Exchange Rate Expectations and Commercial Bank Risk-Taking; a VAR approach with evidence from Estonia

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Abstract:

We present evidence of a peso problem in bank risk-taking. There exists "a short run credit risk accelerator", where the expected nominal exchange rate change risk is magnified by its effect on commercial banks' risk-taking, even though expectations are neutral in the long run. An increase in devaluation or depreciation expectations of the domestic currency results in a short run increase in the share of loans with a risky security collateral, and vice versa. Interestingly, the aggregate effect of devaluation expectations on the banks' risk-taking is negative during the medium run adjustment process. Our result sheds new light on the well-known empirical finding that exchange rate changes have a bigger effect on banks' balance sheets through their indirect effect rather than the direct effect. Finally, these results indicate that the bank risk-taking suffers from the same econometric problems as exchange rate economics in general - whether this is a quantitatively significant problem in a larger sample of countries, deserves further research.

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1 Introduction

Recent research has emphasized that the incentives for risk-taking in banking are significantly affected by the regulatory environment and banking competition - see e.g. Gonzales (2005), Jeitschko et.al (2005), Boyd, de Nicolo and Jalal (2006). The open economy aspects of bank risk taking, however, remain as an relatively uncharted area.

In this paper we estimate a structural VAR and show that expectations about future exchange rate changes also have a quantitively strong impact on the risk-taking by commercial banks in their lending activities. This means that the effect of expectations is amplified in the short run by their indirect effect on future credit losses, even though expectations are neutral in the long run.

The novelty in our analysis is that we use a unique dataset from Estonia which not only allows us to derive the exchange rate expectations by the no-free-arbitrage principle, but also permits us to decompose the commercial bank´s lending according to the riskyness of the collateral required for loans.

Our main results about the peso problem in bank risk-taking are as follows.

First, there exists a "short run credit risk accelerator" whereby a shock to depreciation/devaluation expectations results in a short run increase in the level of risk-taking by domestic commercial banks (and vice versa for appreciation). This explains the stylized fact from e.g. stress-testing missions by IMF where the indirect exchange rate risk is more significant than the direct exchange rate risk. If expected exchange rate movements affect bank´s risk-taking considerably and the correlation between total lending and credit losses rises, it is then not surprising that the indirect exchange rate risk through the corporate leverage is quantitively more important than the direct effect on the bank´s balance sheets.

Second, even though expectations are neutral in the long run, the aggregate effect of expectations on risk-taking is negative during the dynamic adjustment. In other words, the short run higher risk-taking is reversed later by a more sustained decrease in banks' risk-taking. Intuitively, this results from the commercial banks' realization that earlier (rational) expectations were erroneous and resulted in an ex post excessive level of risk-taking, which requires banks to be cautious in their lending later.

From an economic theory viewpoint, the credit risk accelerator result is similar to the well known relationship between capital taxation and risk-taking [see e.g. Atkinson and Stiglitz (1980)]: since a nominal devaluation can be viewed as a tax [see Frenkel and Razin (1989)], commercial banks expecting a depreciation of the domestic currency will expect a lower average return on lending, which leads them to accept a higher variance for their lending portfolio. In other words, expectations of a domestic currency´s depreciation result in a higher risk-taking by domestic banks, and vice versa.

Our results and the previous literature can be contrasted as follows. It is well known that under a full deposit insurance, commercial banks' excessive risk-taking leads to credit expansion and devaluation crises [see for example

Velasco (1987) for a classic model and Freixas and Rochet (2001) for a survey of early banking theory models]. In other words, the causality runs from risk-taking to exchange rate expectations. Our results, however, illustrate that in the absence of full deposit insurance for banks such as is the case in Estonia, the causality can also run in the opposite direction, so that it is devaluation expectations that cause more short run risk-taking by commercial banks.

Whether these interesting empirical results for Estonia are valid for emerging markets or OECD economies also, remains to be investigated. In particular, our findings indicate the possibility that the negative correlation between the banking competition and the bank default probability, as found by Boyd, de Nicolo and Jalal (2006), may result from the relative openness of small countries with less contestable banking markets. Countries with less banking competition are usually more open and thus more vulnerable to effects of exchange rate changes. Whether this is quantitatively significant overall, deserves further research.

The paper is organized as follows. The section 2 describes the dataset. The section 3 briefly goes through the structural VAR model and the section 4 presents our main results. The section 5 illustrates some implications of our results, while the section 6 concludes.

2 Description of data

We use unique data from Estonia which allows us to derive nominal exchange rate expectations by the no-free arbitrage principle, plus also enables us to decompose the commercial banks' aggregate lending into different components according to the riskyness of the loan collateral type. Monthly data was obtained from Bank of Estonia's webpage.

During the early years of the sample, there were multiple speculative attacks on the Estonian currency's peg against D-mark / euro, but Estonia nevertheless maintained a fixed exchange rate system. This provides us with sufficient volatility in expectations data to estimate the VAR model. For the floating exchange rate vis a vis U.S. dollar, expectations were naturally of enough volatilility. A novelty in our analysis which deserves further research is that we are thus able to investigate the differences in banks risk-taking under both fixed and flexible exchange rate systems.

Nominal exchange rate expectations time series is derived by subtracting the foreign currency denominated lending from the domestic currency denominated lending rate for same maturities, which here means the 3-month lending horizon. During our sample, there were two types of foreign currency loans available, namely loans which were 100% U.S. dollar denominated and loans which were 100% euro denominated. No currency basket loan rates are included in our sample, only pure currency loan rates.

We were thus able to derive two expectations series for the Estonian currency with respect to U.S. dollar and euro, respectively. These series are shown in figures 1 and 2.

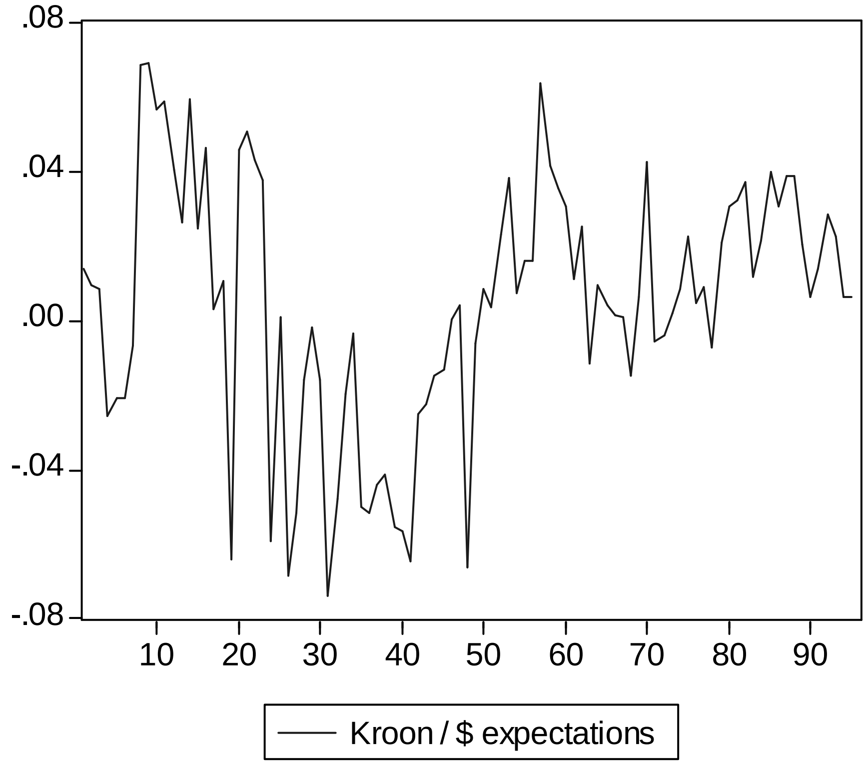

Figure 1: Nominal expectations of the Estonian kroon / US dollar exchange rate, monthly observations during 1998-2005.

For the commercial bank risk-taking, we use the following proxy. Since the dataset includes the type of collateral used for getting a loan, we choose the time series that has a collateral with a high asset price variance : the security collaterized lending's per cent share from the total commercial bank lending volume. Our choice is justified by numerous international financial crises events where excess credit was given to borrowers on the basis of collateral that later dropped in terms of value , resulting in banking crises [Japan in the 1990s being the famous example]. In many emerging market economies, security collaterized lending is of high importance, so this risk-taking proxy is of general interest.

We use the following financial sector statistics of the Bank of Estonia:

1. Weighted average annual interest rates of EEK, DEM, EUR, USD nominated loans by maturity (up to 3 months and 12 months)

2. Loan collaterals, in volumes and in percentages, for example

- First mortgage
- Other mortgage

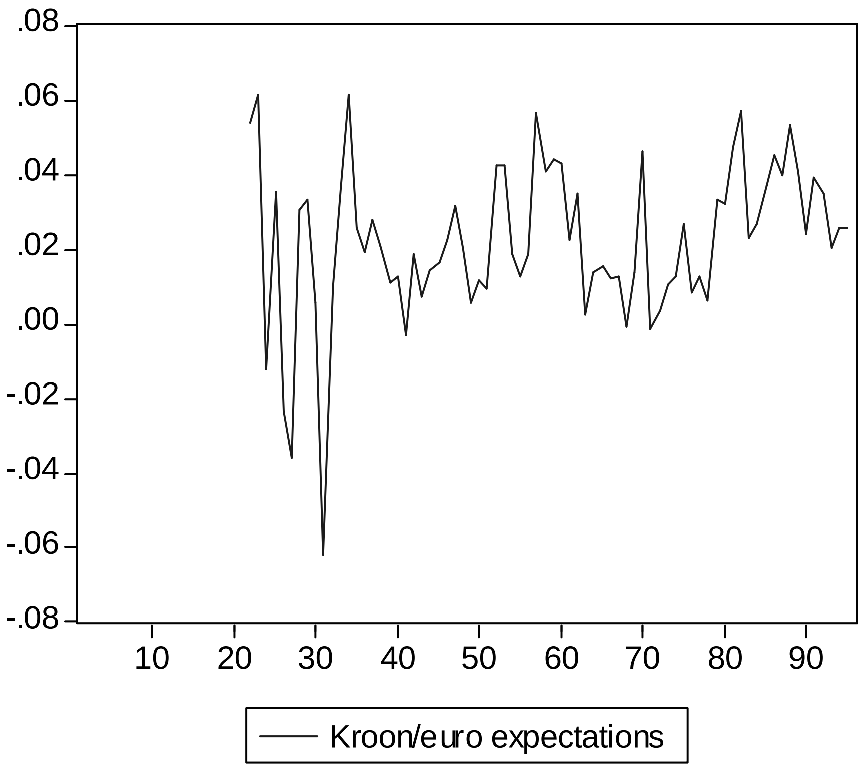

Figure 2: Nominal expectations of the Estonian kroon / euro exchange rate, monthly observations during 1998-2005.

- Securities collateral
- Pledge of building
- Pledge of other movable
- Surety, guarantee
- Without collateral.

3 A structural VAR with a long run restriction

We use a Blanchard-Quah style VAR model to examine the relationship between nominal exchange rate expectations and the share of lending with risky collateral (in the commercial bank´s lending portfolio).

There are two types of shocks: demand shocks such as domestic credit changes and supply shocks.

As originally shown by Blanchard and Quah (1989), one can use long run restrictions based on economic theory to identify the VAR. We thus have the following specification for the vector of variables $y_{t:}$

$$\mathrm{y}_t = \sum_{i=1}^{n} A_i y_{t-i} + B v_t \tag{3.1}$$

where we are posing A equal to the identity matrix and imposing no restrictions on the B matrix. The matrix that describes the long run effect of the structural shocks is then derived from above as being equal to

$$\left(I - \sum_{i=1}^{n} A_i\right)^{-1} B v_t = -\Pi^{-1} B v_t \tag{3.2}$$

Let us denote the conditional expectations operator by E , the nominal exchange rate by e and the commercial bank´s risky lending´s per cent share of total lending by R, we can thus write our structural VAR equation as being equal to

$$\begin{pmatrix} E_t e_{t+3} \\ R_t \end{pmatrix} = A_1 \begin{pmatrix} E_{t-1} e_{t+2} \\ R_{t-1} \end{pmatrix} + A_2 \begin{pmatrix} E_{t-2} e_{+1} \\ R_{t-2} \end{pmatrix} + A_3 \begin{pmatrix} E_{t-3} e_t \\ R_{t-3} \end{pmatrix} + \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} \tag{3.3}$$

where we have decided to use 3 lags in the estimation procedure. Since neither exchange rate expectations nor the risk-taking time series exhibits a trend, we estimate our VAR model in levels instead of differences.

We impose the following long run restriction:

Assumption: *The long run effect of the demand shock (and the resulting exchange rate expectations) on commercial bank´s risk-taking is equal to zero, that is, they are neutral in the long run.*

The above restriction conforms to the standard macroeconomic theory where demand shocks (such as e.g. changes in domestic credit or a nominal devaluation of the domestic currency) have no real effects in the long run.

Quantitatively, the above long run restriction is obtained by rewriting the VAR model as

$$\begin{pmatrix} E_t e_{t+3} \\ R_t \end{pmatrix} = \begin{pmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \begin{pmatrix} v_{1t} \\ v_{2t} \end{pmatrix} \tag{3.4}$$

where we have used the standard notation which denotes

$$\begin{pmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{pmatrix} = \left(I - \sum_{i=1}^{n} A_i \right)^{-1} \tag{3.5}$$

The long run restriction therefore is expressed as being equal to

$$\mathrm{k}_{21} b_{12} + k_{22} b_{22} = 0 \tag{3.6}$$

4 VAR estimation results

In this section we present our main empirical results. The structural VAR is just-identified in both cases and the estimated B matrix for kroon/euro expectations shock VAR is equal to

$$\begin{pmatrix} 0,027954 & -0,002510 \\ 0,009105 & 0,018785 \end{pmatrix}. \tag{4.1}$$

Likewise, the estimated B matrix for the Estonian kroon / U.S. dollar expectations shock VAR is equal to

$$\begin{pmatrix} 0,042381 & -0,006421 \\ 0,008697 & 0,025672 \end{pmatrix}. \tag{4.2}$$

Figures 3 and 4 illustrate the impulse responses for the effect of nominal devaluation and depreciation expectations of the Estonian kroon with respect to euro and U.S. dollar.

From the figure 3, we observe that a nominal devaluation expectation results in a short run magnification of Estonian banks' risk-taking in their lending. When commercial banks are expecting a nominal devaluation, this lowers the expected return for assets. For risk averse banks that are optimizing their

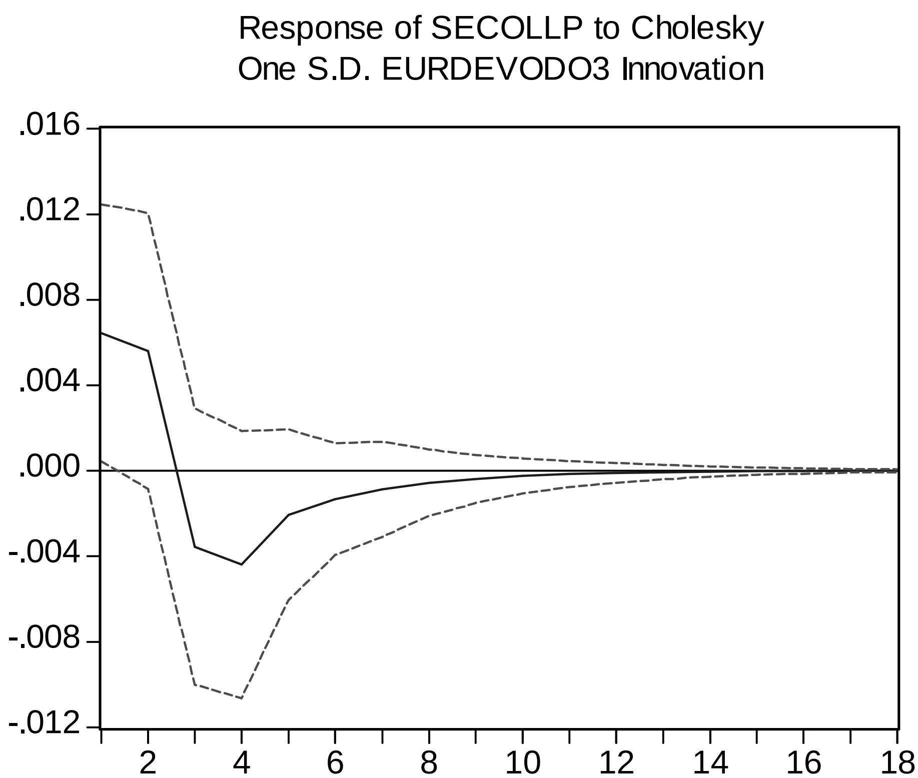

Figure 3: The effect of 3-month nominal Estonian kroon / euro devaluation expectations on the share of loans with a risky security collateral.

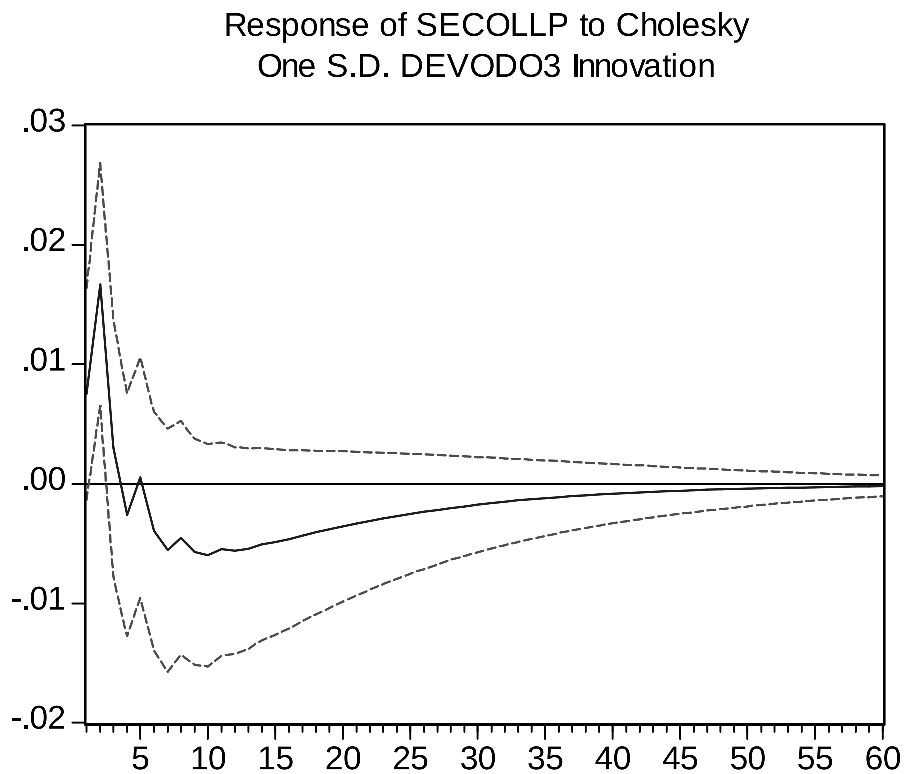

Figure 4: The effect of nominal Estonian kroon / US dollar depreciation expectations on the share of loans with a risky security collateral.

loan portfolio, the lower expected return is compensated by accepting a higher variance for the asset return. In other words, nominal devaluation expectations yield more short run risk-taking in lending activities as relatively more loans are granted with a risky collateral than before.

We also notice that the temporarily higher risk-taking is reversed in the long run. Intuitively, since kroon / euro devaluation never occurred during our sample, Estonian commercial banks decrease their risk-taking after the 3-month horizon is over, realizing that expectations were unwarranted.

The chi-square statistic for VAR Granger causality test is 15.948 so we cannot reject the null hypothesis that devaluation expectations at 3-month horizon (DEVODO3) Granger-cause the risky security collaterized lending share (SECOLLP) at 1% significance level.

Here we notice a qualitatively similar but quantitatively longer response of bank risk-taking to the nominal depreciation expectations for the kroon / U.S. dollar exchange rate. Again, a short run increase in banks' risk-taking is followed by a reversal in the long run.

The puzzle here is that the dynamic adjustment seems to be quantitatively very different under fixed and flexible exchange rate systems. During our sample, the Estonian kroon was fixed with respect to euro while floating against the U.S. dollar. Therefore it seems to take much longer for the banks' risk-taking to adjust in the long run under a floating exchange rate system than under a fixed exchange rate system. We venture a guess that this may have something to do with the higher extrinsic uncertainty related to floating exchange rate systems, but this seems a worthwhile topic for future research on the subject.

The chi-square statistic for the VAR Granger causality test equals 6.813, so we cannot reject the null hypothesis that kroon / euro devaluation expectations (EURDEVODO3) Granger-cause the risky security-collaterized lending share (SECOLLP) at 5% significance level.

Figures 5 and 6 illustrate that the aggregate effect of devaluation / depreciation expectations on the commercial banks' risk-taking during the dynamic adjustment process is negative, even though expectations are neutral in the long run. The economic intuition for this is quite clear: after the initial increased level of risk-taking, banks realize that their expectations were wrong (Estonian kroon was never devalued despite several speculative attacks), which leads banks to readjust by becoming more cautious in their lending during the medium run adjustment process. This correction mechanism lasts until about a year has passed from the initial shock.

5 Implications for banking stress-testing

The empirical results shown above have novel implications for exchange rate stress-testing. Let us illustrate this by referring to the standard framework surveyed e.g. in the International Monetary Fund´s background paper on "Financial Soundness Indicators" (2003).

Denote the variables as

TL = total lending

a = $\Delta(NPL/TL)/\Delta(D/E) \succ 0$

NPL = non-performing loans

D = Corporate sector´s debt

E = corporate sector´s equity

C = capital

π = provisions, expressed as a fixed percentage of non-performing loans

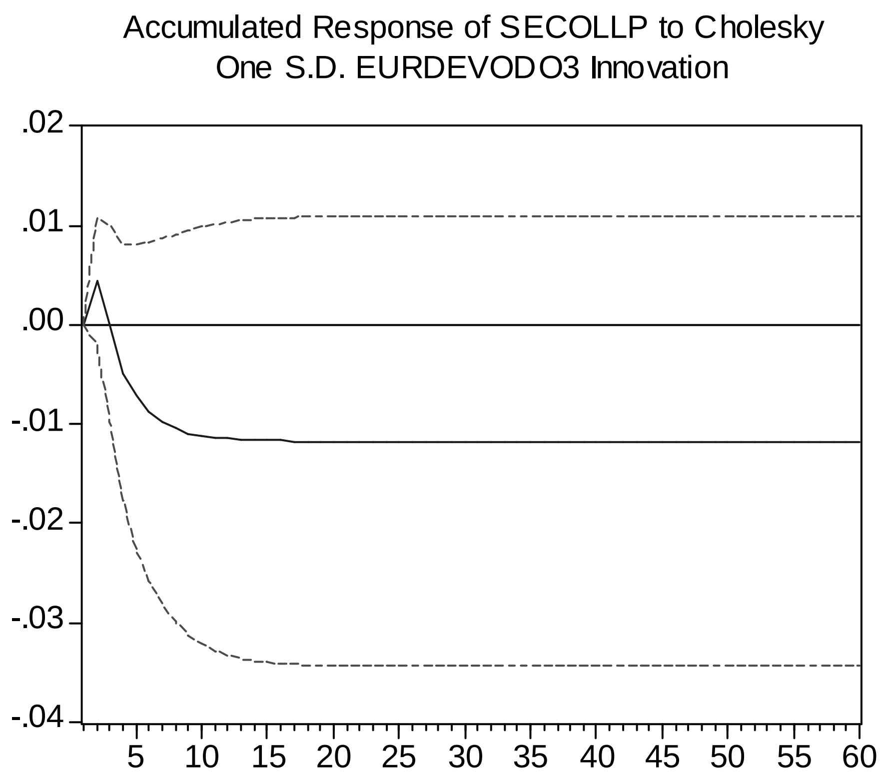

Figure 5: The accumulated response of the risky security-collaterized lending share to the 3-month devaluation expectations with respect to euro.

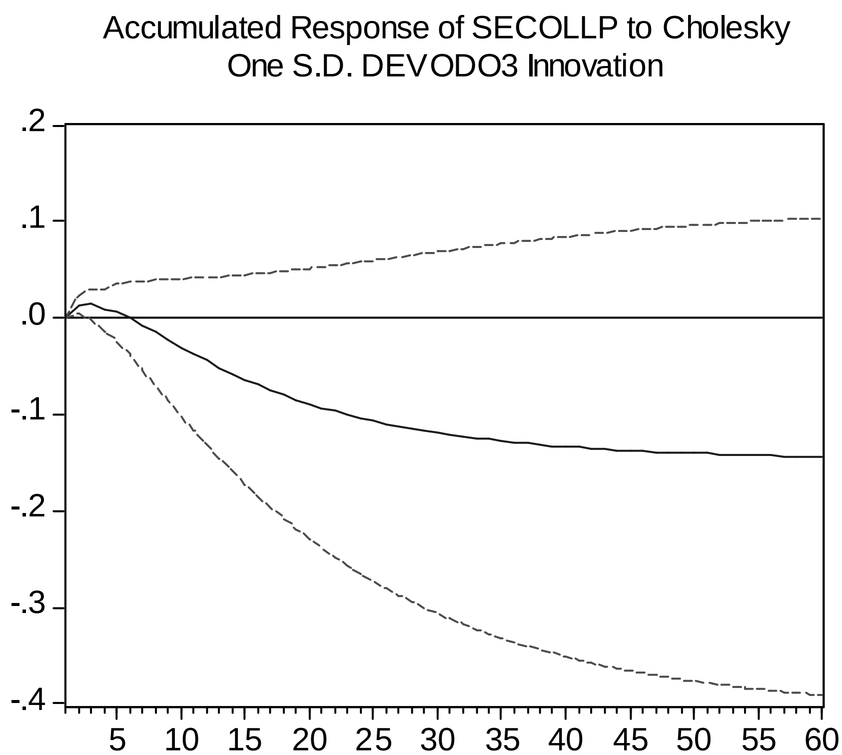

Figure 6: The accumulated response of the risky security-collaterized lending share to the 3-month depreciation with respect to US dollar.

A_{RW}= risk-weighted assets
F = the net open position in foreign exchange

e = the exchange rate in units of foreign currency per domestic currency.

Subscript C denotes corporations and "delta" denotes differential, as usual.

One can obtain the indirect impact of the exchange rate change on the capital to risk-weighted assets ratio, through the effect on the corporate leverage:

$$\Delta\left(\frac{C}{A_{RW}}\right) \approxeq \frac{\Delta e}{e}\frac{TL}{A_{RW}}\left(1-\frac{C}{A_{RW}}\frac{\Delta A_{RW}}{\Delta C}\right)\pi\ \frac{F_C}{E_C}a\left(\frac{D_C}{E_C}-\frac{\Delta D_C}{\Delta E_C}\right) \qquad (5.1)$$

(Details for deriving the above formula can be found e.g. in IMF background paper (2003).)

Here, most stress-testing simulations for banks, including IMF's FSAP missions, assume a constant correlation coefficient parameter a between total lending and credit losses. Our empirical results, however, illustrate that this assumption can yield an underestimated indirect impact of the exchange rate change in a short run and an overestimated impact during the medium run. In other words, *the banking risk-taking estimation and simulations suffer from time-varying parameter problem* just like exchange rate economics in general does. If devaluation expectations raise the risk-taking by banks, future credit losses are more correlated with total lending as before and therefore a is not a constant parameter but also a function of exchange rate expectations, leading to a higher value of $\Delta\left(\frac{C}{A_{RW}}\right)$.

6 Concluding remarks and areas for further research

We have presented evidence of a peso problem in commercial banks´ risk-taking. First, there exists a "short run credit risk accelerator", where the effect of an expected exchange rate movement is amplified through its impact on the risk-taking of domestic commercial banks in their lending activities. For a fixed exchange rate between the Estonian kroon and euro, these expectations were unfulfilled during the sample. Second, during the medium run adjustment process the peso problem leads to a year-long relative cautiousness in commercial banks´ risk-taking.

In other words, observed bank risk-taking measures may have unfulfilled expectations embedded there during the sample, which can lead to similar econometric problems for bank risk-taking estimation as the exchange rate economics has suffered for a long time [see e.g. Lewis (1995) for a survey and Rogoff (1980) for a pioneering work on the peso problem]. Whether this is a quantitatively significant problem in a panel of OECD countries data, for emerging markets data only, or at all, should be rigorously investigated.

Our results illustrate that the possibility of a peso problem in bank risk-taking deserves further research. Given that Basel II requirements imply a continuous monitoring of banking risks, the proper implementation of Basel II should take into account the peso problem wherever it exists.

Even though the findings presented here are far from conclusive, they do point out a possible reason for the empirical results of Boyd, de Nicolo and Jalal (2006), who found that a higher banking competition lowers the probability of a bank default. Namely, if one thinks about this issue in an open economy context, it seems quite plausible that economies with higher banking competition such as USA are also among those economies that are less vulnerable to exchange rate movements. Small open economies with less contestable banking markets also generally have a higher exports to real GNP ratio and are thus more vulnerable to effects of exchange rate changes. This is an area which has not in our opinion received enough empirical attention yet.

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