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Igor Vetlov

Dollarization in Lithuania: An Econometric Approach

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Igor Vetlov*

Dollarization in Lithuania: An Econometric Approach

Abstract

The paper analyses the factors driving dollarization in Lithuania during the period from December 1992 to August 2000. Starting with a brief overview of the major economic and political developments in Lithuania, the study attempts to model the process of dollarization by applying rigorous time series analysis. In particular, it investigates the long- and short-run properties of the relationship between the dollarization ratio and interest rates paid on domestic and foreign currency deposits. The study identifies a relatively stable cointegrating relationship between variables, whereby the dollarization ratio is negatively related to the interest rate spread. In the constructed vector error correction model, the deviations from the long-run relationship are found be significant for the dynamics of all three variables. Overall, the model explains the development of dollarization rather well. Simple specification of the model is possible when interest rates reflect the major economic and political events relevant to the process of dollarization.

Key words: dollarization, transition economy, currency board, unit roots, cointegration, vector error-correction

JEL classification: C22, C51, C52

1 Introduction

Money, by its nature, can serve as a store of value, a unit of account and a medium of exchange. In an environment of high inflation and"excessive exchange-rate volatility, the ability of the domestic currency to deliver these functions can be significantly distorted. Such conditions motivate economic agents to substitute the domestic currency with a more stable currency. The use of a foreign currency as a store of value and unit of account is sometimes referred to as “dollarization” (Calvo and Vègh, 1992). The narrower definition, currency substitution, implies that the foreign currency is used as a medium of exchange.

At the earlier stages of economic transformation Lithuania, like other transition countries, experienced a flight from its domestic currency triggered by a substantial devaluation. The US dollar increasingly became the store of value, the unit of account, and the medium of exchange."Lithuania’s currency reforms in 1992–1993, along with subsequent tightening of monetary policy and stabilization of the exchange rate, helped increase public trust in the domestic currency and significantly reduce the level of dollarization. In April 1994, Lithuania adopted a currency board arrangement (CBA) that featured a fixed exchange rate versus the US dollar. Recently, the Bank of Lithuania (Lietuvos Bankas, LB) announced plans to repeg the domestic currency, the litas, to the euro, while preserving all the other features of the present CBA until full participation in European Monetary Union (EMU).

The absence of active monetary policy in Lithuania in recent years was reflected in little interest in a dollarization discussion by policymakers. With the approach of EMU and monetary integration, the floor has been opened to debate over the pros and cons of full “eurozation.” This new disscussion, however, focuses on the consequences of dollarization/eurozation rather than its determinants. Yet, without understanding the factors that drove Lithuanians to dollarize their assets in the first place, one cannot be sure that dollarization will vanish with the introduction of the euro. Therefore, a study of the past and present determinants of dollarization in Lithuania is quite justifiable from the point of view of future economic policy.

Despite the political implications, the major motivation for the present research is academic. Lithuanian data on dollarization provide a relatively long time series that allow for the application of advanced time series analysis techniques – something still quite rare in studies of transition economies.

Moreover, the Lithuanian CBA creates a special case in the context of dollarization studies.

The present research is primarily focused of the factors of dollarization in Lithuania in recent years. The analysis builds on an earlier related study undertaken by Korhonen (1996), who was the first to apply econometric tools to the study of dollarization in Lithuania. His analysis revealed the importance of the spread between the interest rates paid on domestic and foreign currency time deposits in explaining the development of Lithuanian dollarization in the period July 1993 – May 1996.

The sharp rise in the level of foreign currency deposits over the second half of 1999 calls for a new investigation. Furthermore, the limited number of observations (just over 30 observation points) prevented Korhonen from applying advanced econometric tests in his study. Now we have at our disposal an extended sample of over 90 observations covering the period from December 1992 to August 2000. This allows for the application of a wide range of advanced econometric tools and improved reliability of the statistical results.

Section 2 briefly overviews the related literature on currency substitution and dollarization. We discuss the problem of definition of the phenomenon and draw on some results of the earlier related studies. A particular attention is paid to the papers of Korhonen (1996) and Sarajevs (2000). In section 3, we discuss the degree of dollarization in Lithuania, looking at different measures and trying to evaluate its significance in the context of other Baltic countries. We also survey the development of relevant economic and political factors in Lithuania over the past decade. In section 4, rigorous econometric analysis is applied to a set of selected variables in an attempt to build a simple model of dollarization. Finally, section 5 provides a summary of the main findings with final remarks.

2 A brief review of the literature on currency substitution and dollarization

Currency substitution and dollarization is a relatively new area of economic research, dating back just a quarter of a century.[1] Although, many papers devoted to the topic have been produced, the definition of the phenomena remains unsettled and both terms are used interchangeably.

Every paper on currency substitution discusses the definition of the phenomenon. Usually the scope of the definition depends on a role of money considered. On one hand, McKinnon (1985) proposes a broad definition of currency substitution that distinguishes between *direct currency substitution* (currencies compete as means of payments) and *indirect currency substitution* (a situation when investors switch between non-monetary financial assets). On the other hand, the narrow view of Cuddington (1989), and Calvo and Vègh (1992) relate *currency substitution* to a use of foreign currency as a medium of exchange only. When foreign currency is used as a store of value and/or units of account, the authors apply the term *dollarization*.[2] In Calvo and Vègh (1992), and Sahay and Vègh (1995), we also find a distinction between currency substitution and *asset substitution*. The latter concept is a part of dollarization and captures a process of substitution taking place between interest-bearing assets denominated in the domestic and foreign currency. Finally, some studies view currency substitution as a situation in which foreign economic variables (e.g. foreign inflation and real return differential) influence demand for domestic money. Such interpretation avoids the confusion that surrounds the definition of currency substitution.

A comprehensive overview of both the theoretical and empirical literature on currency substitution and dollarization can be found in Giovannini and Turtelboom (1994), and some follow up in Sarajevs (2000). In an attempt not to repeat the above-mentioned authors in the following we would like just to summarize the stance of the literature as for today.[3]

The theoretical models of currency substitution are developed following framework similar to models of a one-currency world: cash-in-advanced models, transaction costs models, and simply *ad hoc* models. The cash-in-advance models predict that real holdings of different currencies do not go beyond the quantities of domestic and foreign goods purchased since any interest-bearing asset dominates money.[4] The transaction costs models explain the determinants of the demand for domestic and foreign currencies for a store of value purpose. These models emphasize the liquidity property of money and incorporate a transaction cost function in a budget constraint. They show that the demand for different currencies depends on the expected liquidity services and relative returns on money and other assets in the portfolio of the economic agents (Sahay and Vègh (1995c), and Thomas (1985)).

Many authors (e.g. Guidotti and Rodriguez (1991)) have documented the persistence of a high level of currency substitution even when the factors

causing it ceased to exist. As a result, literature explaining the hysteresis-type phenomenon of currency substitution emerged (Uribe (1997), and Sturzenegger (1997). Uribe (1997) also showed that high and prolonged inflation (due to delay and/or inefficiency of a macroeconomic stabilization program) could bring substantial reduction in the costs of using foreign currency. Thus, even after domestic inflation eventually had returned to its initial low level, equilibrium with a high level of currency substitution might prevail.

Lack of reliable data on foreign currency banknotes circulating in a domestic economy makes it extremely hard to test the above-mentioned theoretical models directly.[5] Indeed, domestic foreign currency deposits turn out to be the only available data in practice related to currency substitution, so empirical study of currency substitution in fact boils down to a study of dollarization of the domestic banking sector. As a result, the applied research on currency substitution implicitly employs a definition close to McKinnon's (1985) *indirect currency substitution* or *dollarization* in terms defined in Cuddington (1989) and Calvo and Vègh (1992).

The bulk of empirical studies on dollarization investigate the determinants of the phenomenon in countries of Latin America as their experience with the phenomenon has been indeed rich (for instance, Savastano (1996), Guidotti and Rodriguez (1991), Ramirez-Rojas (1985), and Ortiz (1983)). The key explanatory factors of dollarization in these studies can be roughly divided into two groups: institutional factors and differences in real rates of returns of assets denominated in domestic and foreign currency.

The main institutional factors of dollarization are the degree of openness of the domestic economy, the depth/size of the domestic financial market, and the transaction costs of converting the currencies. A rise/decline in the first one is expected to bring a rise/fall in the degree of dollarization. This relationship is motivated by the demand for foreign currencies to carry out international transactions. The availability of domestic-currency-denominated financial instruments other than domestic currency cash and deposit holdings can substantially reduce demand for foreign currency fiat money.[6] Finally, a high degree of liberalization of the domestic foreign exchange market reduces the costs of switching between different currencies. The latter is expected to facilitate the process of dollarization of the domestic economy.

The key factors of return on assets, interest rates paid on the domestic and foreign currency deposits, domestic and foreign bonds, as well as meas-

ures of devaluation expectations are widely employed. On the other hand, time series for an expected devaluation is usually unavailable. Therefore, the actual rate of devaluation (perfect foresight) or its lagged values (adaptive expectations) are used instead. In addition, other variables which can signal possible devaluation in future are often included in an *ad hoc* manner: real exchange rate, domestic inflation, current account deficit, foreign reserves of the central bank and other related variables.

The past decade witnessed a rise in the level of dollarization in the transition economies of Central and Eastern Europe (CEE). As a result, the empirical literature on currency substitution and dollarization has been recently enriched by case studies of the CEE economies: Buchs (2000), Sarajevs (2000), Mongardini and Mueller (1999), Brodsky (1997), Korhonen (1996), Sahay and Vègh (1995c), and Bas van Aarle and Budina (1995). The overall experience of the transition economies shows that the liberalization of foreign exchange regimes and a lack of alternative financial instruments have been the main institutional factors behind rapid dollarization. Dollarization occurred in reaction to the pressure of high inflation, negative real domestic interest rates and large devaluations at the beginning of economic transformation (Sahay and Vègh, 1995c).

Econometric analysis of dollarization in the transition economies basically utilizes the same explanatory variables as those used in related papers devoted to the developing economies of Latin America. Two studies are of particular interest since they form the basis for the research undertaken in the present paper. The first is the study of dollarization in Lithuania by Korhonen (1996), while the second by Sarajevs (2000), who applies econometric analysis to study dollarization in Lithuania's neighbor Latvia.

Korhonen (1996) measures the degree of dollarization as a share of the total foreign currency deposits in broad money (M2). The explanatory variables: the expected devaluation of the domestic currency and the interest rate spread between the interest rates paid on short-term (1-3 months) time deposits denominated in the domestic and foreign currency – were chosen on the basis of Thomas (1985) model elaborated by Sahay and Vègh (1995c). Applying a Dickey-Fuller unit root test to monthly data from June 1993 to March 1996 (33 observation points), Korhonen finds that all variables in question are stationary. Further modeling reveals that the interest rate spread is an important factor in Lithuanian dollarization, while an expected devaluation (actual exchange rate change with lag) is found insignificant. The au-

thor attributes the latter to the likelihood that the interest rate already incorporates devaluation expectations, so inclusion of a proxy for expected devaluation is unnecessary. A final, but no less important conclusion of the study is that it takes no longer than one month to adjust the deposit portfolio in Lithuania. Korhonen backs up this prediction of the empirical model by drawing attention to the fact that in early 1996 approximately 85 % of all foreign currency deposits in Lithuania were demand deposits.

Sarajevs (2000) measures the level of dollarization in Latvia as a ratio of the total domestic foreign currency deposits to the components of the Latvian broad money M2 denominated in the domestic currency.[7] Both univariate and multivariate modeling strategies are undertaken in the paper. The multivariate analysis employs the following explanatory variables: interest rate spread on long-term deposits in domestic and foreign currency, interest rate spread on short term deposits in the domestic and foreign currency, average monthly domestic inflation, central bank net foreign assets, real exchange rate, share of total trade in nominal GDP, share of government expenditures in nominal GDP, and volatility of government expenditures. Based on monthly data from January 1993 to June 1999 (78 observations), a formal unit root test indicates that the dollarization ratio is a stationary process. Sarajevs disregards the result of the unit root test pointing at low power of the test to distinguish between unit root and near root processes and continues with an error-correction approach. Having identified one cointegrating relationship between variables in question and established weak exogeneity of all the variables except the dollarization ratio in a general VAR model, Sarajevs proceeds with the Engle-Granger two-step procedure (Engle and Granger, 1987). The final model confirms the importance of the spreads, the rate of appreciation of the real exchange rate and the net foreign assets for the dynamics of dollarization in Latvia.

Thus, several tasks can be formulated for the research on dollarization based on earlier related studies. The first concerns the choice of a measure of dollarization in Lithuania and its potential explanatory variables. It is also important here to determine the order of integration of the selected variables, especially when it comes to a measure of dollarization. Provided a clear indication of nonstationarity of the selected time series exists, we can proceed with cointegration analysis and an error-correction modeling strategy.

3 Dollarization in Lithuania

3.1 Measuring Dollarization

To fully evaluate the scale of dollarization in a particular economy, one needs data on foreign banknotes circulating as store of value in the economy and on residents' foreign currency deposits held domestically and abroad. In Lithuania, as elsewhere, reliable data on residents' foreign currency deposits abroad are unavailable. The same is true for the foreign banknotes circulating in the economy. This leases the researcher with foreign currency deposits in the domestic economy. It is reasonable to assume that any calculated degree of dollarization based on such data would constitute only the lower bounds of overall dollarization in Lithuania.

The most valuable source of this kind of statistical data is the *Monthly Bulletin*[8] (*MB*) published by the Bank of Lithuania (Lietuvos Bankas, LB). A more aggregated monetary data on the Lithuanian economy can be found in the *International Financial Statistics* (*IFS*) – the International Monetary Fund's (IMF) monthly publication. Other data (inflation, GDP growth and other figures) are taken from Lithuania's Department of Statistics publications and its website.[9]

In selecting the time range of the data we attempt to cover the longest time span possible taking into account the reliability of the data. The length of the time series (and hence the number of observations) is crucial for carrying out a profound econometric analysis at the same time preserving the statistical validity of the obtained results. Most of the monetary time series published in the *MB* start at the end of December 1992. Therefore, we choose this date as the starting point of the time series employed in the research. Since the present research seeks to employ the very latest data available, the cutting point of the time series used in this paper is August 2000.

Figure 1 (see Annex) displays the three most common measures of dollarization found in the literature. The first (DDR) is the ratio of the residents' foreign currency deposits (demand, saving and time deposits) to domestic currency deposits (demand, saving and time deposits).[10] The second (DR) is the ratio of the residents' foreign currency deposits to the components of money aggregate M2 denominated in domestic currency (see Sarajevs (2000)). It is simply the sum of the residents' domestic currency deposits and the domestic currency in circulation. The last measurement of the Lithua-

nian dollarization (DSH) is the share of the residents' foreign currency deposits in total M2 (e.g. Korhonen (1996)).

As can be seen from Figure 1, the development in all measures of dollarization in Lithuania is rather similar. All measures are found at a high level in the beginning of the period concerned. A dramatic fall in these series then occurs in the second half of 1993. In 1994, the decline in dollarization levels out. Dollarization surges in the first half of 1995, reaching a peak in the summer at a level 50 % above the 1994 level. In the following two years and a half, all measures fluctuate and there is a negative trend in dollarization. At the start of 1998, this trend reverses and the degree of dollarization begins to rise. A dramatic increase in the second half of 1999 brings the level of dollarization up to 1995 levels.

The main difference in these time series lies in their levels. However, with an appropriate re-scaling, these time series follow each other rather closely. The cross correlation coefficients between the measures are high: 0.976 in case of DR and DDR, 0.993 for DR and DSH, and 0.985 for DRR and DSH. Apparently, the choice of approach for measuring dollarization in Lithuania here make little difference for the econometric analysis later in this paper. To keep the analysis focused, we choose the degree of dollarization in Lithuania represented by the measure DR.

Figure 2 breaks down the dollarization ratio DR into two components: foreign currency deposits of residents (FCD) and the broad money aggregate denominated in domestic currency (M2LT). The figure shows that the gap between the two components begins to widen at the beginning of the investigated period. Both time series are negatively affected by the banking crisis at the start of 1996. The latter may imply that banking risk has a symmetric effect on deposit demand for both currencies. It can also be concluded from the figure that the recent rise in the dollarization ratio is due to continuous increase in the foreign currency deposits given depressed demand for the domestic currency assets. Finally, the development of the foreign currency deposits seems to be relatively stable when compared with the behavior of M2LT. The last observation, however, does not come as a surprise given that M2LT includes domestic currency cash, which typically is rather volatile.

Lithuanian ambitions to join the EU (and the EMU at a later stage) and the fact that at present Lithuania maintains a fixed exchange rate versus the US dollar, raises the question of whether its is more appropriate to speak of 'dollarization' or 'eurozation' in the case of Lithuania. In other words, what

is the relative importance of the US dollar and currencies of the euro zone in the Lithuanian banking system at present? Unfortunately for this purpose, the relevant monthly statistical data are only available from January 1999. Over the period from 1999 to 2000 the US dollar was been the dominant foreign currency in Lithuania while deposits denominated in the euro zone currencies accounted for only 10–15 % of all foreign currency deposits with no apparent tendency of increase. Despite the pre-announced plans of the LB to re-peg litas to the euro in 2001, Lithuanian residents were reluctant to adjust the structure of the foreign currency towards the euro. This makes sense given the substantial depreciation of the euro against the dollar up to the end of 2000 and the fact that euro banknotes and coins are not yet in circulation (a psychological factor).

To gain some idea about the significance of the Lithuanian dollarization, we can compare it with the corresponding measures calculated for other two Baltic countries: Latvia and Estonia. A recent discussion paper by Sarajevs (2000) on currency substitution in Latvia allows for comparison of the Lithuanian experience in dollarization with its neighboring economy. For the purpose of comparison in this paper, the corresponding ratio for Estonia is also calculated. The applied common measurement of the degree of dollarization in all three Baltic countries is the ratio of the residents' foreign currency deposits to the domestic-currency-denominated components of M2.[11] These ratios are displayed in Figure 3.

Figure 3 shows that over the period concerned the ratio of dollarization in Lithuania was on average comparable to the corresponding ratio in Latvia. At the same time the dynamics of the two ratios have little in common except for a rise in both ratios over the last year. During most of 1993, the dollarization ratio in Lithuania was considerably higher and in the period 1996–1998 significantly lower than in Latvia over the respective periods.

The case of Estonia is of particular interest here, since both Estonia and Lithuania have operated under currency board arrangements for years: Estonia since June 1992 and Lithuania since April 1994. Thus, a study of dollarization in these countries allows for an indirect analysis of the CBA credibility in Estonia and Lithuania. As follows from Figure 3, except for the initial fall, the ratio of dollarization in Estonia has been generally on an upward trend. Nevertheless, the Estonian ratio of dollarization remains substantially lower than Lithuania's throughout the entire period in question. The latter observation could indicate a relative success of the Estonian CBA

as opposed to the Lithuanian CBA in establishing credibility of the domestic currency. At the same time, following the hysteresis type argumentation, the level of dollarization at the starting point of monetary reform as well as the speed at which the reform is implemented might also be important for the later development of the phenomenon. Indeed, the currency reform in Lithuania was considerably slower than in Estonia and Latvia. It might partially explain apparent differences in the Lithuanian and Estonian dollarization ratios. However, the lack of the relevant data for the earlier period makes its difficult to say anything about the significance of the hysteresis argument here.

3.2 Politico-economic factors of dollarization in Lithuania

Overview of the main events

As was noted in section 2, the excessive domestic inflation and devaluation of the domestic currency in a face of underdeveloped financial market and external liberalization were the key factors triggering the process of dollarization in the recent history of transition economies. The Lithuanian case was not an exception in this respect. The main stages of price liberalization reform in Lithuania took place in 1991–1992. As a result, the rate of inflation accelerated to nearly hyperinflation level reaching 1,163 % (on a December-to-December basis) in 1992. At the same time, the domestic currency depreciated at a dramatic rate: from 1992 to the first half of 1994 the US dollar value of the domestic currency fell by more than 400 %.

To establish credibility of the domestic currency and gain the monetary sovereignty Lithuania embarked on the currency reform in the early 1990s. The reform turned to be rather slow. The LB was re-established in 1990[12], however, the permanent national currency, the litas, was only introduced in June 1993 and only became the sole legal tender from August 1993. In a meantime the LB put into circulation an interim currency, the talonas (May 1992) which circulated alongside the Russian ruble at the rate 1:1 until October 1992 when Lithuania left the ruble zone.[13]

Following the introduction of the litas the LB tightened the monetary policy[14] and stabilized the exchange rate of the national currency. Furthermore, to gain more credibility for the inflation stabilization efforts the currency board arrangement (CBA) was introduced in Lithuania in April 1994.

The legal basis of the CBA was rooted in the *Law on the Credibility of the Litas*. The law guaranteed 100 per cent coverage of the litas in circulation by gold and foreign exchange reserves of the LB. In compliance with the law the exchange rate of the litas was ultimately fixed to the anchor currency – the US dollar (at a rate of 4 litas to the dollar) and could only be changed by joint agreement between the Lithuanian government and the LB. However, even under the CBA the devaluation expectations remained nontrivial. The main difference compared to the previous periods was that, under the CBA, devaluation expectations were largely determined by the credibility of the LB's commitment to maintain the CBA.

Lack of a broad political consensus on the desirability of the CBA's maintenance and speculation over sufficiency of the LB's foreign reserves resulted in low credibility for the Lithuanian CBA in the months following its introduction. Rumors concerning devaluation of the litas persisted throughout the first half of 1995, despite a continuous rise in the LB's foreign reserves. By the end of the year, however, the speculation began to subside as economic growth returned and annual inflation fell below 50 %.

Devaluation speculations resumed in the beginning of 1996 following the banking crisis and scandalous sacking of the Prime Minister Adolfas Šležiavicius. To counteract the damage to the CBA's credibility, the new government program stated explicitly that it would keep the present fixed exchange rate. In March 1996, president Algirdas Brazauskas further proposed a new law whereby Lithuanian residents would be subject to compensation if a devaluation of the litas occurred before 1998.

Further boost to the devaluation expectations came in 1996 with the parliamentary elections and the LB's announcements concerning abandoning the CBA. The future of the CBA was a hot topic in the 1996 parliamentary election debates. The main proponent of dismantling the CBA was the Lithuanian Conservative Party (LCP).[15] In October 1996, the LCP announced that if they prevailed in parliament, the CBA could be abandoned within six months. In February and November 1996 the new LB's governor Reinoldijus Šarkinas also made statements in favor of abandoning the CBA and restoring the LB's independence. Altogether it had a chilling impact on the public. In November 1996, panic among Lithuanians pushed the exchange rate to the maximum upper bound defined in *the Law on Credibility of the Litas* for the first time since the introduction of the CBA: 4.08 litas per dollar.

On January 16, 1997 the three-stage program for 1997–1999 aimed at gradual dismantling of the CBA was approved. Among important issues included in the program was re-pegging of the litas to a basket of the US dollar and the euro by the end of 1999.[16] Practical implementation of this final stage of the program was delayed several times, however. Much of the delay was caused by the worsened economic and political climate (the Lithuanian government changed twice in 1999)[17] at the end of 1998 and in 1999. Following the massive devaluation of the Russian ruble in August 1998, Lithuanian exports collapsed. Real GDP contracted over 4 % in 1999 and official unemployment went into double digits. The fiscal deficit (central government budget) reached a record level since the beginning of the economic transformation in Lithuania: 8.2 % of GDP.

After the Russian crisis in 1998, a run on the LB's foreign reserves followed. Fortunately, the LB's reserves were sufficient to its commitment to maintain the CBA. In the light of the increased macroeconomic uncertainty the implementation of the final stage of the LB's program seemed a dangerous step that could contribute to economic instability and jeopardize success of the whole program. Therefore, the implementation of the final stage of the program was rescheduled to the second half of 2001. According to the recent announcement of the LB the litas will be re-pegged to the euro directly at the prevailing market rate.

Institutional factors

It goes without saying that the institutional factors mentioned in section 2 are not the sort of statistics that are routinely calculated by domestic statistical authorities. Thus, we require some proxy. To capture the degree of openness of the Lithuanian economy, we take the share of Lithuanian foreign trade turnover (a sum of total exports and imports) in total GDP. The required time series for the period 1993–2000 are collected from the editions of *IFS*. The calculated degree of openness of the Lithuanian economy reveals a dramatic decline (almost 50 %)[18] in the second half of 1993 similar to the drop in dollarization in Figure 1. Unfortunately, data on Lithuanian foreign trade and GDP is only available on a quarterly basis. In addition, the methodology of calculating the GDP in Lithuania changed in 1995. Altogether, it makes this degree of openness of the Lithuanian economy rather unreliable variable for our analysis applied for the whole period of investigation.

As regards the second institutional factor – the depth/size of the domestic financial market, it is fairly obvious that the financial market in Lithuania is rather shallow. The stock trade is weak both in terms of the number and value of transactions. At the same time the Lithuanian government T-bills, although introduced in July 1994, have never played a significant role as an alternative wealth-holding instrument. The main purchasers of the T-bills have been foreign investors or domestic banks and other credit institutions. Indeed, the thinness and high risk of the Lithuanian financial market help explain why foreign currency deposits are so popular among Lithuanian residents. It is the only effective alternative interest-bearing financial instrument available to the Lithuanian residents' on the domestic market.

Finally, due to lack of any significant control on currency exchange market the residents can switch between domestic and foreign currencies with minimum costs. Foreign exchange liberalization was implemented in the early nineties, and since the introduction of the CBA in Lithuania in 1994, the dollar has been traded in the range of 4 litai per dollar ± 2 % allowing for some transaction profit for foreign exchange operators.

Returns on assets

The definition of the dollarization ratio employed in this paper includes three components, two of which (foreign currency deposits and domestic currency deposits) are interest-bearing asset, and the third (domestic currency cash in circulation) is a non-interest bearing asset. This implies that interest paid on deposits denominated in domestic and foreign currencies are expected to be crucial explanatory variables for the dollarization ratio in Lithuania.

Figure 4 illustrates the dynamics of the interest rates paid on the domestic and foreign currency deposits in Lithuania. All deposits are classified into three groups: demand deposits, short-term time deposits (up to 3 months) and long-term time deposits (over 3 months). During the first two years of the period under investigation, we note large interest rate spreads between the domestic and foreign currency deposits. These spreads, however, narrow along with the dramatic decline in interest rates paid on the litas-denominated deposits. In the subsequent years, the interest rate spreads both on demand and short-term time deposits continue to fall. In 1999, the spreads practically vanish. In 2000, the interest rate spread on short-term time deposits become negative. Contrary to the previous two spreads, the interest rate

spread on long-term time deposits after the initial decline steadily averages three percentage points.

As mentioned before, foreign and domestic bonds have never been viable options for Lithuanian residents. Although domestic government T-bills are still insignificant in residents' portfolios, its nominal return seems to exhibit an increasing influence on the interest rate paid on domestic-currency-denominated deposits. For example, a remarkable spike in the end of 1999 in T-bill rates is mirrored in Figure 4 by the short-term interest rate paid on the domestic currency deposits. As the development of the domestic market for the T-bill progresses, the T-bill rate becomes a potentially important explanatory variable for the degree of dollarization in Lithuania manifesting itself both directly as an alternative to deposit asset and indirectly by altering the deposit interest rate. The sign of the T-bill rate effect on the dollarization ratio defined in this paper will depend on whether the T-bills are denominated in domestic or foreign currency. For example, the T-bills denominated in domestic currency will compete with domestic currency deposits, and, therefore, tend to boost the dollarization ratio.

Foreign interest rates can also play a role in the domestic dollarization as pointed in recent paper by Catão and Terrones (2000). Assuming a high level of dollarization of the domestic economy, an increase in the cost of foreign currency borrowing from abroad can lead to a further rise in the level of dollarization domestically. In case of Lithuania, the importance of the foreign interest rates is reinforced by the CBA.

Figure 5 displays the development of the US interest rate of the three-month certificate of deposit. Two sharp increases in interest rates are of particular interest here: 1994 and the period from the second half of 1999 to summer 2000. These developments seem consistent with a rise in the dollarization in Lithuania detected in Figure 1. Figure 4 shows that the rise in US interest rates in 1994 was clearly reflected by the interest rate paid on foreign currency deposits in Lithuania, although with some lag. It may also be argued that the rise in US interest rates since the second half of 1999 exercised upward pressure on the interest rate paid on foreign currency deposits in Lithuania, which in turn closed the gap on the short-term time deposit interest rate spread.

4 Econometric analysis of dollarization in Lithuania

The following section reports the results of an econometric exercise applied to analysis of the relationship between the dollarization ratio and interest rates paid on deposits denominated in domestic and foreign currencies.[19]

From the theoretical point of view the specification of the model of dollarization in Lithuania is closely related to portfolio allocation. Its theoretical underpinnings are provided in Thomas (1985) and Sahay and Vègh (1995c). The theoretical model basically predicts higher demand for the assets with higher returns. More precisely, the dollarization ratio is expected to rise with a rise in the interest rate paid on the foreign currency deposits and to fall with a rise in the interest rate paid on the domestic currency deposits.

However, since the interest rate is an integrated variable, a rise in the interest rate can signal many economic developments. In a context of a transition economy with the fixed exchange rate an increase in the interest rate paid on the domestic currency deposits may, for example, signal rising devaluation expectations. In this case, one might expect an increase, rather than decrease, in the dollarization ratio. The conflict here may arise due to a partial nature of the specification of the model, while the empirical data reflects the equilibrium outcomes. It is important to remember that when participants of the market (households, banks, and corporate firms) increasingly expect devaluation, they can react in different ways. For example, when the risk of devaluation rises, banks tend to increase the domestic currency deposits. Households, on the other hand, will lower the proportion of the domestic currency assets in their portfolios. To reach their desired lower level of the dollarization ratio the banks will raise the interest rate paid on the domestic currency deposits and/or lower the interest rate paid on the foreign currency deposits. Given the high concentration of banks in the Lithuanian market (the three largest banks controlled almost 80 % of the market in 1999) the equilibrium level of the dollarization ratio can be expected to be largely influenced by bank decision-making. Thus, it is plausible that an increase in the devaluation expectation will be associated with the relatively higher interest rate paid on the domestic currency deposit and lower level of the dollarization ratio.

Following Sarajevs (2000), other variables (inflation, real exchange rate and others) were included in some preliminary estimates. However, only the set of variables adopted in this section produced relatively fruitful results for the entire period of investigation: from December 1992 to August 2000. The

limited number of variables, nevertheless, should not be viewed as a shortcoming of the model developed in this section. Conversely, the econometric results have the advantages of easy interpretation and high reliability. Besides, given the definition of the dollarization ratio the interest rates paid on deposits denominated in domestic and foreign currencies are expected to be crucial explanatory variables. One can reasonably expect that the interest rate will capture devaluation and inflation expectations better than artificially derived corresponding proxies.

Since the measure of dollarization employed in this paper captures all the residents' deposits, two weighted average interest rates were calculated: the weighted interest rate on all domestic currency deposits and the weighted interest rate on all foreign currency deposits.[20] These interest rates are further applied in the econometric part of the paper as the key variables explaining the dollarization ratio in Lithuania. At this point, it is important to draw attention to the fact that most econometric studies of dollarization apply interest rate spreads.[21] However, it is only an assumption which implies that a change in any of the interest rates in question has numerically the same (but just of opposite sign) effect on the dollarization ratio. This is not necessarily the case, and therefore, must be tested. Thus, contrary to the usual approach, we start with a more general specification allowing for different responses to changes in two interest rates. We then explicitly test whether the magnitude of the dollarization response to interest rates is similar, but with an opposite sign.

In addition, a common linear logarithmic transformation is applied to all three variables. Small letters are used to denote these transformed time series:

dr_t – logarithm of the dollarization ratio

i_dc_t – logarithm of the interest rate paid on the domestic currency deposits

i_fc_t – logarithm the interest rate paid on the foreign currency deposits

The log-linear transformation of the interest rates is not a common practice. Our sample contains highly volatile period of excessively high interest rates in 1993–1994 while the rest of the period is characterized by their relative stability. The log-linear transformation of the interest rates somewhat dampens excessive volatility in the 1993-1994 and slightly augment vari-

ability in the rest of the period of investigation. In economic terms, this makes it possible achieve some comparability of interest rate level over the whole sample. From the econometric point of view, it partly solves the problem of outliers and ensures normality of the data.

4.1 Data Description

A first step is to determine the order of integration of the time series in question. The descriptive analysis of the levels and the first differences of the variables are displayed in Figures 6 and 7. Visually, the three time series can be approximated as nonstationary processes. In Figure 6 the values of the coefficients of the first lags in the autocorrelation functions are close to unity. In addition, lags of higher order are significantly different from zero, indicating persistence in the time series. The persistence in the dollarization ratio is relatively short-lived, dying out on the eighth lag. From Figure 7 it can be preliminary concluded that once the time series are differenced, stationarity is achieved implying that all three variables are integrated of order one. Although the first lag remains significant in case of the first difference of the dollarization ratio, its coefficient is lower than one.

A Dickey-Fuller (DF) unit root test is further applied to the data both in levels and the first differences to confirm the integrational properties of the data. The test is based on the following specification:

$$\Delta X_t = \eta \times X_{t-1} + \varepsilon_t \qquad [1]$$

where $\varepsilon_t \sim nid(0, \sigma)$ is an error term, Δ is a difference operator, X_t is a variable tested for nonstationarity, η is a parameter, t is a time script. The results of the DF tests based on t-value of η are reported in Table 1 (see the Annex). To remove the autocorrelation where needed the equations are augmented by lags.[22] In addition, since the true data-generating process is unknown, different deterministic terms are included in the specification of the equations.

From Table 1 follows that the first difference of all the variables is stationary. There is also a clear indication that the interest rate paid on the foreign currency deposits is nonstationary. The results for the interest rate paid on the domestic currency deposits suggest the same. We can disregard the

result of the DF test based on specification with no deterministic terms since it is clear from Figure 6 that the time series has a none zero mean implying that at least constant must be included in the specification. When it comes to the dollarization ratio, the nonstationarity hypothesis is marginally rejected at the 5 % level of significance in case only the constant is included. In all the other cases, however, the hypothesis of nonstationarity of the dollarization ratio is accepted.

Contrary to Korhonen (1996), we conclude that over a longer period the dollarization ratio is generally a nonstationary process integrated of order one. The interest rates paid on the domestic and foreign currency deposits are also found to be integrated processes of the same order: I(1). These findings allow us to proceed further with the investigation of cointegration between the dollarization ratio and the interest rates paid on the domestic and foreign currency deposits.

4.2 Long-run analysis: VAR(8)

Following Johansen's Full Information Maximum Likelihood (FIML) procedure, we begin with estimating a general unrestricted Vector Autoregressive (VAR) model for the levels of the dollarization ratio and interest rates. The general unrestricted VAR(8) is specified as follows:

$$\mathrm{Y}_t = \sum_{i=1}^{8} \left(\Gamma_i \times \mathrm{Y}_{t-i}\right) + \Lambda \times C + \zeta_t, \qquad [2]$$

where $\zeta_t \sim nid(0, \Omega)$ is an error term, $\mathrm{Y}_t = \begin{bmatrix} dr_t \\ i\_dc_t \\ i\_fc_t \end{bmatrix}$ is a vector of variables

of interest, C is a vector of constants, Γ and Λ are matrices of coefficients of the model, and *t* is a time script. Based on the discussion in section 3, we also include a dummy for 1996 which takes value of one in the period from January to December 1996 and zero otherwise. Centered seasonal dummies were added to VAR(8) in an unrestricted manner.

The number of lags of VAR(8) is chosen such that its residuals satisfy all the conventional design criteria (Gaussian white noise residuals). Further augmentation of the VAR model is not particularly inviting due to extra losses

of the degree of freedom. At the same time, both the likelihood ratio and the Wald general restriction tests suggest that no significant information gains can be realized by adding higher order lags.[23]

The results of the standard statistical tests applied to the residuals of the individual equations of VAR(8) and the residuals of the whole system are reported in Table 2. The related graphical analysis is displayed in Figure 8. Analysis of the residuals reveals high correlation between residuals of the interest rates. The correlation between the residuals of the dollarization ratio and the residuals of the interest rates is not very high, however, they are of the expected signs. Finally, high correlation between the actual and fitted values indicates that the system does a good job in explaining the variables in question. The latter, however, is not surprising given that the variables are nonstationary in which case we might face the spurious regression problem.

The dynamic analysis of VAR(8) is presented in Table 3 and Table 4. From Table 3, follows that there is only one non-zero eigenvalue of the long run adjustment matrix indicating one cointegrating relationship in the system. Modulus of all eigenvalues of the companion matrix of VAR(8) in Table 4 are inside the unit circle implying dynamic stability of the system. The recursive estimation of the system in Figure 9 also reveals stability of the system and its equations individually.

Based on VAR(8), we can further apply a cointegration test to determine the number of cointegrating vectors in the system. The results of the test are presented in Table 5. Both *max* and *trace* tests indicate the existence of one cointegrating vector at the 1 % level of significance using critical values corrected for the degrees of freedom.[24] Graphical exposition of all the three vectors is given in Figure 10. Once again, we find evidence of only one cointegrating vector in the system. None of the eigenvalues can be characterized by outstanding stability, however, only the first eigenvalue remains at a relatively high level.

Unrestricted cointegration analysis displayed in Table 6 reports the estimated $\hat{\alpha}$ (adjustment coefficients) and $\hat{\beta}$ (loading coefficients) vectors. The estimates of the $\hat{\beta}$ coefficients of the first cointegrating vector have the expected signs. The coefficient of the dummy has a negative sign indicating that the events of 1996 described in section 3 had a positive influence on the dollarization ratio. Analysis of the adjustment coefficients in the first cointegrating relationship suggests that the adjustment to the equilibrium is slowest in the case of the dollarization ratio. We also note that the adjust-

ment coefficients in other cointegrating relationships are relatively small and in some cases are close to zero.

Bearing in mind the observations described above, the long-run analysis is restricted to one cointegrating vector. The results of the tests for weak exogeneity and exclusion from the long-run relationship are displayed in Table 7. All adjustment coefficients are statistically significant implying that a model comprising a system of all three equations must be considered when modeling the short-run dynamics. On the other hand, none of the variables in question can be excluded from the long-run relationship. The constant and the dummy appear to be important components of the cointegrating vector. To see whether the loading coefficients on the interest rates are of the same magnitude, we restrict one coefficient to be equal the other, but with opposite sign. The restriction is rejected at 1 percent level of significance ($\chi^2(1) = 13.465$ [0.0002]).

Thus, no additional restrictions can be imposed on the cointegrating vector that could be statistically accepted within the system considered here. Table 8 presents the final result of the analysis of the long-run relationship between the dollarization ratio, the interest rate paid on the domestic currency deposits, and the interest rate paid on the foreign currency deposits in Lithuania. The recursive estimation of the coefficients of the cointegrating vector in Figure 11 shows their relative stability bearing in mind the fact that the estimation period is rich with the economic and political disturbances mentioned in section 3.

4.3 Short-run analysis: VECM(7)

The error correction model (VECM) for Lithuanian dollarization is specified as:

$$\Delta \mathrm{Y}_t = \sum_{i=1}^{7} \left(\Phi_i \times \Delta \mathrm{Y}_{t-i}\right) + \mathrm{A} \times ecm_{t-1} + \sum_{j=0}^{11} \left(\Psi_j \times SD_{t-j}\right) + \zeta_t, \qquad [3]$$

where $\zeta_t \sim nid(0, \Omega)$ is an error term, $\mathrm{Y}_t = \begin{bmatrix} dr_t \\ i\_dc_t \\ i\_fc_t \end{bmatrix}$ is a vector of variables of interest SD_t's are seasonal dummies, ecm_t is the error correction term, A is a vector of adjustment coefficients, Φ and Ψ are matrices of

coefficients of the model, Δ is the first difference operator, t is a time script.

The error correction term reflects the deviation from the long-run relationship established previously. It enters the system as an instrument variable and is specified in the following way:

$$ecm_t = ecm_{t-1} + \Delta dr_t + 0{,}99986 \times \Delta i\_dc_t - 1{,}1118 \times \Delta i\_fc_t - 0{,}60204 \times \Delta Dummy96 \quad [4]$$

Thus, VECM(7) is basically a system of three endogenous variables and one identity imposed by the long-run relationship. In addition, based on the discussion in section 3 some dummies were added to the individual equations, where turned to be significant.

The main results of the estimation are presented in Tables 9 and 10, and Figures 12 and 13. Several observations can be made. First, the analysis of the residuals in Table 9 reveals no problems as regards the design criteria, except for the autocorrelation detected in the individual equation of the interest rate paid on the foreign currency deposits. Low standard errors of the individual equations suggest a good fit of the model. The correlation between the residuals of the interest rate is high and positive indicating that some common process (or processes) drives errors in the two equations.

VECM(7) appears to be a dynamically stable system: the eigenvalues of the companion matrix are within the unit circle. The matrix of the long-run adjustments has full rank, implying stationarity of the system. It also lacks any structural breaks as follows from the results of the recursive estimation in Figure 12.

Figure 13 illustrates graphically that the development in all three variables is well captured by VECM(7), despite the relatively small system of endogenous variables. However, a number of explanatory variables per equation is large and it can partially explain good fit of VECM(7). Many of these variables are statistically insignificant and in principle should be removed (see Table 10). Further reduction of the system, nevertheless, is problematic. As reduction of the system proceeds, the design criteria (particularly autocorrelation) worsen.

The error-correction term appears to be statistically significant in all three equations. It has the expected signs and its point estimates are roughly of the same magnitudes observed in the earlier discussion of VAR(8).

Finally, political dummies which reflect change in the government in January 1996 and 1999, and the parliamentary elections in October 1996 (*Dummy9601*, *DummyGV*, and *Dummy9610,* respectively) are statistically

significant and have a positive effect on the dollarization ratio. The dummy for the Russian rouble devaluation in August 1998 (*DummyRC*) also has positive effect on the dollarization ratio. The dummy for the banking crisis in December 1995 (*DummyBC*) has a significant negative effect on the dollarization ratio. This outcome can be attributed to the peculiarity of the dollarization definition employed in the present paper. Following the banking crisis, both the denominator and nominator of the dollarization ratio decline, although the denominator would be reasonably expected to decline to a lesser extent since the withdrawn domestic currency deposits appear in a form of domestic currency cash. As a result, while both the domestic and foreign currency deposits are subject to the same banking risk, the withdrawal of the deposits from the banking sector tends to lower the dollarization ratio. In addition, the banking crisis motivates non-residents to transfer their deposits away from Lithuanian banks, leading to a contraction of the total supply of foreign currency in Lithuania.

The dynamic structure of VECM(7) is rather complex. It is difficult to make an unambiguous inference regarding the short-run effects of the interest rates on dollarization looking at Table 10, so we perform an impulse-response analysis of VECM(7). Figure 14 illustrates the responses accumulated over three years of the dollarization ratio and the interest rates to a shock in one of the variables. The system is re-estimated without the cointegrating identity equation. The initial values are set to zero and a shock at time t=1 in a variable is traced through.

Figure 14 shows that an initial shock to the dollarization ratio leads to a further rise as the interest rate paid on the foreign currency deposits rises. A rise in the latter results in the positive value of accumulated changes in the interest rate paid on domestic currency deposits. A shock to the interest rate paid on domestic currency deposits eventually makes the dollarization ratio fall. A somewhat mysterious result is the negative reaction of the interest rate paid on foreign currency deposits. Generally, one would expect this variable to be determined purely by the situation abroad. If there were some influence from the interest rate paid on domestic currency deposits, it would be positive. However, the opposite is observed here. It could be argued that what we are dealing with here is a strong indirect effect: the interest rate paid on foreign currency deposits fall due to the lower dollarization ratio. Finally, the system predicts that a shock to the interest rate paid on the foreign currency deposits will bring only a moderate rise in the dollarization ratio, since the interest rate paid on domestic currency deposits will rise at the same time.

5 Conclusions and final remarks

Near hyperinflation and large devaluations of the domestic currency at earlier stages of economic transition, coupled with the delays in the introduction of the national currency, led to a high level of dollarization in Lithuania. With the eventual introduction of the litas in 1993, dollarization of the economy significantly declined. However, further stabilization measures, which included the adoption of the currency board arrangement (CBA) and pegging of the litas to the US dollar in 1994, did little to de-dollarize the economy. Later, dollarization in Lithuanian was heavily influenced by the credibility of the authorities to maintain the CBA and fixed exchange rate. Since its introduction, the CBA has been a main campaign theme of Lithuanian political parties. Economic difficulties have often been related (reasonably or unreasonably) to Lithuanian monetary policy. Thus, the political process has contributed to dollarization in Lithuania. The statements of the LB concerning the future of the CBA (especially in 1996) also helped sustain the high degree of dollarization in Lithuania, and even inspired dollarization later on.

The econometric analysis of dollarization in Lithuania undertaken in this paper establishes a relationship between the ratio of resident's foreign currency deposits to the domestic currency components of broad money, as well as interest rates paid on domestic and foreign currency deposits in the period December 1992 to August 2000. All time series in question were found to be integrated of order one. Furthermore, a relatively stable cointegrating relationship among the variables was identified, whereby the level of the dollarization ratio related negatively to the interest rate paid on domestic deposits and positively to the interest rate paid on foreign currency deposits. The results of tests for weak exogeneity showed the endogenous nature of the variables, so a system of equation was considered when modeling short-run dynamics.

The estimated vector error correction model (VECM) of Lithuanian dollarization was dynamically stable and tracked the data well. The deviation from the long-run relationship appeared to be statistically significant in all three dynamic equations. The slowest adjustment, about 6 % per month, was recorded in the case of the dollarization ratio. The adjustment coefficients of interest rates were around 21 % per month. Statistical significance of some of political dummies included in the VECM reflected the importance of political uncertainty in the process of dollarization in Lithuania. The

use of the dummies helped improve the overall fit of the system. Even without the dummies, the model captured the turning points in the periods of dramatic events, which implied that interest rates in Lithuania incorporated sufficient information to explain the process of dollarization and no additional variables needed to be brought into the model. The lag structure of the VECM was rather complex, however, and the impulse-response exercise revealed that an increase in the interest rate paid on the domestic currency deposits has a large negative effect on dollarization. A positive shock to the interest rate paid on foreign currency deposits, on the other hand, has a positive effect on dollarization, but is dampened to some extent by a rise in the interest rate paid on domestic currency deposits.

On the basis of econometric findings, the rise in the dollarization ratio in the second half of 1999 can be attributed first of all to a decline in the interest rate spread. This is a product of two factors. The first is related to the upward pressure from the interest rates paid on the US dollar-denominated assets elsewhere abroad on the interest rates paid on foreign currency deposits (where the US dollar is the dominant currency) in Lithuania. A second factor is the construction of the weighted interest rate itself. The change in the effective interest rate which aggregates all the interest rate across the spectrum of the deposits by maturity not only reflects the changes of the individual interest rates but also changes in the maturity. In 1999, the effective maturity of the foreign currency deposits increased as the residents began to shift from short-term foreign currency deposits to long-term deposits offering higher interest rates.

The uncertainty regarding the future of the CBA also appeared to exert some influence on the rise of dollarization in 1999. On one hand, the dramatic devaluation of the Russian ruble in second half of 1998 led to collapse of Lithuanian exports and overall economic decline in 1999 motivating expectations of some drastic changes in all areas of the economic policy-making including the CBA. On the other hand, the imprecision in the LB's recent announcement to change in the anchor currency of the Lithuanian CBA leaves the public to speculate about the time and a possible devaluation. In addition, Lithuania went through three prime ministers in less than twelve months in 1999.

As concerns policy implications, it can argued that *ceteris paribus* a rise in the interest rates paid on the domestic currency assets and/or decline in the interest rate paid on the foreign currency assets tends to lower dollarization in Lithuania. When it comes to predicting the future, however, one needs to

be cautious. Much of the future development of the dollarization ratio in Lithuania will depend on the behavior of the Eurodollar rate abroad and recovery of the euro given the currency structure of resident's foreign currency deposits in the domestic banking system. The implementation of the litas re-peg to the euro is also of great importance here. The success of the reform will be largely influenced by the LB's ability to carry it out in as transparent and credible way as possible.

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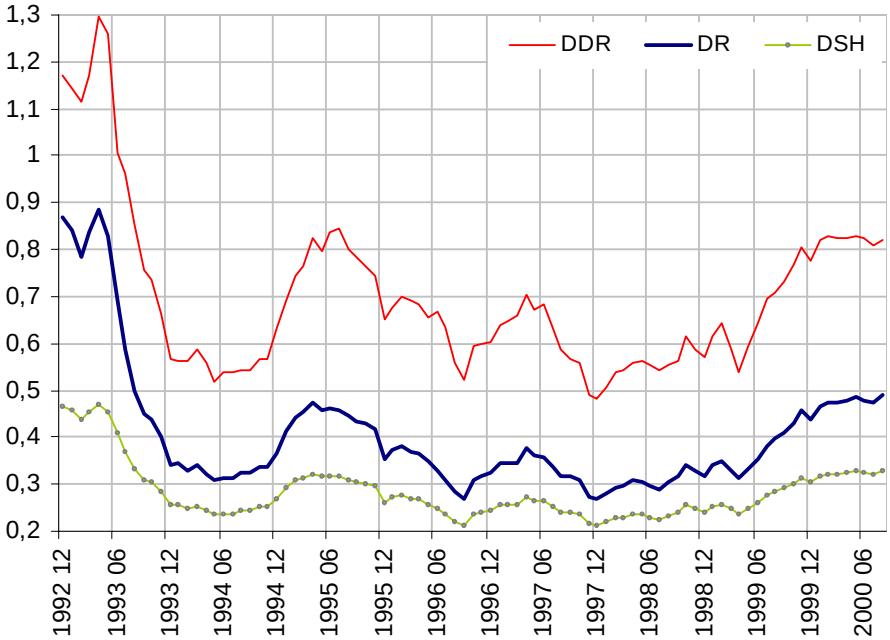
Annex

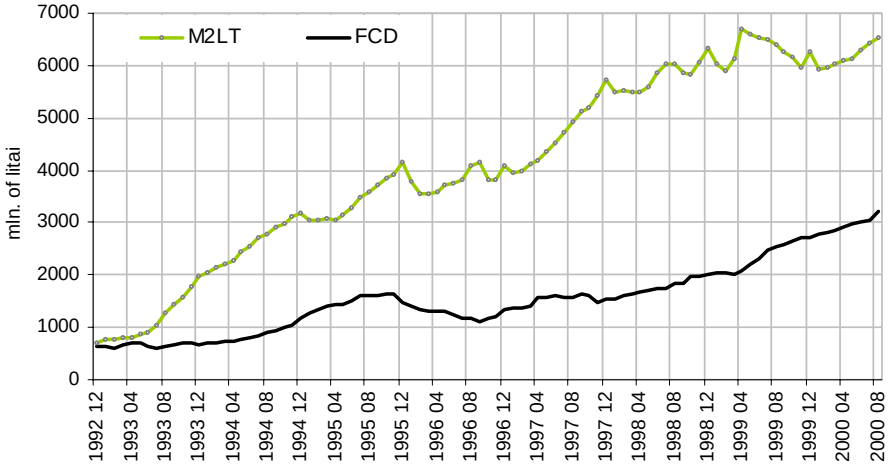
Figure 1. The scale of dollarization in Lithuania



Source: Bank of Lithuania, author's calculations.

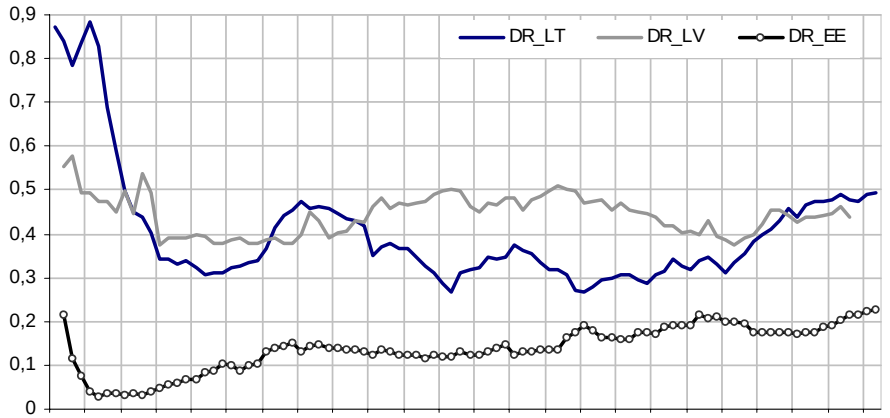
Note: DDR is the ratio of the residents' foreign currency deposits to domestic currency deposits; DR is the ratio of residents' foreign currency deposits to domestic-currency-denominated components of M2; DSH is the share of the residents' foreign currency deposits in total M2.

Figure 2. Components of dollarization ratio DR: foreign currency deposits of residents (FCD) and broad money aggregate denominated in domestic currency (M2LT)



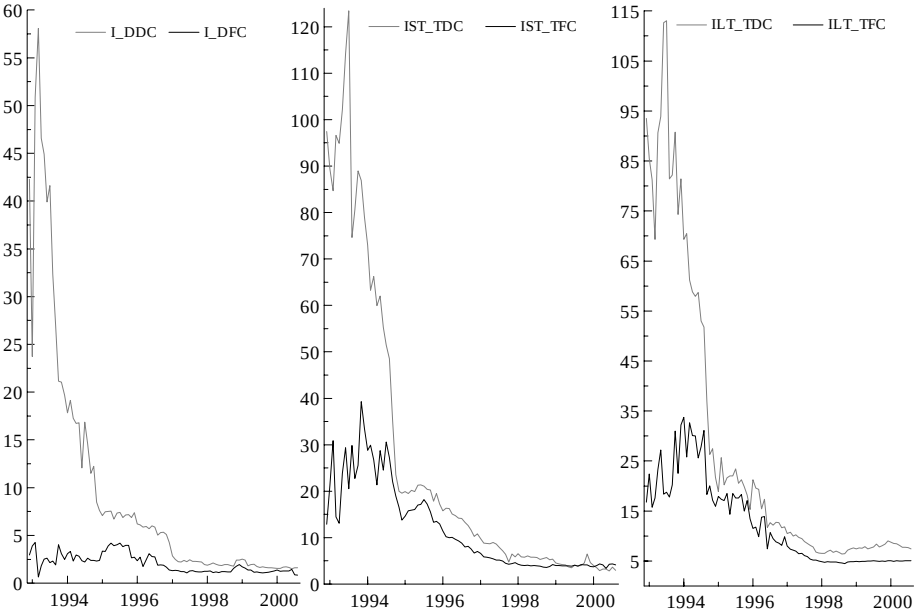
Source: Bank of Lithuania, author's calculations.

Figure 3. The scale of dollarization in Lithuania (DR_LT), Latvia (DR_LV), and Estonia (DR_EE)



Source: Bank of Lithuania, Bank of Latvia, Bank of Estonia, author's calculations.
Note: All three measures of dollarization are calculated as a ratio of the corresponding country's residents' foreign currency deposits to domestic currency denominated components of M2.

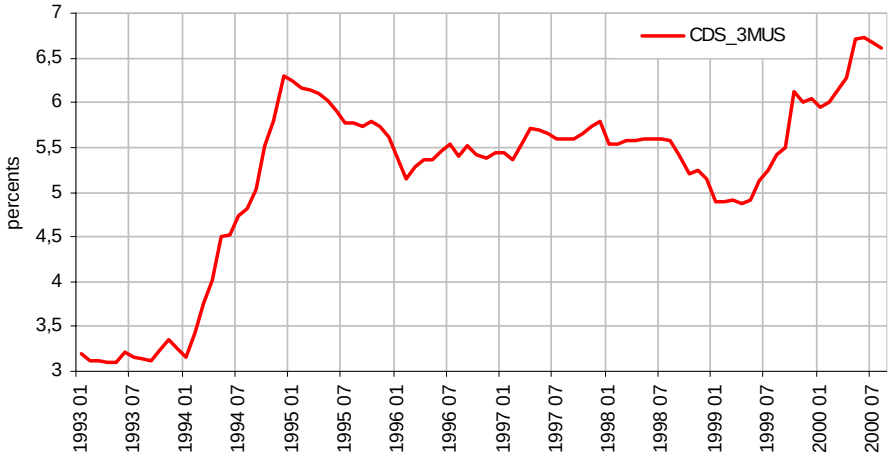
Figure 4. The development of the interest rates in Lithuania, 1992.12–2000.8



Source: Bank of Lithuania.

Note: I_DDC – interest rate on demand deposits in domestic currency, I_DFC – interest rate on demand deposits in foreign currency, IST_DDC – interest rate on short-term (up to 3 months) time deposits in domestic currency, IST_FDC – interest rate on short-term (up to 3 months) time deposits in foreign currency, ILT_DDC – interest rate on long-term (over 3 months) time deposits in domestic currency. ILT_FDC – interest rate on long-term (over 3 months) time deposits in foreign currency.

Figure 5. The three-month certificate of deposit interest rate in the United States



Source: IFS.

Figure 6. Descriptive analysis of time series in levels: actual values, autocorrelation function, and spectral density

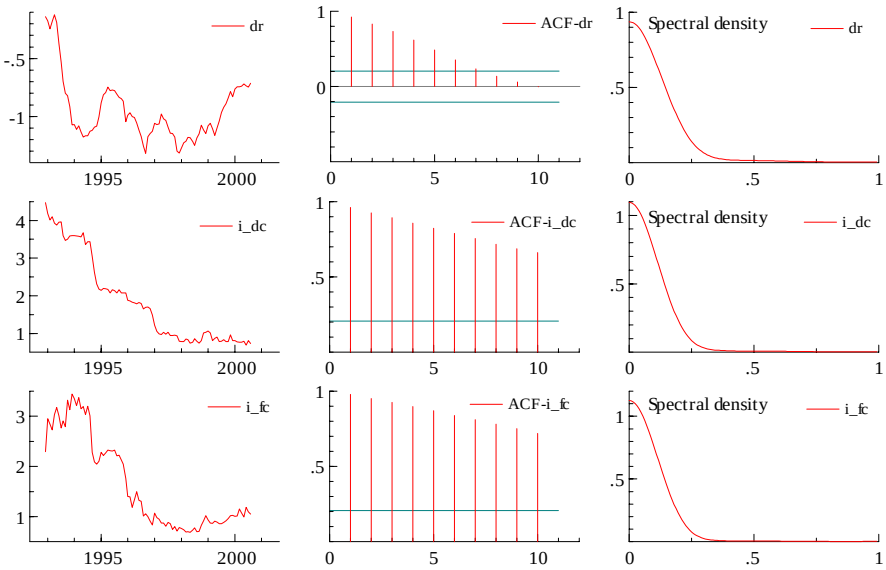
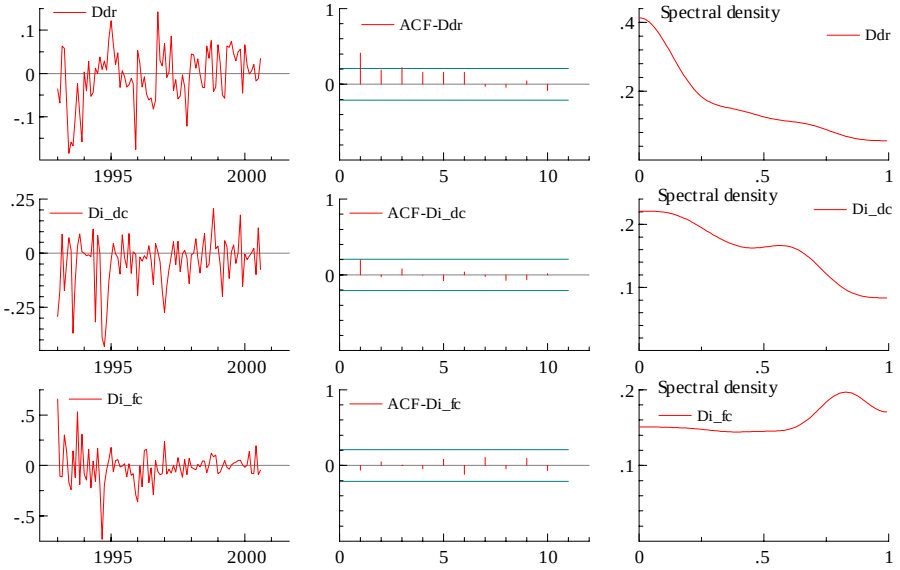


Figure 7. Descriptive analysis of the time series in first differences: actual values, autocorrelation functions, and spectral densities



Note: Capital 'D' placed in front of a variable indicates first difference operator.

Table 1. The results of the Augmented Dickey-Fuller tests for unit root in levels and first differences of the degree of dollarization and interest rates paid on deposits denominated in domestic and foreign currency, December 1992–August 2000

Variables	Deterministic terms included	Augmentation	t-values of η	Variables	Deterministic terms included	Augmentation	t-values of η
	-	1	-0.240		-	-	-6.084**
	C	1	- 2.918*		C	-	-6.079**
dr_t	C, T	1	- 2.366	Δdr_t	C, T	-	-6.522**
	C, SD	1	-2.520		C, SD	-	-5.005**
	C, T, SD	1	-2.030		C, T, SD	-	-5.425**
	-	-	-4.389**		-	-	-7.363**
	C	-	-2.735		C	-	-7.919**
i_dc_t	C, T	-	-1.430	Δi_dc_t	C, T	-	-8.127**
	C, SD	-	-2.654		C, SD	-	-6.935**
	C, T, SD	-	-1.304		C, T, SD	-	-7.146**
	-	-	-1.115		-	-	-10.935**
	C	-	-0.914		C	-	-11.050**
i_fc_t	C, T	-	-1.723	Δi_fc_t	C, T	-	-11.045**
	C, SD	-	-0.835		C, SD	-	-10.088**
	C, T, SD	-	-1.497		C, T, SD	-	-10.078**

Notes: ** – the hypothesis of unit root is rejected at a 1 % level of significance; * – the hypothesis of unit root is rejected at a 5 % level of significance; C – is for constant; T – is for time trend; SD – is for seasonal dummies; Δ – stands for the first difference operator; the critical values are provided in Hylleberg *et al* (1990).

Table 2. Residual analysis of the model VAR(8), 1993.08-2000.08

Correlation of residuals				Standard deviations of residuals	Correlation of actual and fitted values
	dr_t	i_dc_t	i_fc_t		
dr_t	1	-	-	0.041	0.983
i_dc_t	-0.152	1	-	0.143	0.998
i_fc_t	0.171	0.55	1	0.078	0.992

Misspecification tests of VAR(8) model

	Univariate tests			Multivariate tests		
	AR 1-6 $F(6,42)$	*Normality* $\chi^2(2)$	*ARCH 6* $F(6,36)$	*AR 1-6* $F(54,84)$	*Normality* $\chi^2(6)$	*Heteroscedasticity* $\chi^2(294)$
dr_t	0.80987 [0.5682]	1.6371 [0.4411]	0.08965 [0.9970]	0.90586 [0.6480]	4.5569 [0.6018]	307.03 [0.2888]
i_dc_t	0.89682 [0.5062]	1.7687 [0.4130]	0.30623 [0.9296]			
i_fc_t	0.62761 [0.7072]	3.8421 [0.1465]	0.66002 [0.6820]			

Note: the numbers in square brackets indicate the p-values of the corresponding statistics.

Figure 8. Graphic analysis of the unrestricted VAR(8) model: actual and fitted values of the time series in question, actual values of the residuals, their correlograms and spectral densities

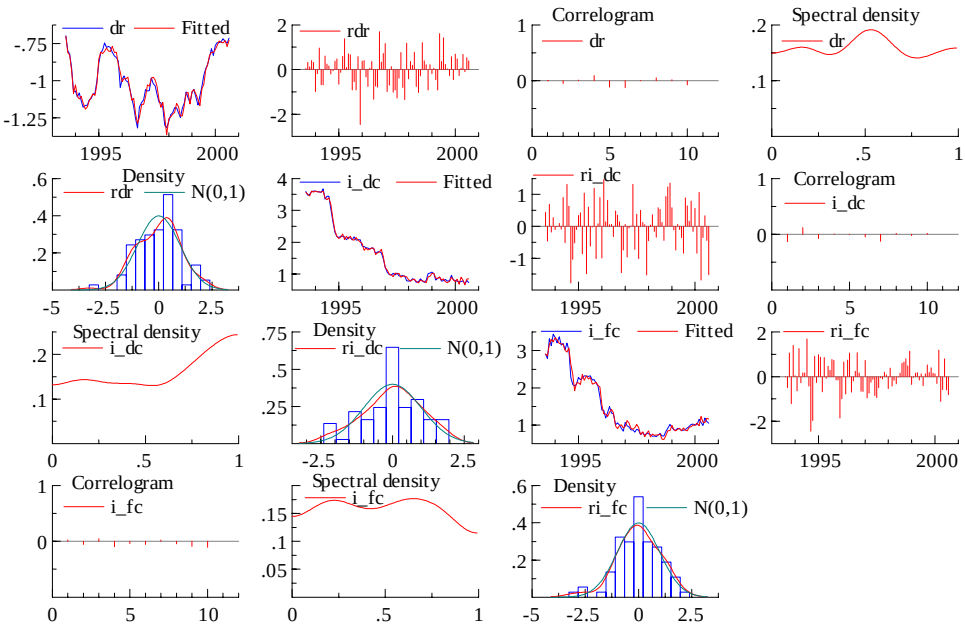


Table 3. Eigenvalues of long run Π matrix of the VAR(8)

Real	Complex	Modulus
-0.5037	0.0000	0.5037
-0.03980	0.01929	0.04422
-0.03980	-0.01929	0.04422

Table 4. Eigenvalues of companion matrix of the VAR(8)

Real	Complex	Modulus	Real	Complex	Modulus
0.9479	0.0000	0.9479	-0.7802	0.4632	0.9073
0.9102	-0.05798	0.9120	-0.7802	-0.4632	0.9073
0.9102	0.05798	0.9120	-0.8928	0.0000	0.8928
0.3674	0.0000	0.3674	-0.7987	0.0000	0.7987
0.8657	-0.2182	0.8928	-0.5975	0.6236	0.8637
0.8657	0.2182	0.8928	-0.5975	-0.6236	0.8637
0.7029	-0.4214	0.8195	-0.4165	0.7936	0.8963
0.7029	-0.4214	0.8195	-0.4165	-0.7936	0.8963
0.6158	-0.6464	0.8928	-0.1680	0.7127	0.7323
0.6158	0.6464	0.8928	-0.1680	-0.7127	0.7323
0.2732	-0.7931	0.8389			
0.2732	0.7931	0.8389			
0.1954	-0.8500	0.8722			
0.1954	0.8500	0.8722			

Figure 9. Recursive graphic analysis: estimates of 1-step residuals ±2*SE (standard error); Chow stability tests (1-step, break-point and forecast tests) of individual equations and VAR(8)

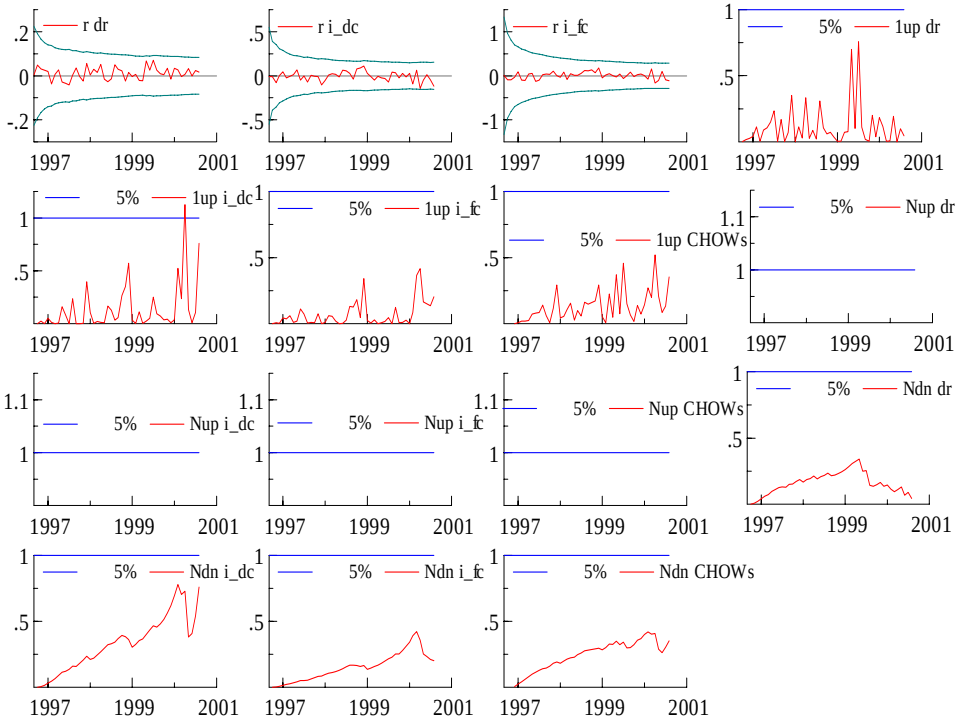


Figure 10. The Johansen's FIML co-integrating vectors (concentrating out short-run disturbances), actual and fitted values, and corresponding recursively estimated eigenvalues

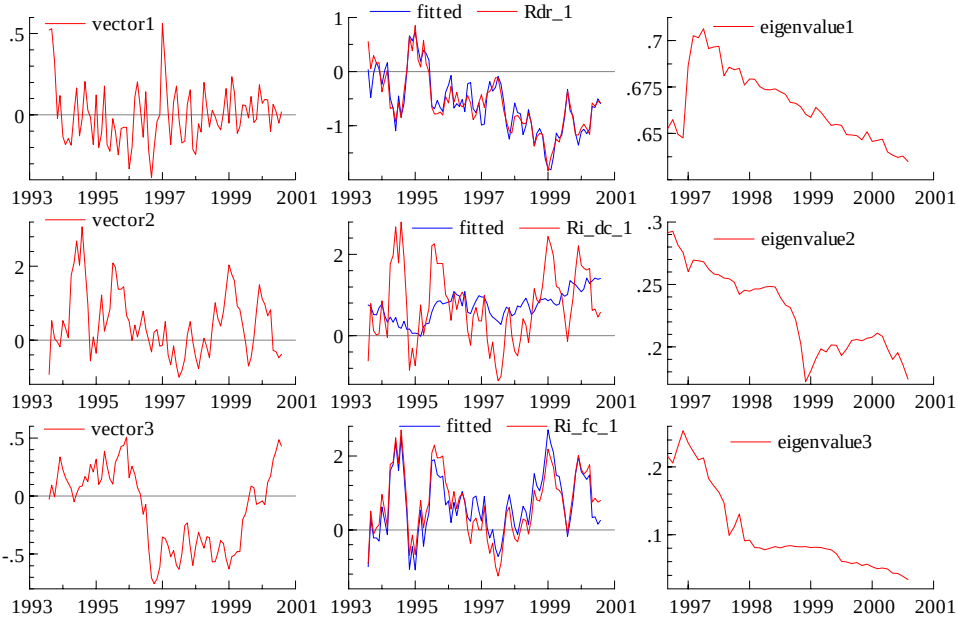


Table 5. Johansen's FIML co-integration test, August 1993– August 2000

Null	Alternative	Eigenvalue	*λ-max* test	*T-nm*	95%	*Trace* test	*T-nm*	95%
r = 0	r > 0	0.64	85.63**	61.45**	22.0	104.8**	75.24**	34.9
r = 1	r > 1	0.17	16.27*	11.68	15.7	19.21	13.79	20.0
r = 2	r > 2	0.03	2.941	2.11	9.2	2.941	2.11	9.2

Notes: ** - indicates rejection of null at a 1 % level of significance; * - indicates rejection of null at a 5 % level of significance.

Table 6. Unrestricted cointegration analysis, August 1993– August 2000

		dr_t	i_dc_t	i_fc_t	*Constant*	*Dummy96*
Standardized $\hat{\beta}$	1	1	0.99986	-1.1118	1.1937	-0.60204
Eigenvectors	2	-1.9894	1	0.32037	-2.8961	-0.13257
	3	1.4786	-0.83824	1	-1.2199	-0.16420
Standardized $\hat{\alpha}$	1	-0.059	-0.234	0.191	-	-
Coefficients	2	0	-0.021	-0.048	-	-
	3	-0.016	0.01	-0.012	-	-

Table 7. Tests for imposed restrictions on $\hat{\alpha}$ and $\hat{\beta}$ vectors

	dr_t	i_dc_t	i_fc_t	*Constant*	*Dummy96*
Testing restrictions on $\hat{\alpha}$ vector					
weak exogeneity restrictions					
separate test $\chi^2(1)$	8.34[0.00]**	5.88[0.02]*	26.67[0.00]**	-	-
joint test for i_dc_t and i_fc_t $\chi^2(2)$		64.31[0.00]**			
Testing restrictions on $\hat{\beta}$ vector					
long-run exclusion test $\chi^2(1)$	44.46[0.00]**	68.66[0.00]**	63.71[0.00]**	43.73[0.00]**	48.03[0.00]**

Note: the numbers in square brackets indicate the p-values of the corresponding statistics; ** - indicates rejection of null at a 1 % level of significance.

Table 8. Restricted $\hat{\alpha}$ and $\hat{\beta}$ vectors

	Cointegrating vector	Standard errors	Adjustment coefficient vector	Standard error
dr_t	1	0	-0.058	0.025
i_dc_t	0.99986	0.122	-0.234	0.050
i_fc_t	-1.1112	0.124	0.191	0.094
Constant	1.1937	0.047	-	-
Dummy96	-0.60204	0.093	-	-

Figure 11. Restricted co-integrating analysis applied to the VAR(8): restricted cointegrating vector (concentrating out short-run disturbances), recursive estimates of their parameters ±2*SE (standard error)

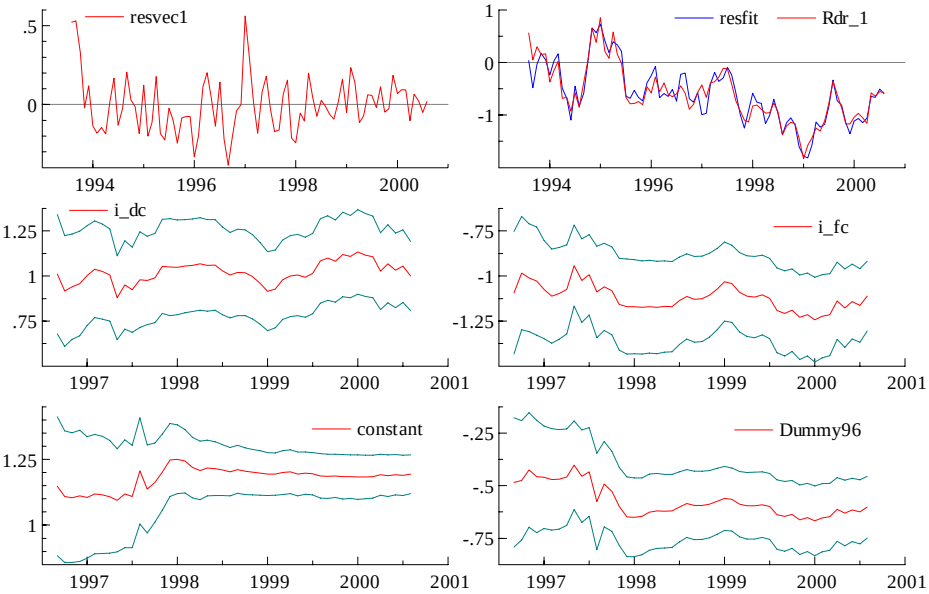


Table 9. Residual analysis of the model VECM(7), August 1993– August 2000

	Correlation of residuals			Standard deviations of residuals
	Δdr_t	Δi_dc_t	Δi_fc_t	
Δdr_t	1	-	-	0.03
Δi_dc_t	-0.071	1	-	0.068
Δi_fc_t	0.029	0.512	1	0.096

	Misspecification tests of VECM(7) model				
	Univariate tests			Multivariate tests	
	AR 1-6 F(6,38)	*Normality $\chi^2(2)$*	*ARCH 6 F(6,32)*	*AR 1-6 F(54,87)*	*Normality χ^2 (6)*
Δdr_t	0.792 [0.582]	0.569 [0.752]	0.349 [0.905]	0.866[0.7131]	1.190[0.9774]
Δi_dc_t	1.104 [0.378]	0.226 [0.893]	0.168 [0.984]		
Δi_fc_t	3.096 [0.014]*	0.133 [0.936]	0.228 [0.965]		

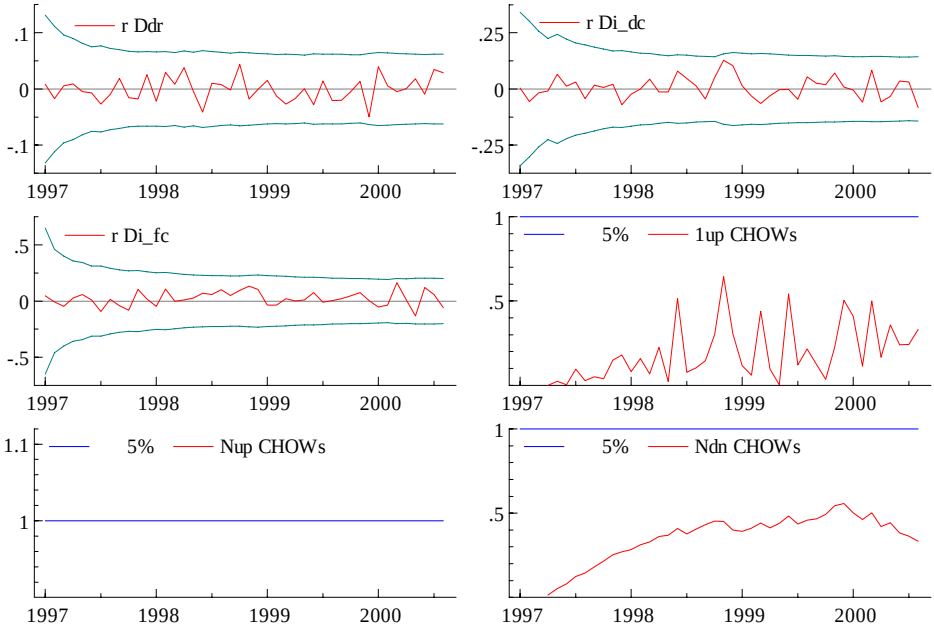
Note: the numbers in square brackets indicate the p-values of the corresponding statistics; * - indicates rejection of null at a 5 % level of significance; LR test of over-identifying restrictions: χ^2 (14) = 16.9578 [0.2584].

Table 10. The output of VECM(7) model estimation by FIML, August 1993–August 2000

	Equation for Δdr_t			Equation for Δi_dc_t			Equation for Δi_fc_t		
Variable	Coefficient	Std. Error	t-value	Coefficient	Std. Error	t-value	Coefficient	Std. error	t-value
Δdr_{t-1}	0.328	0.0992	3.306	-0.05	0.2161	-0.233	0.187	0.2888	0.646
Δdr_{t-2}	0.044	0.0938	0.467	-0.074	0.2162	-0.342	-0.054	0.2892	-0.185
Δdr_{t-3}	0.008	0.0868	0.090	0.18	0.2037	0.885	0.293	0.2768	1.058
Δdr_{t-4}	0.135	0.0838	1.609	-0.173	0.1978	-0.876	0.058	0.2717	0.212
Δdr_{t-5}	0.145	0.0799	1.810	-0.403	0.1901	-2.121	-0.597	0.2646	-2.256
Δdr_{t-6}	0.055	0.0814	0.678	0.496	0.1843	2.690	0.019	0.2587	0.072
Δdr_{t-7}	-0.167	0.0712	-2.344	0.042	0.1637	0.253	0.359	0.23	1.561
Δi_dc_{t-1}	-0.065	0.0480	-1.361	0.01	0.1098	0.089	-0.26	0.1526	-1.703
Δi_dc_{t-2}	-0.048	0.0433	-1.100	-0.159	0.0998	-1.593	-0.244	0.1399	-1.744
Δi_dc_{t-3}	-0.019	0.0432	-0.437	0.181	0.1002	1.801	0.266	0.14	1.898
Δi_dc_{t-4}	-0.016	0.0461	-0.351	-0.199	0.1076	-1.853	0.002	0.1484	0.014
Δi_dc_{t-5}	-0.134	0.0451	-2.972	-0.126	0.1032	-1.218	0.057	0.1437	-0.394
Δi_dc_{t-6}	-0.047	0.0434	-1.073	-0.004	0.0986	-0.036	-0.211	0.1390	1.519
Δi_dc_{t-7}	0.090	0.0382	2.366	0.121	0.0856	-1.416	0.013	0.1202	0.105
Δi_fc_{t-1}	-0.056	0.0287	-1.961	0.105	0.0726	1.440	-0.293	0.0992	-2.957
Δi_fc_{t-2}	0.015	0.0293	0.503	0.272	0.0653	4.159	0.286	0.0913	3.135
Δi_fc_{t-3}	0.039	0.0322	1.213	-0.089	0.0756	-1.171	0.098	0.1063	0.923
Δi_fc_{t-4}	-0.101	0.0316	-3.197	0.05	0.0733	0.683	-0.213	0.1021	-2.083
Δi_fc_{t-5}	0.073	0.0315	2.311	0.127	0.0735	1.728	-0.057	0.0997	-0.570
Δi_fc_{t-6}	0.097	0.0353	2.734	-0.011	0.0818	-0.134	0.034	0.1141	0.295
Δi_fc_{t-7}	0.048	0.0299	1.607	0.194	0.0689	2.810	0.080	0.0969	0.828
ecm_{t-1}	-0.064	0.0209	-3.049	-0.213	0.0483	-4.415	0.208	0.0674	3.080
$Dummy9601$	0.230	0.0549	4.189	-0.301	0.1313	-2.292	-	-	-
$DummyRC$	0.093	0.033	2.810	-	-	-	-	-	-
$DummyBC$	-0.163	0.0342	-4.772	-	-	-	-0.444	0.0749	-5.926
$Dummy9610$	0.134	0.0324	4.124	-	-	-	-	-	-
$DummyGV$	0.048	0.0141	3.377	-	-	-	-	-	-
$DummyTB$	-	-	-	-0.271	0.0658	-4.116	-0.713	0.0916	-7.784
$\Delta Dummy96$	-	-	-	0.248	0.0778	3.182	-	-	-

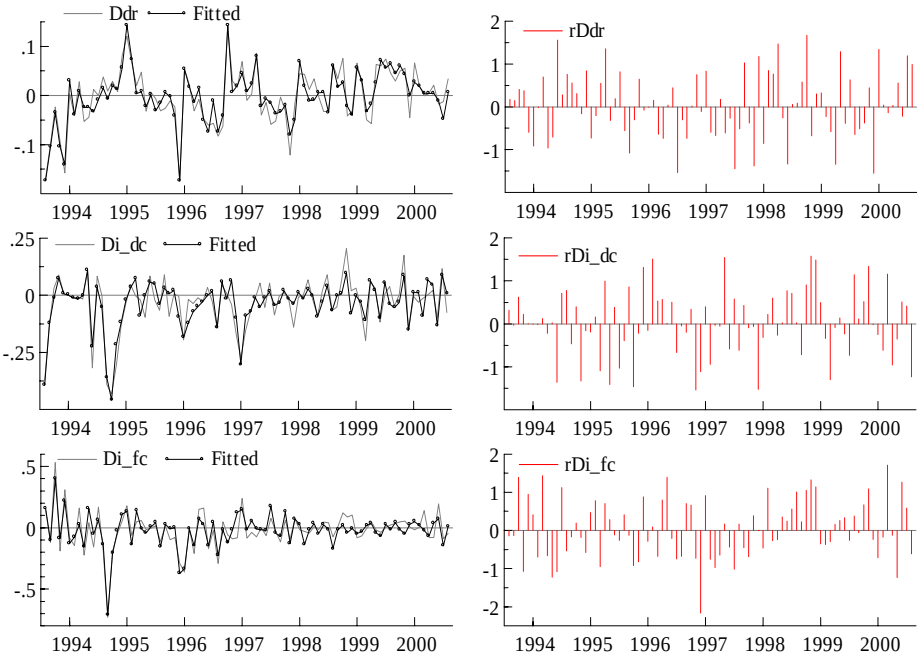
Note: DummyRC=1 for 1998.08, zero otherwise; DummyBC=1 for 1995.12, zero otherwise; DummyTB=1 for 1994.09 and 1994.10 (opening of the Lithuanian Government T-bills market), zero otherwise; Dummy9610=1 for 1996.10, zero otherwise; DummyGV=1 for 1999.05-1999.10, zero otherwise; Dummy9601=1 for 1996.01, zero otherwise; stands for the first difference.

Figure 12. Recursive graphic analysis: estimates of 1-step residuals ±2*SE (standard error) and Chow stability tests (1-step, break-point and forecast tests) of VECM(7)



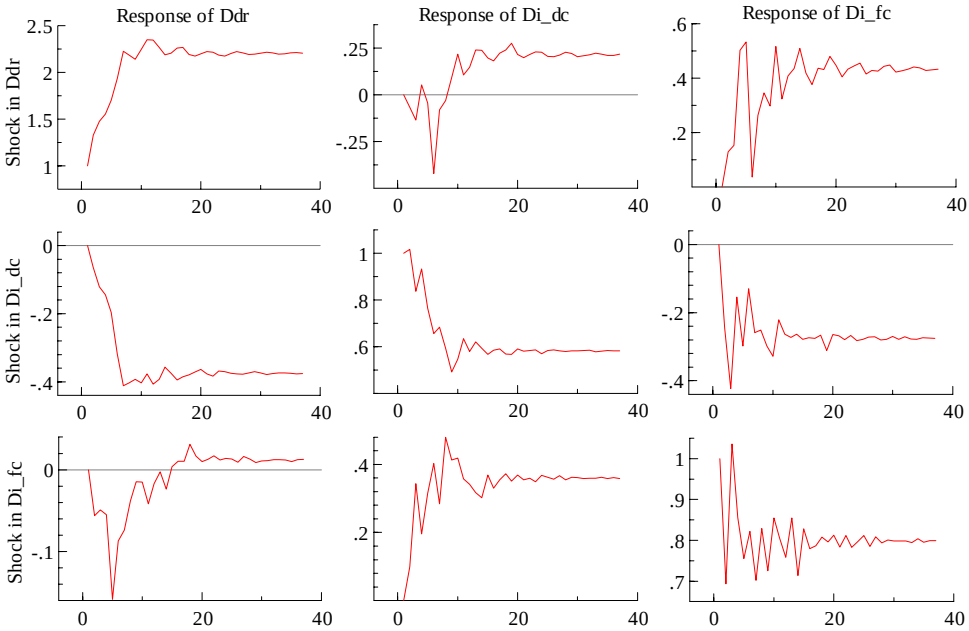
Note: Capital 'D' placed in front of a variable indicates first difference operator.

Figure 13. Graphic analysis of VECM(7) model: actual and fitted values of the time series in question and actual values of the residuals



Note: Capital 'D' placed in front of a variable indicates first difference operator.

Figure 14. Impulse-response analysis of VECM(7)



Note: Capital 'D' placed in front of a variable indicates first difference operator.

Notes

* The author is employed as a senior economist at the Economic Research Centre, Bank of Lithuania. Address for correspondence: 4 Totoriu St., LT-2629 Vilnius, Lithuania. E-mail: ivetlov@lbank.lt. All opinions expressed in the paper are those of the author and do not necessarily reflect the views of the Bank of Lithuania. The paper was written during a research visit to the Bank of Finland's Institute for Economies in Transition (BOFIT) in October-December 2000. The preliminary version of the paper was presented in a seminar on dollarization in Lithuania held at the BOFIT on the 12th of December 2000. The author is grateful to Jukka Pirttilä (BOFIT), Iikka Korhonen (BOFIT), Tuomas Komulainen (BOFIT), and other participants in the seminar for useful comments and suggestions. The author is also indebted to his colleagues from the Bank of Lithuania: Edvinas Bindokas, Žilvinas Kalinauskas, Romas Karaliunas, Jurga Maslauskaite, as well as to Raoul Lättemäe from the Bank of Estonia for providing relevant data. Any errors are the sole responsibility of the author.

[1] The early works are Kouri (1976), and Calvo and Rodriguez (1977), who analyzed the behavior of real exchange rate in the presence of currency substitution.

[2] The name is basically due to a fact that the US dollar appears to be the major foreign currency to compete with domestic money.

[3] For more details and the related references, we strongly encourage readers to take a look at Giovannini and Turtelboom (1994) and Sarajevs (2000).

[4] The later assumption of the cash-in-advance models limits their application in case of the developing and transition economies where as a result of underdeveloped financial markets a foreign currency holdings is the main alternative store of value asset (Giovannini and Turtelboom, 1994).

[5] Some efforts to construct data on foreign currency banknotes circulating in a domestic economy were put by Melvin and Fenske (1992), and Brodsky (1997). As the authors themselves acknowledged, these attempts, however, did not seem to produce any sensible results due to poor credibility of the newly derived data.

[6] For example, shares of the domestic companies or bonds of the domestic government.

reliability of the comparison. While the Lithuanian data was found in a complete agreement with the IMF standards there were detected minor difference in case of Estonia and Latvia when comparing the *IFS* data on the monetary aggregates with corresponding time series provided by the Estonian an Latvian central banks. The national sources were used since the *IFS* did not provide separate data on foreign currency deposits in case of Estonia and Latvia.

[12] The Bank of Lithuania was first established in Kaunas in 1922. Under the Soviet occupation (1940–1990) it ceased to exist.

[13] For more details on the currency reform in Lithuania in early nineties see Lainela and Sutela (1993).

[14] The reserve requirement ratio was raised from 10 % to 12 %. In addition, foreign currency deposits were made subject to the reserve requirement. The money M2 growth rate dropped from 351 percents in 1992 to 102 percents in 1993 (Saavalainen, 1995).

[15] The Conservative Party won the elections eventually and later in the year formed a new government led by Gediminas Vagnorius.

[16] The choice of US dollar instead of the DM or a basket of currencies as the anchor for the litas was extensively criticized recently on the ground of importance of trade with the EU.

[17] In May 1999, a new government led by Rolandas Paksas was formed. In October, Paksas resigned and Andrius Kubilius assumed the PM position.

[18] One might be puzzled by the significant fall in the degree of openness of the Lithuanian economy in the beginning of the period in question. One hypothesis regarding the phenomenon could be a recovery in the domestic demand for Lithuanian products.

[19]It is assumed that a reader is familiar with the standard econometric techniques used in the modern time series analysis. For the description of the econometric methods applied in this section a reader can consult relevant econometric textbooks, for example, Hamilton (1994) or Harris(1996). Graphs and the main econometric results reported in the section were obtained applying PcFiml (Doornik and Hendry, 1997) and PcGive (Doornik and Hendry, 1996) statistical software.

[20] The weights are based on the relative values of deposits created per month.

[21] Also in Sarajevs (2000) and Korhonen (1996).

[22] First, 12 lags of the endogenous variable are added to the equation, then, insig - nificant lags are removed until the procedure runs into the problem of autocorrelation.

[23] For example, in case of VAR(8) and VAR(12) the Wald test accepts the restriction towards VAR(8) with $\chi^2(36)=42.823[0.2017]$. The likelihood ratio based on these models is 16.6 which is below the 5 % level of significance (Hamilton, 1994).

[24] Although *max t*est indicates the presence the second cointegrating vector at the 5 % level of significance, we restrict our analysis to one cointegrating vector. As follows from the discussion in Harris (1995, pp.88-89), the finite sample bias leads to over-rejection of null hypothesis of no cointegration. Thus, to be cautious, we look at the results corresponding to the critical values corrected for degrees of freedom.

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