with two sectors: a tradables (T) sector that produces the consumption good, and an H-sector that produces housing services or nontradables more generally. The H-good is an intermediate good which is used as an input in the production of both T- and N-sector goods.

The T-good is the numeraire and the price of the H-good–i.e., the inverse of the real exchange rate–is denoted by p_t. There are no exogenous sources of risk, such as terms-of-trade or productivity shocks. The only source of risk is endogenous relative price risk. As we shall see, in the equilibrium we will characterize the price will take on two values

$$p_t = \begin{cases} \overline{p}_t & \text{with probability } u_t \\ \underline{p}_t & \text{with probability } 1-u_t \end{cases}, \quad u_t = \{0, u\}$$

We will refer to $1-u_t$ as the crisis probability.

Nontradables sector. The H-good (y^H_{t+1}) is produced using inputs from the H-sector (I_t) via a linear production technology.

$$y^H_{t+1} = \theta I_t,$$

The H-sector is populated by OLG of developers with two-period lives, who can be interpreted as conglomerates of housing service producers and housing finance specialists that intermediate outside debt financing for them.

In the first period of his life, a representative junior developer receives an endowment $\underline{w}$ of T-goods and works for a senior developer against a claim on a fraction $(1-c)$ of profits. He then uses all his income as internal funds to start a new business, borrow and invest. In the second period of his life, the now senior developer hires a junior developer, sells his output and uses his share c of the profits (if any) to consume the T-good. The economy has a finite horizon with T periods.

To allow for the possibility of currency mismatch we assume that developers can finance themselves by issuing two types of one-period bonds: H-bonds that have an interest rate ρ^H_t and whose promised repayment is indexed to the price of H-goods, $p_{t+1}(1+\rho^H_t)b^H_t$, and T-bonds that have an interest rate ρ^H_t and whose promised repayment is not indexed, $(1+\rho_t)b_t$. We can interpret T(H)-debt as foreign(domestic) currency denominated debt. Notice that H-bonds allow developers to hedge their exposure to fluctuations in the price of housing services, while T-bonds expose developers to insolvency in case of a sharp real exchange rate depreciation–i.e., a fall in H-prices. To simplify the menu of financing contracts, we assume that developers either are fully unhedged or are fully hedged.

The investable funds of a young developer equal his internal funds w_t plus the debt he issues. Thus, the budget constraint is

$$p_t I_t \leq w_t + b_t + b^H_t.$$

Since currency mismatch implies that a firm can go bust, profits are $\max\{\pi_t, 0\}$,with

$$\begin{aligned} \pi_t &= p_t q_t - L_t, \\ L_t &= (1+\rho_t)b_t + p_{t+1}(1+\rho^H_t)b^H_t \end{aligned}$$

The internal funds w_t of a young developer equal the endowment $\underline{w}$ plus either a share $1-\beta$ of

profits under solvency or, if the firm is insolvent, a small government aid payment a_t

$$w_t = \begin{cases} \underline{w} + (1-c)[p_t q_t - L_t] & \text{if } \pi_t > 0 \\ \underline{w} + a_t & \text{if } \pi_t = 0 \end{cases}$$

Borrowing constraints are another necessary ingredient of a boom-bust cycle. Otherwise, if borrowers could always borrow, a systemic financial crisis could never occur.[1] As it is standard in the literature, we generate borrowing constraints by introducing agency problems in credit markets. In particular, we assume that by incurring a non-pecuniary cost $h[w_t + b_t + b_t^H]$, a young developer can engineer a scam that will allow him to divert the revenues to himself and not repay any debt in the next period, provided the firm has positive notional profits.

There must be a reason that leads agents to take on insolvency risk, but that does not eliminate borrowing constraints. Here, the reason is that the government grants bailout guarantees if there is a systemic crisis, but not otherwise. We introduce 'systemic bailout guarantees' by assuming that in case a majority of H-firms defaults, the government pays lenders of non-diverting firms a share γ of the promised debt repayment amount (L_t). However, in case of an isolated default the government does not bail out lenders.

Bailouts are domestically funded by taxing the tradable sector and the profits of solvent H-sector developers. The government has access to international capital markets: during a crisis it can borrow any amount to finance the bailout as long as its intertemporal budget constraint is satisfied.

Tradables sector

The T-good is produced by a continuum of measure, one of perfectly competitive firms that use labor as an input with a linear production function:

$$y_t^T = A_t l_t$$

Workers live for one period and have Cobb-Douglas preferences over housing services and the tradable good: $u = c_T^{1-\alpha} c_N^{\alpha}$. Since the T-sector is perfectly competitive, in any equilibrium the wage equals A_t, and the T-sector demand for housing services is

$$C_{N,t} = \frac{\alpha A_t}{p_t}$$

The parameter A_t summarizes the productivity of the economy outside of the H-sector. We assume

[1] Except in case of a large economy-wide exogenous shock such as wars or natural disasters.

that

$$A_t = A \text{ if } t < T \text{ and } A_T = \overline{A}$$

where $\overline{A}$ is a constant defined by (9) in the appendix. This constant is set high enough so that at terminal time T the H-sector can repay all its debt.

For notational convenience in the rest of the paper, we define the T-sector demand for housing services in tradeable units as

$$d_t \equiv p_t C_{N,t}$$

The Credit Market.

During period t, given his internal funds w, the representative young developer borrows from international lenders. He then decides whether to implement a diversion scheme. Next period payoffs are as follows. If there is no diversion and no default, lenders receive their promised repayment L, the now old developer gets $c\pi$ and the young developer gets $(1-c)\pi$. If there is no diversion, but the firm defaults lenders get γL if a bailout is granted and zero otherwise; the old developer gets zero and the young developer gets the aid a_t. Finally, if there is diversion, lenders get nothing, the old developer gets cpq and the young developer gets $(1-c)pq$.

To close the model we impose several parameters restrictions that ensure the existence of an internally consistent mechanism that generates the intuitive feedback-loop stories told by commentators, and that we summed up in the introduction. Specifically, we impose the following recursive set of parameter restrictions:

$$1 < h < 1+r \tag{1}$$

$$\frac{h}{1+r} < c < \frac{1+(1+r)^{-1}}{1+h^{-1}} \tag{2}$$

$$\frac{h}{1+r} < u < \frac{1}{c}\frac{h}{1+r} \tag{3}$$

$$\varepsilon < \frac{1-\frac{hu^{-1}}{1+r}}{1-c} \tag{4}$$

The first restriction says that diversion costs should be neither too high nor too low. If they were too high, borrowing constraints would not arise in equilibrium. If they were too low, borrowing constraints would be too tight and so insolvency risk-taking would not be profitable. The second restriction imposes bounds on the payout rate to old developers. The third restriction says that the probability of a crisis, $1-u$, should be positive but small for risk-taking to occur in equilibrium. The last restriction implies that crisis costs are severe enough so as to generate a fall in the price of H-goods which is large enough to bankrupt H-sector producers with currency mismatch in their

balance sheets.

3.1 Safe and Risky Equilibria

The expected payoff of a young developer is

$$E_t(u_{t+1}\pi_{t+1}c[1-\delta_t]) + E_t(cp_{t+1}q_{t+1} - h[w_t + b_t + b_t^n])\delta_t,$$

where $\delta_t = 1$ indicates that the developer adopts a diversion scheme.

A symmetric equilibrium is a sequence $\{b_t, b_t^N, \rho_t, \rho_\tau^n, I_t, C_t, p_t\}$ such that (i) given internal funds w_t, prices $(p_t, \overline{p}_{t+1}, \underline{p}_{t+1})$ and the likelihood of crisis u_{t+1} the young developer's plan $(b_t, b_t^N, \rho_t, \rho_\tau^n, I_t, \delta_t)$ maximizes his expected payoff and lenders break even; (ii) T-sector demand C_t maximizes workers utility; and (iii) the price p_t clears the H-sector market

$$C_t(p_t) + I_t(w_t, p_t) = q_t(I_{t-1})$$

We will characterize two symmetric equilibria: a risky one where all developers take on insolvency risk via currency mismatch, and a safe one where they do not. We derive the equilibria in two steps. First, we take as given the price path and derive the allocation. We then derive the equilibrium price path.

In any equilibrium, lenders fund only plans that do not lead to diversion. Since they are risk neutral and perfectly competitive they set the interest rates so that they break even, and lend up to an amount so that developers don't divert. Along any equilibrium path a bailout next period will be granted only if a systemic crisis occurs. A crisis will occur only if a majority of developers denominate their debt in T-goods.

Consider first a safe equilibrium. That is, one where there is no currency mismatch and could correspond to a nonliberalized economy. Since lenders are risk neutral and the opportunity cost of capital is $1 + r$, the interest rate that they require satisfies

$$[1 + \rho_t^n]E_t(p_{t+1}) = 1 + r.$$

Furthermore, to avoid diversion by the firm, lenders impose a borrowing constraint:

$$(1 + r)b_t^n \leq h(w_t + b_t^n).$$

If investment yields a return that is higher than the opportunity cost of capital, the firm will borrow

up to an amount that makes the credit constraint binding. Thus, the budget constraint implies that credit and investment are:

$$b_t^n = [m^s - 1]w_t \qquad I_t = m^s \frac{w_t}{p_t}, \qquad \text{where} \;\; m^s = \frac{1}{1 - h\delta}, \;\; \delta \equiv \frac{1}{1+r}. \tag{5}$$

Notice that a necessary condition for borrowing constraints to arise is $h < 1 + r$. If h, the index of contract enforceability, were greater than the cost of capital, it would always be cheaper to repay debt rather than to divert. Thus, lenders will not impose a ceiling on the amount they are willing to lend and agents will not be financially constrained.

Next, consider a risky equilibrium where there is currency mismatch. If there is enough real exchange rate variability, T-debt is risky and it might lead to insolvency: $\pi(\underline{p}_{t+1}) = \beta \underline{p}_{t+1} q_{t+1} - (1+\rho_t) b_t < 0$. A firm might choose T-debt and risk insolvency because risky T-debt is cheaper than safe N-debt. To see why suppose for a moment that tomorrow's real exchange rate can take on two values. With probability u it takes an appreciated value ($\bar{p}_{t+1}$) that leaves every firm solvent, while with probability $1 - u$ it takes a depreciated value ($\underline{p}_{t+1}$) that makes all H-sector firms go bust and generates a crisis. Since lenders constrain credit to ensure that borrowers will repay in the no-crisis state, it follows that in the no-crisis state debt is repaid in full and there is no bailout. Meanwhile, in the crisis state there is bankruptcy and each lender receives a bailout equal to what he was promised. Thus, the interest rate on T-debt is

$$1 + \rho_t = 1 + r.$$

Meanwhile that on H-debt is

$$1 + \rho_t^n = \frac{1+r}{u\bar{p}_{t+1} + (1-u)\underline{p}_{t+1}}$$

It follows that choosing T-debt over H-debt reduces the cost of capital from $1+r$ to $[1+r]u$. Lower expected debt repayments, in turn, ease the borrowing constraint as lenders will lend up to an amount that equates $u[1+r]b_t$ to $h[w_t + b_t]$. Therefore, credit and investment are:

$$b_t = [m^r - 1]w_t \qquad I_t = m^r \frac{w_t}{p_t}, \qquad m^r = \frac{1}{1 - u^{-1}h\delta} \tag{6}$$

By comparing (6) with (5) we can see that In the presence of systemic bailout guarantees, taking on credit risk allows agents to reduce the expected value of debt repayments, which eases borrowing constraints and increases the investment multiplier: $m^r > m^s$. This increase in leverage is possible because systemic guarantees mean that in a crisis lenders expect to be bailed out. The fact that T-debt is cheaper than H-debt does not imply that agents will always be willing to issue T-debt.

This is because with probability $1-u$ T-debt will result in bankruptcy for a borrower. One can show that it is individually optimal to choose T-debt if crises are rare events and there is enough real exchange rate variability:

$$\frac{\beta\theta\bar{p}_{t+1}}{p_t} \geq \frac{1}{\delta} > h > \frac{\beta\theta\underline{p}_{t+1}}{p_t} \tag{7}$$

The first inequality ensures that in the good state returns are high enough to make the production of N-goods profitable. The third inequality ensures that in the bad state there is a critical mass of insolvencies so that lenders will be bailed out. Finally, the second inequality is necessary for borrowing constraints to arise in equilibrium.

3.2 The Lending Boom and the Bust

Along a risky path there is a self-reinforcing mechanism in which agents find it more and more profitable to take on currency mismatch (and risk insolvency) over time as the return $\frac{\theta\overline{p}_{t+1}}{p_t}$ increases along the risky path. As long as a crisis does not occur, internal funds w_t increase at an increasing rate provided they start from a high enough level. Thus, the rate of return on the risky strategy is increasing over time.

$$\frac{1+\rho_t}{\theta\overline{p}_{t+1}/p_t} = \frac{1+r}{\left[\frac{w_{t+1}}{w_t} + \frac{d}{m^r w_t}\right]\frac{1}{p_t}} \tag{8}$$

If we set H-productivity θ low enough, there is sort of a "debt deflation" as there is an appreciation of the real exchange rate ($\overline{p}_{t+1}/p_t$ goes up).

In parallel to the real appreciation, a lending boom develops. That is, credit grows at an increasing rate and the H-sector grows faster than the rest of the economy. As a result, the credit-to-output ratio grows over time.

Another characteristic of the boom is that the H-sector investment demand captures an ever-increasing share of its own goods. This H-boom is reminiscent of what went on in the housing and financial services across many countries.

The Bust

In our setup crises can happen because if the multiplier is large enough ($m^r(1-c) > 1$) and the aid policy is not very generous, then a shift in expectations can lead to a steep enough price fall that will bankrupt firms with currency mismatch in their books: $\underline{p}_{t+1}q_{t+1} < L_{t+1}$.

The longer the boom has been going on–and the greater that increase in internal funds have experienced–the greater the bust. Also, the less generous the aid policy the greater the bust.

$$\frac{\underline{p}_{t+1}}{\overline{p}_t} = \frac{m^r w_{t+1}^{crisis} + d}{\theta m^r w_t}\,\frac{1}{p_t}$$

After a bust, internal funds and credit collapse. Thus, developers are able to command a much lower share of H-output and so most H-output is consumed by the T-sector. In the wake of crisis the price collapse is accompanied by a sharp fall in the H-to-T output ratio.

4 Emerging Europe

The results from the theoretical section suggest that financial liberalizations can lead to excessive risk-taking associated with currency mismatches, which can then lead to high growth but at the price of self-fulfilling crises. The experience of emerging Europe during this decade provides an illustration of such boom and bust pattern. Most emerging European economies grew very fast before the recent crisis, but were hurt the most by it, compared with other emerging economies.

The boom followed a period of structural and economic reforms, during the shift to a free market economy in the 1990s, and more recently, in most cases, while preparing and eventually joining the EU. These reforms opened up the economy to foreign capital inflows and led to externally financed booms, currency mismatches, and eventually a crisis in a number of countries during 2008-09. Despite progress in structural reforms, structural bottlenecks and contrast enforcement problems remain, at least relatively to advanced European economies. Moreover, the systemic bailout guarantee seems to apply, as the recent rescue programs, financed by the IMF and in some cases by the EU, in a number of countries suggest. Therefore, emerging Europe seems to be in the risky equilibrium of the model. The model could provide a better understanding of the recent economic developments in emerging Europe, but also some insights about the region's post-crisis growth prospects.

This section first discusses some data illustrating emerging Europe's recent boom and bust. We also use the data to argue that the region is consistent with the assumptions of the model. We then provide estimates of the extent of currency mismatch in the banking sector in emerging Europe, which is an key contribution. We then show that currency mismatches are linked to the boom and bust cycle in emerging Europe during recent years. Finally, we calibrate the model for emerging Europe and use the results to discuss the region's growth prospects.

Before the current global crisis, emerging Europe included some of the fastest growing emerging economies, a number of them growing even faster than emerging Asia (Figure 1, first chart). Growth was driven by private consumption on the demand side (Figure 1, second chart) and by nontradables (services and construction), but also manufacturing in some cases, on the supply side (Figure 1, third and fourth charts).

Reforms in emerging Europe during recent years have been to a large extent driven by EU

negotiations and membership requirements. Most countries in the region either joined the EU or started membership negotiations, or at a minimum applied for membership during this decade; Slovenia and the Slovak Republic have also introduced the euro as their currency (Table 1). The road to the EU includes a large number of deep economic, legal, and institutional reforms to comply with the EU acquis. The latter also includes the opening of the capital account.

Consistent with some of the assumptions in the theoretical model, these EU-driven reforms, as well as other reforms, have led to concrete institutional improvements and openness in emerging Europe (Figure 2). The legal structure and property rights have improved (Figure 2, first chart) and capital controls and credit market regulations have been dismantled (Figure 2, second and third charts) in most countries. Moreover, these trends seem to have been stronger in EU-member countries. However, as also assumed in the model, institutional and legal impediments remain, at least compared with what seen on average in the euro area (see comparisons with the euro area in Figure 2). The opening up of the economy combined with privatization in the financial sector led to a boom in foreign bank ownership throughout the emerging Europe (Figure 2, fourth chart). The share of foreign banks in total bank assets ranges from 29 percent in Slovenia to 99 percent in Estonia, with an average of 77 percent and a median of 84 percent.

Structural reforms, the opening of the capital account, financial liberalization and the domination of foreign banks, with relatively easy access to financing from their parent banks, were the main ingredients of the economic boom and the accompanied external imbalances in emerging Europe during the pre-crisis period (Figure 3). Financial openness, measured as foreign assets plus foreign liabilities over GDP, increased substantially, and borrowing costs fell sharply throughout the region (Figure 3, first and second charts). The large capital inflows in the region included primarily direct investment and borrowing by banks (Figure 3, third chart). The latter was used to finance a credit boom, which was unprecedented in most countries (Figure 3, fourth chart). The result was the build up of large external imbalances, with current account deficits and levels of external debt well above what had be seen in other emerging markets before a crisis (Figure 3, fifth and sixth charts). Lending interest rates in foreign currencies were lower than in domestic currencies by an average of about 3 percentage points (Figure 3, seventh chart). Exchange rates appreciated in most countries in the region, regardless of the exchange rate regime (Figure 4).

Emerging Europe was hit by the crisis considerably more than other emerging economies (Figure 5). Borrowing costs increased sharply, although from historically low levels, to all economies in the region (Figure 5, first chart). Real GDP growth turned sharply negative in 2009 and was substantially below what seen in other emerging economies (Figure 5, second chart). However, and consistent with the model projections, there are some indications that emerging Europe will recover

in the post-crisis period, although growth may not reach pre-crisis levels. According to the latest IMF WEO projections, growth in the region will be second only to emerging Asia by 2014, and faster than in other emerging market groups (Figure 5, second chart).

The boom led to substantial currency mismatches in emerging Europe. Banks were borrowing in foreign currencies, mostly in euros, but also in U.S. dollars and Swiss Francs, to extend loans in foreign currencies, hedging their direct exposure to exchange rate risk. However, they were still exposed to credit risk resulting from the exposure of their clients to exchange rate risk, to the extent that their clients did not have income sources in foreign currency. With the data showing pre-crisis growth to be driven primarily by consumption and nontradables, such credit risk could be substantial, as indeed was proven to be the case during the crisis.

For the countries with available data (10 countries, or 86 percent of East Europe's GDP, excluding Russia), we measure currency mismatches in the banking sector for the period 1998-2008 as follows (see Appendix for details on the calculation and data sources):

foreign currency foreign assets + foreign currency domestic assets ■ foreign currency foreign liabilities ■ foreign currency domestic liabilities ■ foreign currency lending to households ■ foreign currency lending to nonfinancial corporates without foreign currency income

We divide this sum by total bank assets for an estimate of currency mismatches in relative terms.

This calculation assumes that households have no foreign currency income, and lending to them is therefore subject to credit risk, and therefore, indirectly subject to exchange rate risk. Similarly, lending to nonfinancial corporates that have no foreign currency income is subject to exchange rate risk through credit risk.

Therefore, we subtract from the asset site of the banking sector foreign currency balance sheet an estimate of the loans to unhedged clients, as they could expose the banks to credit risks resulting from exchange rate risk. Although banks seem to be relatively covered based on data from their balance sheet, these loans may not be serviced during a crisis and therefore should not be used to offset liabilities in estimates of currency mismatches. Furthermore, although we do not consider this case, even loans to customers with foreign currency income may not be serviced during a crisis, if their foreign income declines, for example, due to a drop in exports as foreign demand falls.

The estimates show substantial currency mismatches in almost all countries in the sample (Figure 6). The share of foreign currency lending to total lending reached well above 50 percent in most emerging European economies in 2007, which was substantially above shares in other emerging economies (Figure 6, first chart). Currency mismatches are considerably larger when we adjust for unhedged lending, as discussed above, than when we don't adjust (Figure 6, second

chart). Most countries are not shown to have currency mismatches in the latter case, compared to very large mismatches when we adjust for unhedged foreign currency lending. Furthermore, currency mismatches increased substantially in most emerging European economies in our sample during the boom years (2003-2007), reaching in some cases very large negative levels as a share of total bank assets.

Our estimates of currency mismatches are highly correlated with developments during the boom and bust years, which is consistent with the model predictions (Figure 7). The increase in currency mismatches in the banking sector during the boom years is positively correlated with the change in the stock of private sector credit to GDP, average real GDP growth, the increase in current account deficits, and the accumulation of external debt (Figure 7, first four charts). In contrast, it is negatively correlated with real GDP growth during the crisis and positively correlated with the current account reversal during this period (Figure 7, two last charts).

A simple panel regression also confirms the links between currency mismatches and growth (Table 2). We estimate a panel regression with random effects for the 10 countries in our sample, for the period 1998-2009. The dependent variable is annual real GDP growth. The independent variables include the level and the change of our measure of currency mismatch (both with one lag), a crisis dummy that takes the value of 1 in 2009, which is the year when growth turned negative throughout emerging Europe, and interaction terms.

The results suggest that rising currency mismatches are positively correlated with growth, unless there is a crisis, in which case the correlation turns negative; the level of currency mismatch seems to matter only during a crisis. In more detail, the estimate of the lagged change in currency mismatch is negative and statistically significant, suggesting that periods with increasing currency mismatches are followed by periods of faster growth, unless there is a crisis. The crisis dummy is negative and statistically significant, reflecting the sharp downturn in emerging Europe in 2009. The interaction term of the lagged change in currency mismatch and the crisis dummy is positive and statistically significant, suggesting that countries that increased their currency mismatches before the crisis had an even more severe downturn during the crisis. The level of the currency mismatch matters only as an interaction with the crisis dummy. This is consistent with the theoretical predictions, as only the change in currency mismatches determines the extent to which bottlenecks in the nontradable sector are relieved, while the level of currency mismatches reflects balance sheet exposures that deepen the crisis after a shock.

Model calibration for emerging Europe

[Section to be revised based on latest calibration]

In what follows, we calibrate the theoretical model for emerging Europe. As discussed above,

the boom and bust in a number of emerging European economies during recent years offer a test case for the model's predictions. In turn, model calibrations could be used to spread light on the region's future growth prospects.

The key parameters of the model include the probability of a crisis, the degree of contract enforcement, the intensity of nontradable inputs in the production of tradables, and the severity of financial distress costs (the fall in the cash flows of distressed firms during a crisis). The existence of a risky equilibrium requires that the probability of a crisis is low enough, for risk-taking to be profitable ex-ante, and the severity of contract enforceability is in some intermediate range, so that although borrowing constraints exist, the additional leverage associated with risk-taking is relatively large. With risk-averse agents, the growth gains from risk-taking would have to be high enough to compensate for the welfare costs of financial crises.

Crisis probabilities are estimated for each emerging European economy in the sample based on actual crises during the last 14 years (1996-2009, with IMF's WEO projections for the last year). We use two definitions of crisis. The first is a growth crisis, for growth of real GDP less than -1 percent, following Pitlik and Wirth (2003). The second is a balance of payments crisis, for a nominal depreciation of the currency of at least 30 percent that is also at least a 10 percent increase in the rate of depreciation compared to the year before, using annual Nominal Effective Exchange Rates, following Laeven and Valencia (2008). The average crisis probability for the first definition is equal to 12.6 percent, while for the second definition is 4.2 percent. Alternatively, we could assume a probability of 6 percent, which is consistent with the historical frequency of systemic crises (see Ranciere, Tornell and Westerman, 2008). A risky equilibrium exist in all these three cases .

We don't have data for the intensity of nontradable inputs in the production of tradables in emerging Europe, and we use the benchmark value of 0.35, which is calibrated using Mexican input-output data. The degree of contract enforceability is set equal to 0.75, so that growth on the risky equilibrium matches the average growth rate in emerging Europe during the boom years of 2004-2007. The risk free interest rate is the ECB policy rate . The financial distress costs are set at 80 percent (equal to financial distress costs so that the cumulative decrease in GDP during a crisis is equal to the one in Latvia during 2007-2010, based on the latest IMF's WEO projections), suggesting that that crises are very severe.

Calibrating the model for emerging Europe yields the following results (Figure 8):

- Economies on the risky equilibrium do have the potential to grow faster than economies on the safe equilibrium, but only if crises do not occur often (first chart in Figure 8). An important implication is that to the extent that pre-crisis policies in some countries in the region were overexposing the economy to shocks, they were hurting long-term growth prospects.

- Focusing on the risky growth path, countries with good institutions, leading to better contract enforceability, seem to benefit more from taking on risk in terms of average growth rates (second chart in Figure 8). However, crises will also be more severe because of higher leverage.
- A high intensity of nontradable inputs in tradable production also leads to faster growth (third chart in Figure 8).

With this set of parameters, the model calibrations suggest that emerging Europe's growth prospects would have been substantially below recent trends in the "safe" equilibrium. Average real GDP growth during 1996-2007 was 5.3 percent, while during the boom years of 2004-2007 it was 6.6 percent. Including the recent crisis, average growth during 1996-2009 was 4.5 percent. And including the latest IMF's WEO projections, average growth during 1996-2014 is projected to be 4.2 percent, or if we consider only the boom-bust-recovery period of 2004-2014, 3.9 percent. The counterfactual growth rate if emerging European economies would have fared on a "safe" equilibrium growth path would have been equal to 3.7 percent. Starting from 1996, the latter suggests that GDP would have been lower than its 2009 level, despite the crisis, by 9.8 percent.

5 References

Hilaire, Alvin and Anna Ilyina, 2007, "External Debt and Balance-Sheet Vulnerabilities in Croatia," in Republic of Croatia: Selected Issues, (Washington: International Monetary Fund).

Laeven, L. and F. Valencia, 2008, "Systemic Banking Crises: A New Database," IMF Working Paper 08/224 (Washington: International Monetary Fund).

International Monetary Fund, 2008, Annual Report on Exchange Arrangements and Exchange Restrictions (Washington: International Monetary Fund).

Pitlik, Hans, and Steffen Wirth, 2003, "Do Crises Promote the Extent of Economic Liberalization? An Empirical Test", European Journal of Political Economy, Vol. 19, pp. 565–581.

Ranciere, Romain, Aaron Tornell and Frank Westermann, 2008, "Systemic Crises and Growth," Quarterly Journal of Economics, vol. 123 (1), pp 359-406.

Ranciere, Romain, and Aaron Tornell, 2009, The US boom-bust cycle," mimeo.

Sorsa, Piritta, Bas Berend Bakker, Christoph Duenwald, Andrea M. Maechler, and Andrew Tiffin, 2007, "Vulnerabilities in Emerging Southeastern Europe—How Much Cause for Concern?" IMF Working Paper 07/236 (Washington: International Monetary Fund).

Vamvakidis, Athanasios, 2009, "Convergence in Emerging Europe: Sustainability and Vulnera-

bilities," Eastern European Economics, forthcoming.

6 Appendix. Terminal Conditions

Along the risky path, the H-sector is accumulating debt. To satisfy the solvency constraint, at some point it must repay. A way to ensure solvency and keep the dynamics simple is to assume that the demand from the T-sector is constant and then experiences a jump at a terminal time T. So we set:

$$A_t = \begin{cases} A & \text{if } t \leq T-1 \\ \overline{A} & \text{if } t = T \end{cases}$$

Where $\overline{A}$ is large enough to allow developers to repay all debt at T.Since at T there is no H-investment, there is a unique price

$$p_T = \frac{\alpha \overline{A}}{q_T}$$

It follows that at $T-1$ all developers find optimal to only choose a safe plan. Thus

$$q_T = \theta m^s \frac{w_{T-1}}{p_{T-1}}$$

The net present value condition at period $T-1$, $E_{T-1}(\pi_T^s) \geq (1+r)w_{T-1}$,holds iff

$$\frac{p_T \theta}{p_{T-1}} \geq 1+r \Leftrightarrow \alpha \overline{A} > (1+r) m^s w_{T-1}$$

Hence, there exists a risky equilibrium iff

$$\overline{A}_0 > \alpha^{-1}[1+r] m^s \cdot \overline{w}_{T-1}(w_0, a) \tag{9}$$

where $\overline{w}_{T-1}(w_0, a)$ is the internal funds that obtain if no crisis occurs on $[0, T-1]$. This completes the characterization of the risky equilibrium. The process for $\overline{A}$ with a jump is meant to capture some more fondamental long run trend in the demand of housing. Such trends can reflect, for example, some demographic factors such as aging or the rate of divorce that influence the demand for housing in the very long run.

Calculation of Currency Mismatches and Data Sources

The measure of currency mismatch in the paper is the gap between foreign currency assets and liabilities, both with respect to residents and non residents (domestic and foreign net assets in foreign currencies), adjusted for an estimate of foreign currency lending that is not hedged, and divided by total bank assets. The formula of the calculation is the following:

foreign currency foreign assets + foreign currency domestic assets − foreign currency foreign liabilities − foreign currency domestic liabilities − foreign currency lending to households − foreign currency lending to nonfinancial corporates without foreign currency income

In more detail:

- Foreign currency foreign assets include all foreign currency claims of the banking sector towards nonresidents, such as deposits or loans in foreign currencies.

- Foreign currency domestic assets include all foreign currency claims of the banking sector towards residents, such as foreign currency loans, which, as the main text discusses, grew very rapidly during the recent boom in emerging Europe.

- Foreign currency foreign liabilities include all foreign currency claims of nonresidents towards the domestic banking sector, such as loans of foreign banks, including parent foreign banks to their domestic subsidiaries, and foreign currency deposits of nonresidents. As the main text discusses, bank loans from abroad were very large during the recent boom in emerging Europe. Foreign currency deposits of nonresidents were also substantial in some countries.

- Foreign currency domestic liabilities include all foreign currency claims of residents towards the domestic banking sector, such as foreign currency deposits of residents. The latter have been historically very large in the region. During the liberalization of the early 1990s, large amounts of foreign currency that were held in mattresses, primarily deutsche mark, were deposited in banks. They were later converted into euros. These deposits are so high in some cases, that these countries are characterized as being euroized (Croatia is an example), even though the euro is not used for transactions. During the 1990s, they primarily served as a hedge for inflation, given memories of price instability during liberalization. Even though inflation stabilized at low levels in the current decade, most of these deposits remained in foreign currencies, in some cases expecting euro adoption in the short or medium-term.

- Foreign currency lending to households is part of the banks' foreign currency domestic assets. However, we assume that households have no foreign currency income, and therefore, are not hedged when they borrow in foreign currency.

Therefore, we subtract foreign currency lending to households from the banks' foreign currency assets in the calculation of the banks' currency mismatch, because such lending is subject to exchange rate risk, directly for the households, and indirectly for the banks, through credit risk in the latter case. As discussed above, private sector foreign currency deposits, including of households, are large in emerging Europe and they do provide a hedge. However, we assume that households that already have large foreign currency deposits don't need to also borrow in foreign currency. Therefore, was assume mismatches between households with deposit and households with loans in foreign currency.

- Foreign currency lending to nonfinancial corporates is also part of the banks' foreign currency domestic assets. However, some of this lending goes to corporates that do not have foreign currency income and are, therefore, not hedged, resulting to credit risk for the banks and, therefore, indirect exchange rate risk. To adjust for the latter, we subtract from the banks' foreign currency domestic assets foreign currency loans to nonfinancial corporates that have foreign currency income (we assume that financial firms have foreign currency income).

Data on foreign currency, domestic and foreign asset and liabilities, by sector, and data on total bank assets are from Haver Analytics.[1] Data are available for 10 countries: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Ukraine. These economies produce 86 percent of East Europe's GDP, excluding Russia (or 86 percent of emerging Europe's GDP excluding Russia and Turkey). Based on data availability, we measure currency mismatches for the period 1998-2008, although in most cases we focus on the boom and bust period after 2003.

We use a number of sources for the share of foreign currency lending to corporates with no foreign currency income. Up to 2003, this share is based on EBRD survey data for 2002 (see EBRD,…) for the share of foreign currency loans to total loans in exporting and nonexporting companies. For the subsequent years, we use EBRD survey data for 2005 for the Czech Republic, Estonia, Hungary, Lithuania, and Poland.[2] For Bulgaria and Romania, the share of unhedged foreign currency lending is given by the share of corporate foreign currency lending to tradable sectors, as estimated in Sorsa, Bakker, Duenwald, Maechler, and Tiffin (2007). For Croatia, it is based on Central Bank survey data for the share of foreign currencies loans to unhedged clients (this includes both households and corporates; see Hilaire and Ilyina (2007)). And for Latvia, it is estimated based on data provided by the

[1] Net foreign assets data for Bulgaria are from the IMF's International Financial Statistics.

[2] The EBRD survey data for 2002 refer to the stock of debt. However, the data for 2005 refer to the last loan only. We have assumed that the latter applies to the stock of debt as well, which is an approximation. The results are robust if we do not make this assumption and use other proxies instead.

central bank for the share of tradables in corporate foreign currency loans. The results remain robust if we use only EBRD data, or if we use only data from the sources described above for Bulgaria, Romania, Croatia, and Latvia, and assume that the other countries have similar shares of unhedged foreign currency lending (taking the average, or the minimum).

Table 1. EU membership and progress in EU application

	EU membership	Euro adoption	EU application	Stabilization and Association Agreement	Candidate status	Opening of EU Negotiations
Albania	No	No	No	Jun-06	No	No
Belarus	No	No	No	No	No	No
Bosnia & Herzegovina	No	No	No	Jun-08	No	No
Bulgaria	Jan-07	No	Dec-95	n.a.	n.a.	Dec-99
Croatia	No	No	Feb-03	Oct-01	Jun-04	Oct-05
Czech Republic	May-04	No	Jan-96	n.a.	n.a.	Mar-98
Estonia	May-04	No	Nov-95	n.a.	n.a.	Mar-98
Hungary	May-04	No	Mar-94	n.a.	n.a.	Mar-98
Latvia	May-04	No	Sep-95	n.a.	n.a.	Dec-99
Lithuania	May-04	No	Dec-95	n.a.	n.a.	Dec-99
Macedonia, FYR	No	No	Mar-04	Apr-01	Dec-05	No
Moldova	No	No	No	No	No	No
Poland	May-04	No	Apr-94	n.a.	n.a.	Mar-98
Romania	Jan-07	No	Jun-95	n.a.	n.a.	Dec-99
Serbia	No	No	No	Apr-08	No	No
Slovak Republic	May-04	Jan-09	Jun-95	n.a.	n.a.	Dec-99
Slovenia	May-04	Jan-07	Jun-96	n.a.	n.a.	Mar-98
Turkey	No	No	Apr-87	No	Dec-99	Oct-05
Ukraine	No	No	No	No	No	No

Source: European Commission.

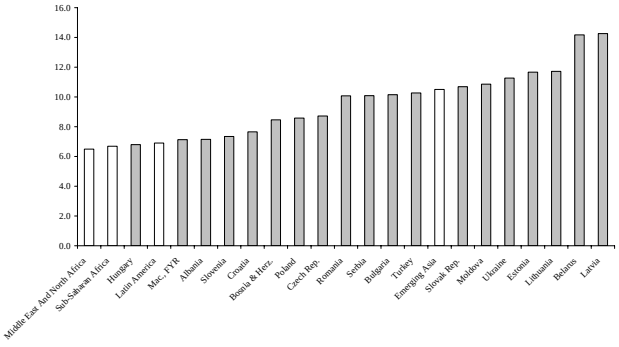
Table 2. Panel growth regression with random effects for emerging Europe, 1998-2009

Lagged change in currency mismatch	-0.09** (-2.23)	-0.10*** (-2.56)
Crisis dummy	-10.42*** (-18.89)	-9.22*** (-16.16)
Interaction term: (lagged change in currency mismatch) x (crisis dummy)	0.17*** (4.29)	0.14*** (3.75)
Lagged currency mismatch		0.02 (1.55)
Interaction term: (lagged currency mismatch) x (crisis dummy)		0.06*** (4.00)
Adjusted R^2	0.59	0.61

Note: The dependent variable is real GDP growth (the results are robust if per capita real GDP, or PPP-adjusted per capita real GDP is used instead). The GDP data are from the IMF World Economic Outlook database, with projections for 20009. Currency mismatch is measured as explained in the text. The crisis dummy takes the value of 1 in 2009, which is the year when growth turned negative throughout emerging Europe. The sample includes 10 emerging European economies: Bulgaria, Croatia, Czech Rep., Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and Ukraine. The period is 1998-2009. The regression is estimated with random effects, as both the likelihood ratio test and the Hausman rests indicate redundant fixed country effects. Heteroscedasticity-consistent standard errors in parentheses. *, **, and *** indicate statistical significance at the 10, 5 and 1 percent level, respectively.

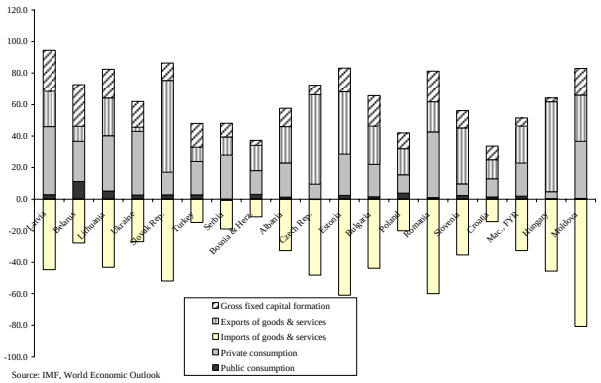
Figure 1. Growth in emerging Europe, 2004-2007

PPP per capita growth, annual average in percent, emerging Europe and other emerging economies, 2004-2007



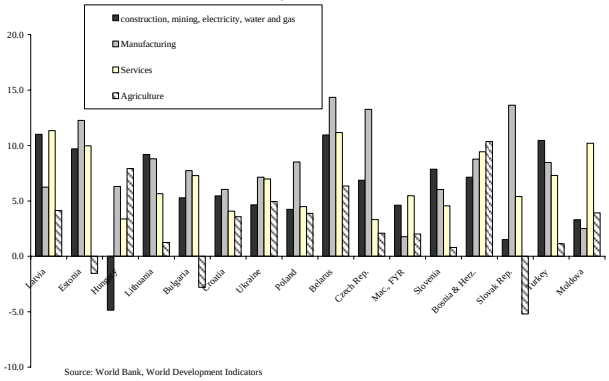
Source: IMF, World Economic Outlook

Contributions to real GDP growth, emerging Europe, 2004-2007



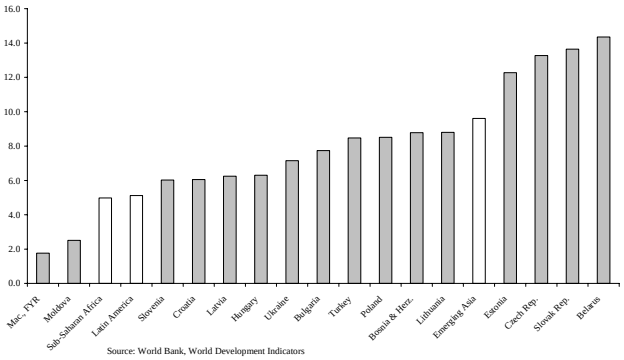
Source: IMF, World Economic Outlook

Value added by sector, average real annual growth rates, emerging Europe, 2004-07 (countries ranked by increase in external debt/GDP)



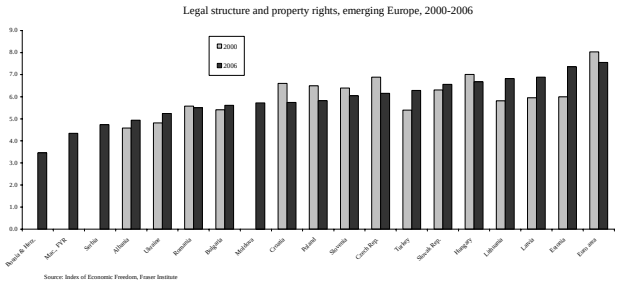
Source: World Bank, World Development Indicators

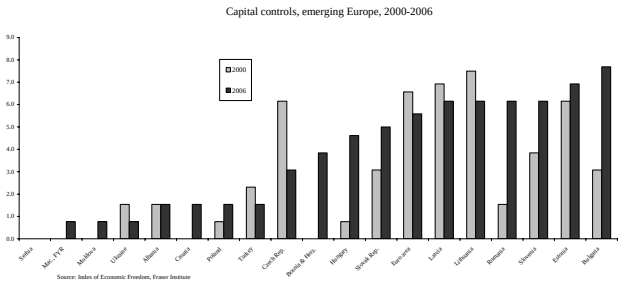
Average annual real growth rate of manufacturing value added, emerging Europe and other emerging economies, 2004-07

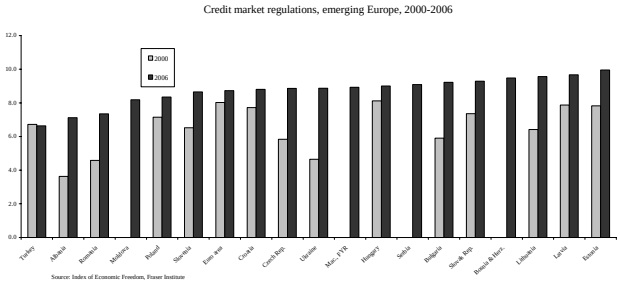


Source: World Bank, World Development Indicators

Figure 2. Legal reforms, capital account opening, and financial liberalization in emerging Europe, 2000-2006







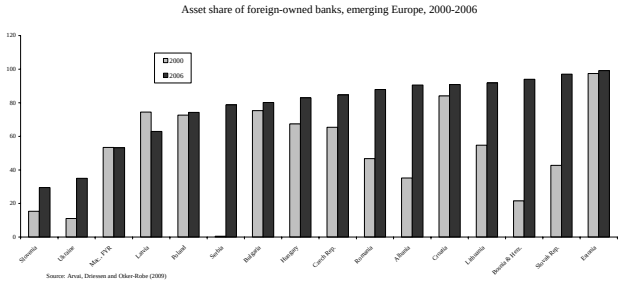
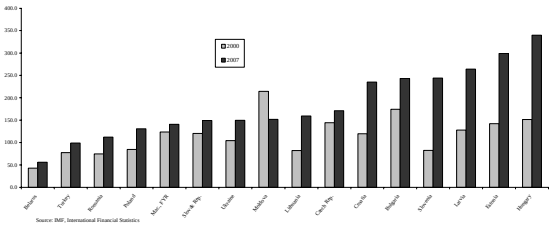


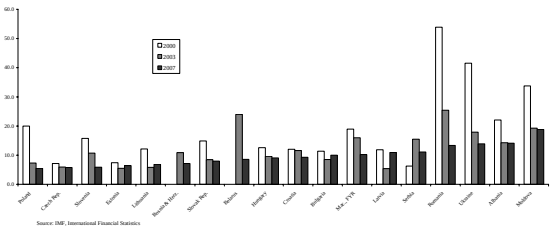
Figure 3. The build up of external imbalances in emerging Europe, 2000-207

Financial openness (foreign assets plus foreign liabilities/GDP), emerging Europe, 2000-2007



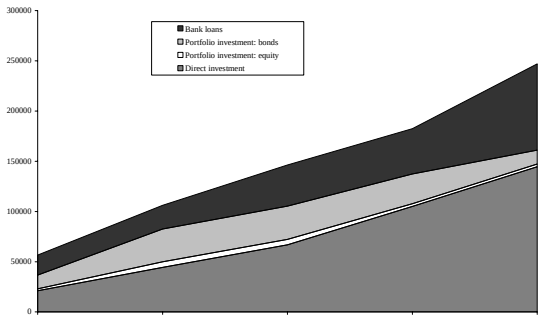
Source: IMF, International Financial Statistics

Lending interest rates, emerging Europe, 2000-2007



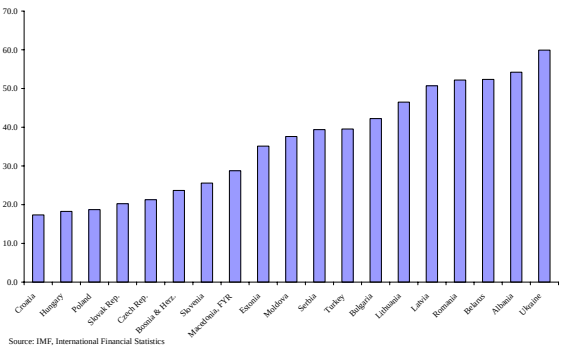
Source: IMF, International Financial Statistics

Capital inflows ($ million), emerging Europe, 2003-2007



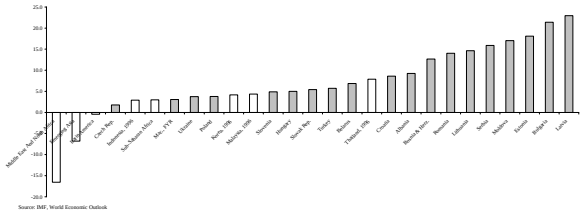
Source: IMF, International Financial Statistics

Private sector credit growth, 2004-07



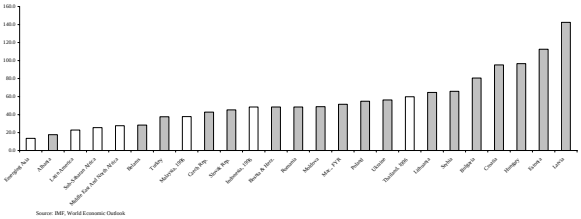
Source: IMF, International Financial Statistics

Current account deficit/GDP: emerging economies 2007 and east Asia 1996



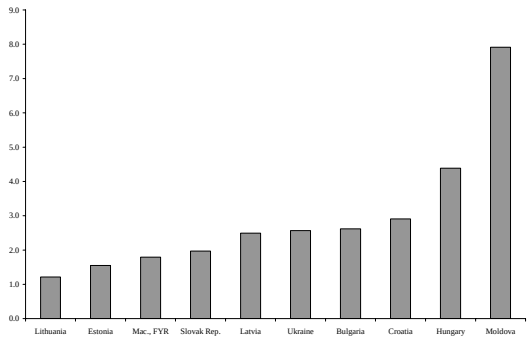
Source: IMF, World Economic Outlook

External debt/GDP: emerging economies 2007 and East Asia 1996



Source: IMF, World Economic Outlook

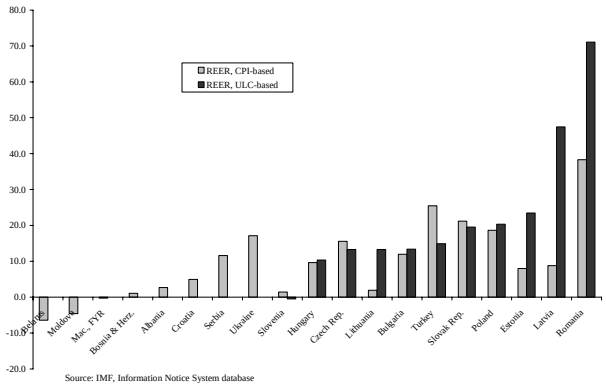
Difference between local and foreign currency lending rates (in percent), 2007



Source: IMF, International Financial Statistics, and Haver Analytics

Figure 4. Real exchange rate appreciation and exchange rate regimes in emerging Europe, 2004-2007

Real effective exchange rates, change in percent, emerging Europe, 2004-2007



Source: IMF, Information Notice System database

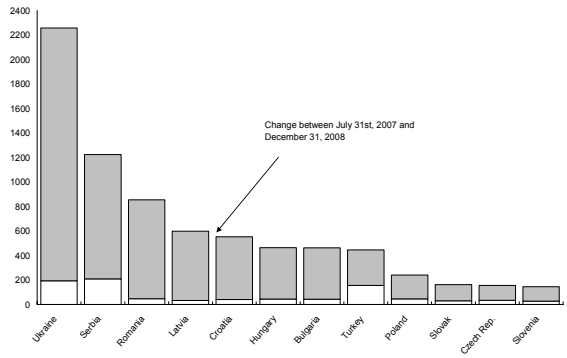
Exchange rate regimes in emegring Europe

Albania	Independently floating
Belarus	Conventional peg with the US dollar
Bosnia & Herzegovina	Currency board
Bulgaria	Currency board
Croatia	Managed floating (de facto fixed to the euro)
Czech Republic	Managed floating
Estonia	Currency board
Hungary	Pegged exchange rate within horizontal bands
Latvia	Conventional peg (de facto currency board)
Lithuania	Currency board
Macedonia, FYR	Conventional peg
Moldova	Managed floating
Poland	Independently floating
Romania	Managed floating
Serbia	Managed floating
Slovak Republic	Pegged exchange rate within horizontal bands (fixed to the euro since mid-2008, euro adoption in January 2009)
Slovenia	Euro since 2007, pegged within horizontal bands before
Turkey	Independently floating
Ukraine	Conventional peg with the US dollar up to November 2008, floating since then

Source: IMF (2008)

Figure 5. The crisis in emerging Europe

Sovereign Spreads, July 31st, 2007 - December 31st, 2008
(Basis points)



Real per capita GDP growth in emerging economies, 2004-2014

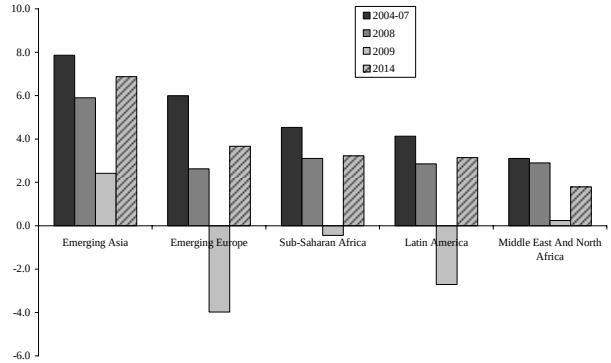
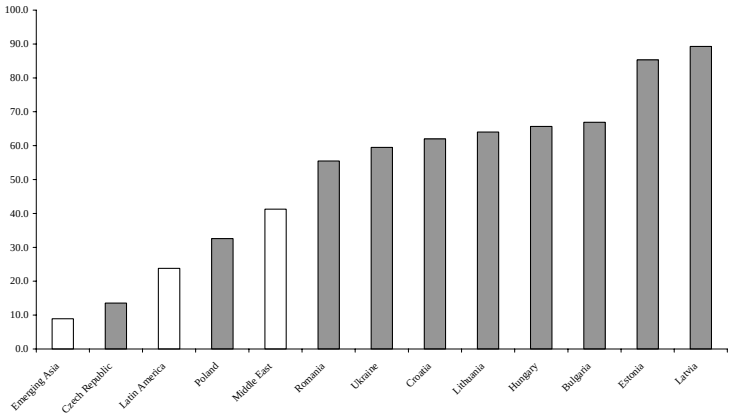


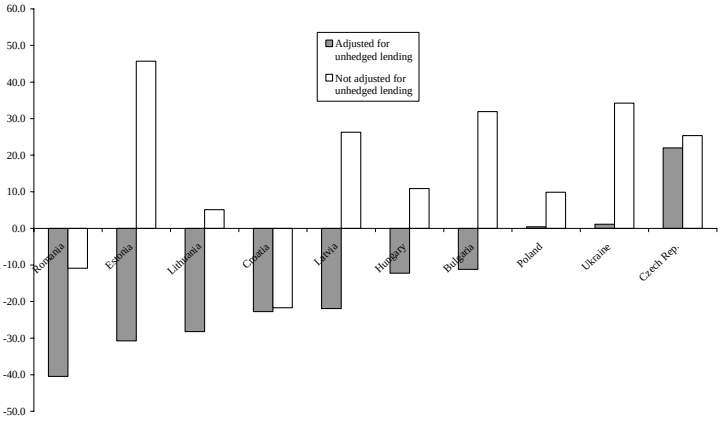
Figure 6. Currency mismatches in emerging Europe

Bank loans in foreign currency in percent of total bank loans, emerging Europe, 2007

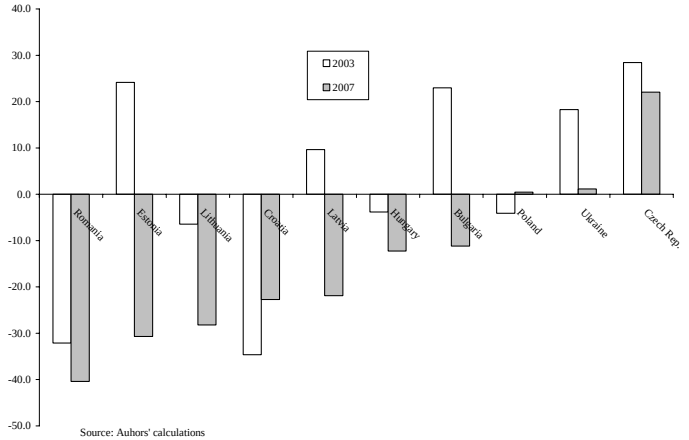


Source: IMF, Database of Vulnerability Exercise for Emerging

Currency mismatches in emerging Europe, with and without adjustment for unhedged lending, 2007



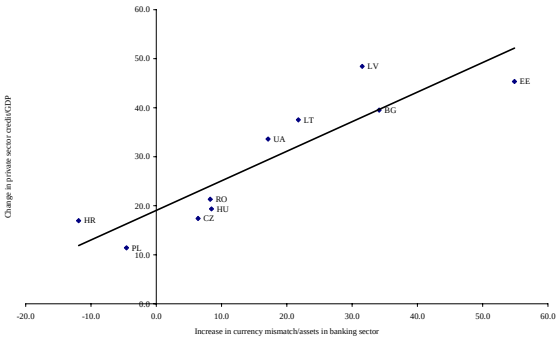
Currency mismatch in percent of bank assets, emerging Europe, 2003-07



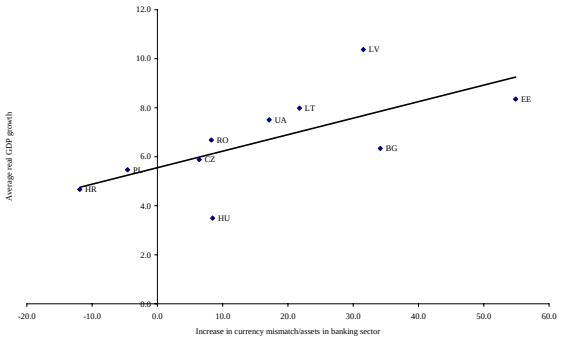
Source: Auhors' calculations

Figure 7. Currency mismatches and the economic boom and bust in emerging Europe

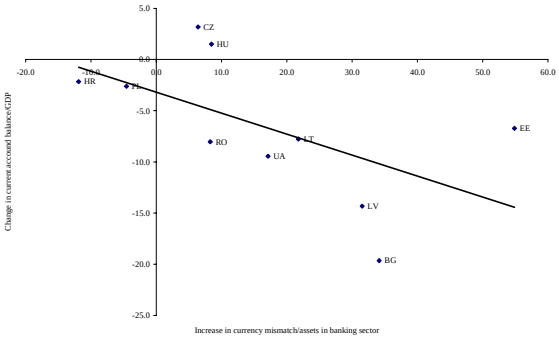
Currency mismatch and private sector credit, emerging Europe, 2004-07



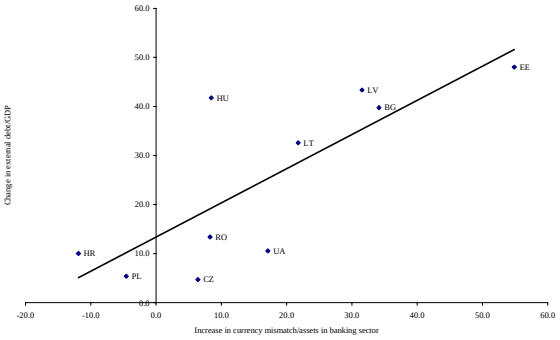
Currency mismatch and real GDP growth, emerging Europe, 2004-07



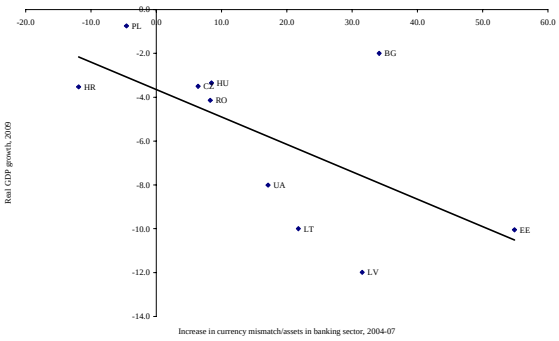
Currency mismatch and current account balance, emerging Europe, 2004-07



Currency mismatch and external debt, emerging Europe, 2004-07



Currency mismatch and growth during the crisis in emerging Europe



Currency mismatch and current account reversal in emerging Europe

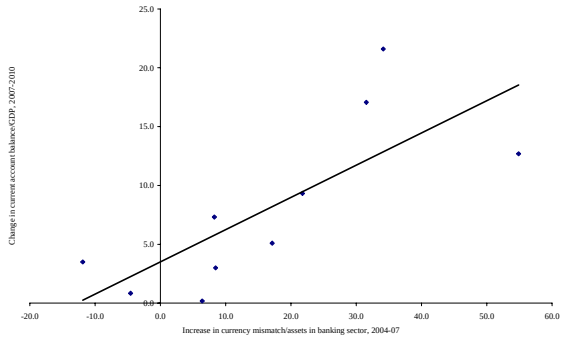
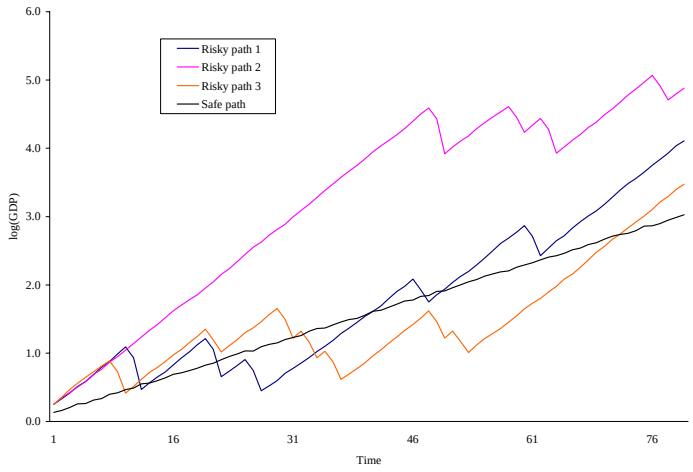
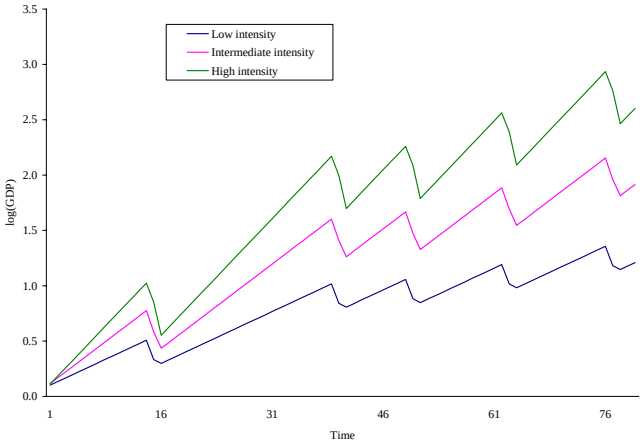


Figure 8. Model calibrations for emerging Europe

Risky vs. safe growth paths for different realization of crisis risk



Risky growth paths and the intensity of nontradables in the production of tradables



Risky growth paths and contract enforceability