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On The Road to Euro: How Synchronized Is Estonia with the Euro zone?

Zuzana Brixiova,[1] Margaret H. Morgan,[2] Andreas Wörgötter [3 4]

Abstract

While the currency board served Estonia well during transition in the 1990s, it has limited its ability to counter the impact of the global financial crisis and heightened the currency risks. The euro adoption has thus become a top policy priority again. However, this paper finds that even after almost two decades of hard peg with the core of the euro zone shocks affecting Estonia are relatively weakly synchronized with those of the zone, contributing to large output volatility. Nevertheless, the case for euro adoption by Estonia holds, since the costs of the loss of independent monetary policy were paid, and – as the global financial crisis demonstrated – the currency board is no substitute for the common currency. To reduce future output volatility, Estonia should move to counter-cyclical fiscal policies, maintain labor and product market flexibility, and adopt policies stimulating rise in the knowledge and high-tech content of its production.

JEL classification: E32; F42; C53

Keywords: shock synchronization; structural VAR; euro adoption; financial crisis; Estonia

1. Introduction

In 1992, shortly after regaining independence from the Soviet Union, Estonia left the ruble zone and established its own currency (Kroon), which helped gather support for difficult reforms associated with the transition to a market economy. Simultaneously, the country introduced currency board, pegged initially to the German mark and since 1999 to euro. Under this regime the monetary base became fully backed by the foreign exchange reserves of the Bank of Estonia, the Kroon was completely convertible, and all restrictions on capital account transactions were abolished. With the adoption of the currency board, Estonia gave up its exchange rate and monetary policy in order to enhance credibility of its monetary stance and reduce inflation.[5] The money supply

[1] African Development Bank, Development Research Department

[2] Organization for Economic Cooperation and Development, Economics Department

[3] Organization for Economic Cooperation and Development, Economics Department

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[5] As Lättemäe (2001) points out "…The price stability objective is tied to the anchoring role of the exchange rate, and all the necessary adjustments are left to the market. There is no central bank policy rate or other operational monetary policy targets in Estonia…." In Estonia, the deposits of commercial banks (required and excess reserves) with the Central Bank are also backed. Under this arrangement, foreign exchange operations of the central bank were the main instrument of the monetary policy, supplemented by the reserve requirement ratio.

became endogenous, consisting of exchanging domestic currency at a fixed exchange rate to the currency that forms the reserve (Sepp and Randveer, 2002).

The currency board arrangement increased credibility by eliminating any possibility of discretionary monetary easing, since lending by the Bank of Estonia to the domestics banking sector or for government needs was prohibited except to banks experiencing systemic risks. Even in such situations, the lending could not exceed the accumulated excess foreign exchange reserves over the monetary base (Knöbl, Sutt and Zavoico, 2002). By doing so, the board constrained the policy space to respond to future asymmetric shocks with respect to the euro area. It also limited the possibility for the central bank to provide liquidity to the banking sector in the event of a financial crisis to the amount of excess reserves over the monetary base. By joining the EU and the ERM II in June 2004 and aiming at an early euro adoption (at the prevailing exchange rate), Estonia has solidified its commitment to permanently fixed exchange rate regime.[6] In other words, Estonian policy makers viewed euro adoption – at the prevailing exchange rate -- as the most appropriate exit strategy from the currency board (Lättemäe and Randveer, 2006).

The currency board served the country well during the 1990s and in fact played a key role in successful stabilization efforts, with inflation falling from high double digits in 1993 to low single digits by the late 1990s. During the 2000s, however, the benefits of the currency board declined. Estonia was one of the fastest growing emerging market economies in the world during this period, and until 2005 also had low inflation. However, growth was unbalanced, driven by non-tradables (especially the real estate sector) and financed by large capital inflows, which in turn fuelled domestic credit expansion, mostly in foreign currency. The combination of complete convertibility of the capital account with the currency board facilitated these capital inflows, as the currency board constrained the Bank of Estonia's room to mitigate the inflows and curtail the growth of private sector credit. Eventually, the credit boom created systemic risks to the banking sector through heavy exposure to international funding. The inflexible monetary policy framework implied that exchange rate adjustments were not possible to counter the severe adverse external shock when the global financial crisis hit. These factors contributed to a severe recession that Estonia experienced in 2009 (Brixiova, Vartia and Wörgötter, 2010).[7]

Given the large share of the private sector credit denominated in foreign currency and the associated currency risk, the global financial and economic crisis has made euro adoption even more attractive and put it on top of the country's policy agenda (Bank of Estonia, 2009). The heightened currency risk during the crisis demonstrated that the currency board is not a substitute for joining the euro area.[8] The enhanced interest has been driven mostly by the desire to eliminate this risk, triggered by the speculation in the wake of the global crisis. Estonia was able to maintain an orderly financial system

[6] The full convertibility rule and strong legal commitments to the arrangement increase the credibility of the peg and separate the arrangement from other fixed exchange rate systems (Lättemäe, 2001).

[7] Other components of the macroeconomic framework, especially fiscal policy, have been also important.

[8] Estonia was not alone in this aspect – euro adoption has gained interest also in other small European countries, such as, for example, Denmark or Iceland.

throughout the crisis largely due to good cross-border cooperation and provision of liquidity from the Nordic banks, which account for 95 percent of the Estonian banking market.[9]

The objectives of the paper are threefold. First, using several empirical methods, the paper establishes that the alignment of Estonia's shocks with those of the euro area, one of the preconditions for joining currency area posited by the optimal currency area approach, is low. Second, drawing on the existing literature, the paper suggests that in a small open economy with strong trade linkages to the euro zone such as Estonia benefits of the fixed exchange rate regime on balance still outweigh the cost created by the lack of alignment. Moreover, the paper posits that the recent financial crisis has illustrated the advantages of common currency zone and increased the case for the euro adoption in Estonia, given its large share of foreign-denominated debt. Third, the paper briefly discusses policies that can help mitigate the cost of Estonia's incomplete business cycle synchronization with the euro zone.

The paper is organized as follows. After this Introduction which provides a brief background on the Estonian monetary policy framework, Section 2 conducts empirical analysis on the degree of synchronization of Estonia's business cycles with those of the euro area. Section 3 posits that euro adoption would be beneficial for Estonia. Section 4 concludes. While this paper focuses on Estonia, its conclusions can apply to other countries with either a currency board or a fixed exchange rate regime and weak business cycle synchronization with the euro zone, such as the other two Baltic countries.

2. How Synchronized is Estonia with the Euro Zone?

The interest among policy makers and researches in the cyclical alignment of the new EU members with the euro area started in the 1990s and picked up around the EU enlargement period. It has remained high since most of the new EU members still have the EMU accession ahead of them and was only heightened by the global financial and economic crisis.[10] The objective of this section is to reassess the business cycle synchronization between Estonia and the euro area, utilizing several empirical methods and recent data.

It needs to be underscored that in the case of Estonia, the degree of synchronization with the euro zone does not affect anymore the country's decision whether to join the common currency area or not. This is because Estonia has been paying the price of abolishing independent monetary and exchange rate policies to counter adverse shocks since the introduction of the currency board in 1992. Hence joining EMU will not create a new challenge in this respect, as the challenge of coping with adverse shocks through alternative mechanisms already exists under the currency board. Still, Estonian policymakers need to be aware of the degree of cyclical alignment of their economy with the euro zone in order to determine to what extent such

[9] In the fall of 2008 a run on one of the branches of a major Nordic bank occurred, but the parent bank supplied liquidity swiftly. In February 2009, the Bank of Estonia strengthened its capacity to provide liquidity by signing a precautionary agreement with the Swedish Central Bank.

[10]. Slovenia joined the euro area in January 2007 and the Slovak Republic in January 2009.

mechanisms should be employed. This becomes particularly important in the context of the post-crisis recovery, as there are concerns that Estonia's return to trend growth could take longer than in the EMU countries.

2.1 Background Theory

The empirical analysis below draws on the traditional optimal currency area (OCA) theory (Mundell, 1961 and others), which posits that symmetry of macroeconomic shocks is a key consideration for participation in a monetary union (or adopting fixed exchange rate). The traditional OCA analysis claims that membership in a currency union provides economic efficiency gains by relieving the member country of the macro economic instability risk, provided its business cycles are synchronized with those of the currency area. Asymmetric, country-specific shocks would weaken the case for a common currency/peg and increase the need for an independent monetary policy and a flexible exchange rate regime. Costs of pegs, and especially monetary unions, thus rise with diverging business cycles. [11] Business cycles may not be synchronized due to asymmetric shocks and/or differences in the transmission mechanisms of common shocks, but structural similarity reduces the impact of these factors.

Even with asymmetric shocks in place, the exchange rate and monetary policy tools can be relinquished in countries with mobile labour (Mundell, 1961), a high degree of economic openness (McKinnon, 1963), and diversification in production and consumption (Kenen, 1969). Other factors that ease monetary integration include flexible wages and prices, financial integration, and counter-cyclical fiscal policy which is effective in stabilizing the economy. However, the original OCA work abstracted from important benefits of monetary integration/pegged to a strong currency, most notably enhanced credibility, but also lower transaction costs and increased political integration. The political aspect became relevant in, for example, Italy, where the euro adoption helped insulating financial markets from disruptive political events, such as collapses of governments and resignations (Fratzscher and Stracca, 2009).

The backward looking OCA approach cannot address structural and other changes resulting from the monetary integration. Specifically, the OCA endogeneity hypothesis of Frankel and Rose (1998) argues that some of the OCA criteria, especially the synchronization of business cycles, will become more fulfilled once the country joins a monetary union. Austria is considered to be an example of a country which did not constitute an OCA (with Deutsche Mark) in 1980s, but now forms an OCA with the euro area. Hochreiter and Tavlas (2004) conclude for Austria that: "… the hard peg mattered because it mustered a domestic constituency in favor of change, providing the impetus for the domestic economy to become more flexible so that the peg could be sustained. The hard peg also furnished a disciplinary framework for sound macroeconomic policies." A similar statement can be made of Estonia, which with the onset of the currency board introduced a fiscal rule of an annually balanced budget and kept its public debt at a minimum. It made its labor markets more flexible than new EU member states with flexible exchange rate regimes (Brixiova, 2009).

[11] OCA theory identifies factors that may lead to excessive output volatility under a fixed exchange rate regime.

Another stream of research on structural similarity argues that with intensified trade, countries would draw more on their comparative advantages and become less diversified. This paradigm posits that if the country's trade with the common area currency is not intensive and/or it is mostly inter-sectoral, shocks would be asymmetric. The empirical work shows that integration raises share of intra-industry trade and shock synchronization. Imbs (2004) found that the share of intra-industry trade in the euro area has increased significantly since 1999. Fidrmuc (2004) showed in his work on Central and Eastern Europe that the intra-industry trade rather than total trade matters for convergence.

In line with this theoretical underpinning, the extent of Estonia's cyclical alignment with the euro zone is assessed below through (i) the degree of structural similarity (including intra-industry trade) and (ii) shock synchronization between Estonia and the euro zone. Structural similarity is measured in terms of extent of intra-industry trade and similarity of production. The degree of similarity of shocks is examined through structural VAR. While the empirical literature on the cyclical alignment of the new EU members with EMU is well advanced, research on Estonia and the other Baltic countries is sparse.[12] This paper thus adds to this stream of academic literature by carrying out a new empirical analysis on the extent of Estonia's synchronization with the euro area, utilizing several methods and more recent data. The paper also examines whether the alignment has increased since the Estonian Kroon was pegged to euro in 1999 (continuing the Deutschmark peg since 1992).

2.2 Structural Similarity

2.2.1 Structural Similarity Measured by Value Added

The structural similarity of production between Estonia and the euro area is measured in terms of Bray-Curtis index (Figure 1). Denoting x_{ij} to be the share of sector i in the total value added of country j, with countries in this case being Estonia and the euro zone, and N as total number of sector, the index can be defined as:

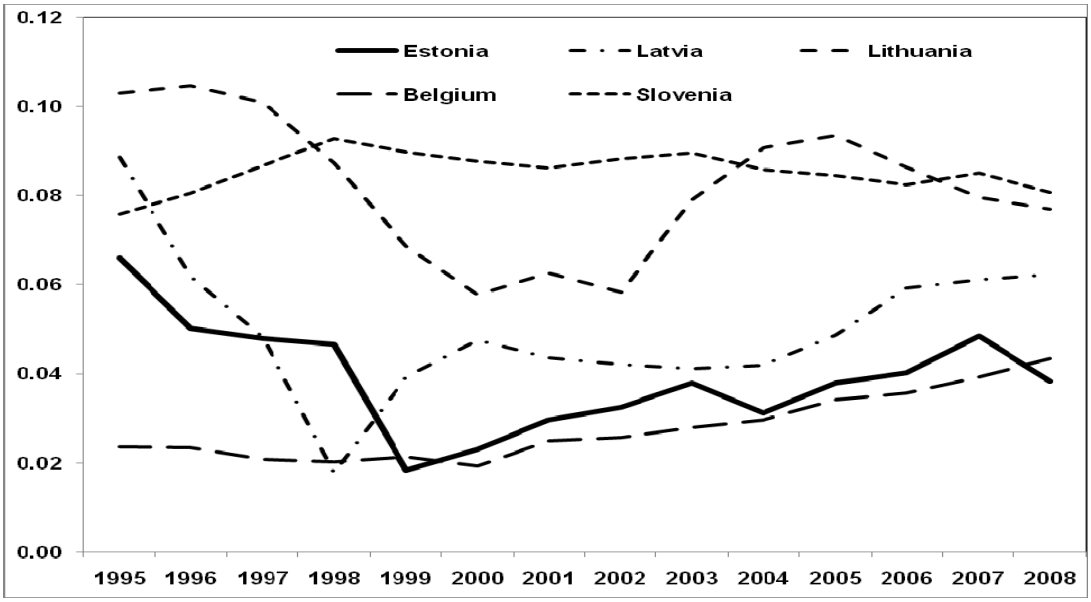
$$d_{jk} = \frac{\sum_{i=1}^{N} \left| x_{ij} - x_{ik} \right|}{\sum_{i=1}^{N} (x_{ij} + x_{ik})} \qquad (1)$$

By design, the index takes values between [0,1]. Since the index is essentially a metric based on distance, lower values indicate a greater structural similarity between sectoral contributions to total values added in Estonia and the euro area. According to this index, Estonia's production structure – when measured by four key categories (agriculture, industry, construction and services) – converged towards that of the euro-16 countries during 1995 – 2008 (Figure 1). In fact, when measured by these four

[12] Exceptions include Jurgutyte (2006) who utilizes structural VAR for examining business cycle synchronization in Lithuania and the euro area and more recently Fadejeva and Melihovs (2008) who employ factor component analysis.

categories, Estonia's production structure is more similar to the euro area's one than the production structures of the other two Baltic countries as well as than the structures of the current euro-zone members, Slovenia and the Slovak Republic. After a rapid convergence in late 1990s caused by a reallocation of production and employment from the industry to services, Estonia's production structure has began to broadly resemble to that of advanced euro zone countries, such as Belgium and Austria. A key factor behind the Estonia's structural divergence form the euro-16 average during 2005-2007 has been the rapid increase of the share of construction in output.

Figure 1. Bray-Curtis structural similarity index, 1995-2008



Source: Authors' calculations based on Ameco data.

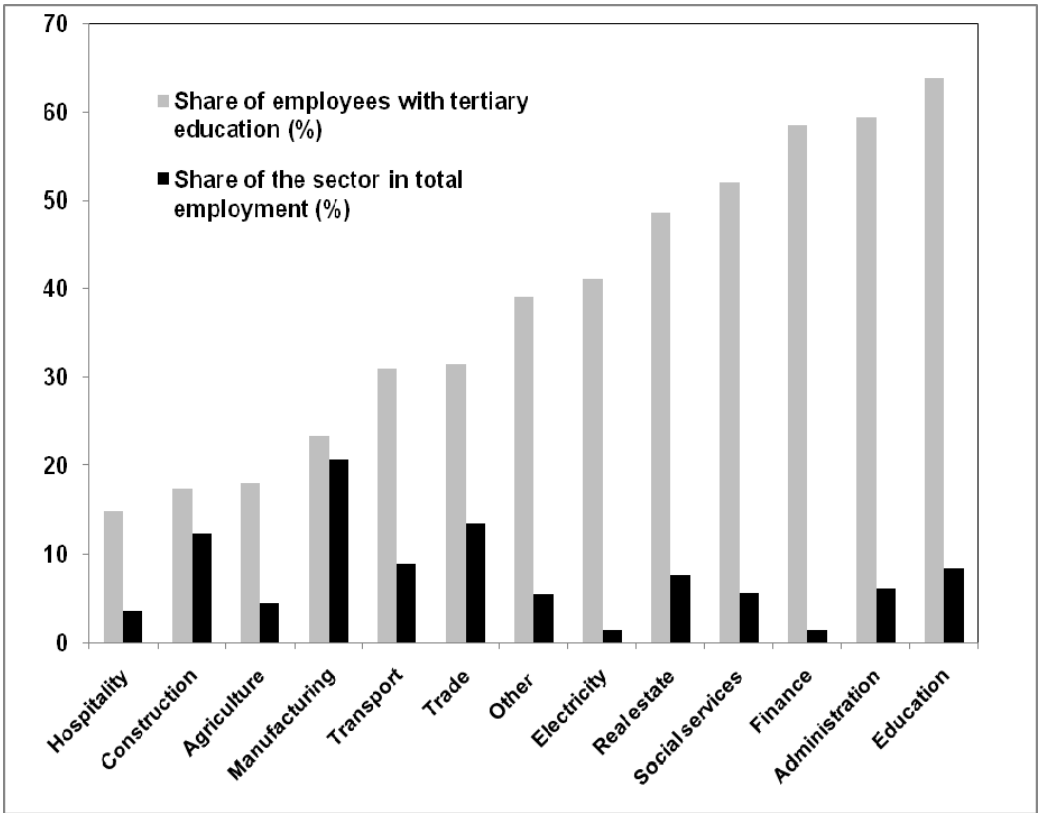
However, when the four main sectors (agriculture, industry, construction and services) are subdivided further, Estonia's production structure becomes notably less akin to that of the euro zone, especially those of the advanced countries. This is because of the relatively low high-tech and knowledge component in Estonia's production and employment (Figure 2). Specifically, even though Estonia has a relatively high rate of tertiary graduates, its shares of employment in high-tech sectors and knowledge intensive services are low. In fact, most of the jobs created during 2000–07 were in sectors with low shares of skilled employment, such as construction and trade (Eurofound, 2008 and OECD, 2009). In contrast, in the neighbouring Finland, most of the new jobs were in knowledge-intensive services, such as business services, health, and education.[13]

[13]. According to Olenko (2006), Estonia differed from EU14 average (EU15 excl. Luxembourg) during 1993-2001 in part due to concentration of services in transport and communication relative to more knowledge intensive activities such as business activities, financial services and health care.

2.2.2 Structural Similarity Measured by Intra-Industry Trade

Another indicator of structural similarity is the Grubel-Lloyd Index of intra-industry trade, which measures the intensity of Estonia's trade with the euro area. Estonia's trade with the EU has been intensive and increased over the years – in 2000-07 exports to the EU amounted to over 70% of total exports (Table 1), while imports accounted for about 80% of total imports. However, the share of intra-industry trade with the euro zone has remained low in 2007 (Figure 3), indicating that Estonia's comparative advantages have been more driven by factor endowment than product and process specific specialization and learning by doing.[14] This relatively high specialization in low quality products thus exposes Estonia to risks of external asymmetric shocks, as argued in Trotignon (2003) and demonstrated by the global financial crisis.

Figure 2. Estonia: share of employed with tertiary education and share of sectors in total employment in 2007



Source: Authors' calculations based on data from the Statistics Estonia.

[14] Gabrisch and Senana (2003) decomposed intra-industry trade into horizontal and vertical shares and found that vertical structures predominated, with the EU demonstrating comparative advantage in higher quality products and the transition economies in lower-quality products after trade liberalization materialized.

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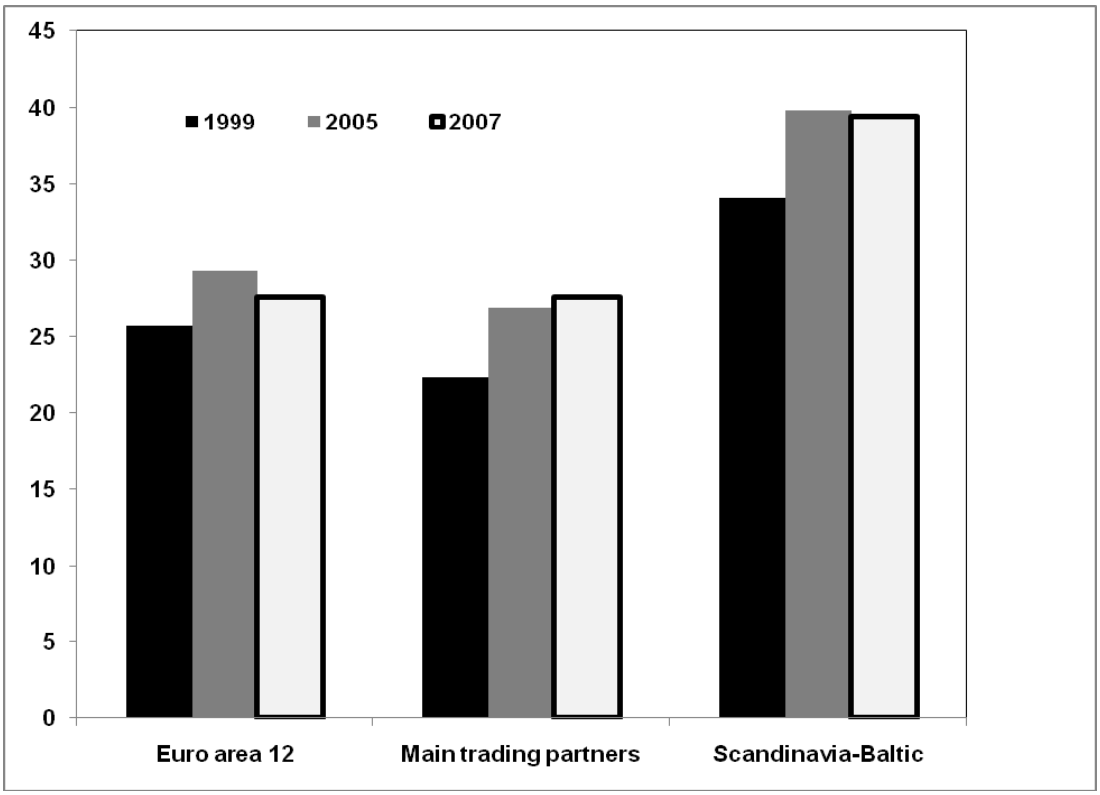
Table 1. Direction of exports of Estonia, Latvia, and Lithuania, 1994-2007

	Estonia		Latvia		Lithuania	
	1994-99	2000-07	1994-99	2000-07	1994-99	2000-07
	(in % of total exports)					
EU total	65.0	72.9	60.5	75.0	56.7	65.4
Advanced EU	51.2	58.5	39.4	51.0	37.2	41.2
Emerging EU	13.8	14.4	21.1	24.0	19.5	24.2
Russia	15.4	8.2	18.1	9.0	19.8	11.8

Source: Obiora (2009).

Figure 3. Estonia: Grubel-Lloyd index of Estonia's intra-industry trade, 1999-200715



Note: 0 indicates no intra-industry trade, while 100 indicates that all trade is intra-industry. Main trading partners are 32 countries which account for 85% to 90% of Estonia's total trade. Euro area 12 is the euro area 15 except for Luxembourg, Cyprus and Malta. The results were estimated at the 4-digit level of SITC Rev 3 and aggregated using shares. See OECD Economic Outlook No. 71, June 2002, pp. 159-170. Source: UN Comtrade database and authors' calculations.

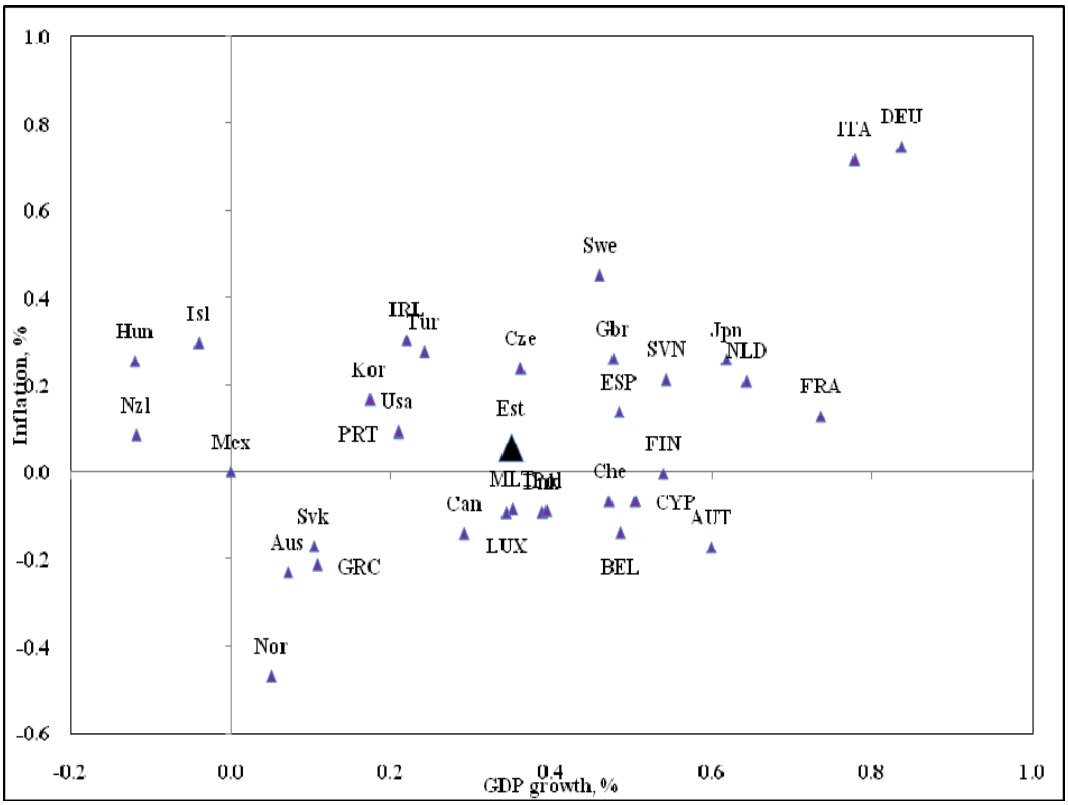
[15] The Grubel-Lloyd index of intra-industry trade (IIT) in product class i between countries A and B is $IIT_{i,AB} = 100 * \left(1 - \frac{X_i - M_i}{X_i + M_i}\right)$, where X = exports and M = imports.

2.3 Synchronization of Economic Shocks

2.3.1 Correlation of Economic Activity

First, we examine whether synchronization of economic shocks between Estonia and the euro zone exists using simple correlation coefficients for output and inflation. As Figure 4 illustrates, Estonia's correlation of the real GDP growth with the Euro area countries has been lower than most euro zone (Slovenia), but exceeded that of Ireland and the Slovak Republic (which joined EMU in 2009). While correlation of the inflation rate was low, this was the case for several smaller euro zone members as well.

Figure 4. Correlation of GDP growth and inflation between selected countries and the euro area, Q1 2001 – Q1 2008



Note: Growth is the current compared to the previous quarter and inflation is growth of the GDP deflator. The euro area countries (15 as of 2008) are displayed in capital letters. Source: Eurostat and OECD National Accounts Database.

2.3.2 Structural VAR Approach

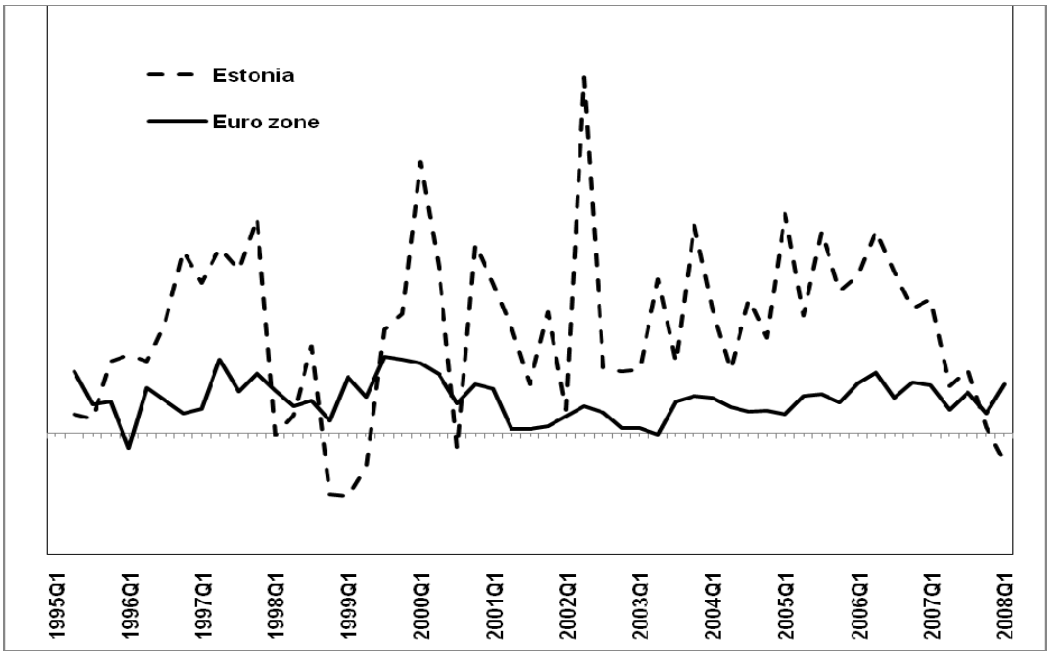
This section utilizes the structural VAR framework to identify the nature of the underlying shocks that the Estonia's economy faces and how similar they are to those faced by the euro area. Two formal, and complementary, approaches are adopted. Both methods indicate that Estonia's structural shocks are not particularly aligned with those of the euro area, and that the country-specific factors play an important role.

(i) What Role do Euro Area Shocks Play in Estonia's Output Fluctuations?

To shed some light on this question, first a graph showing quarterly real GDP growth rates (quarter-on-quarter) of Estonia and the euro zone is presented, which shows that the output volatility in Estonia is very high – of a completely different magnitude than in the euro zone (Figure 5). The rest of the analysis in this section follows from this observation.

In the paragraphs below, a variance decomposition of Estonia's output fluctuations through the Choleski decomposition is carried out. Variation in the change of the forecast error was decomposed into global, regional and country-specific output shocks. Global shocks are represented by the group of OECD countries, regional ones by the euro zone, and the country-specific by Estonia.

Figure 5. Quarterly real GDP growth (q-o-q), Q1 1995 – Q1 2008 (in percent)



Source: Eurostat and OECD National Accounts Database.

The three variables of the model -- global output, y^G, regional output, y^R, and country output, y^C -- are subject to three shocks – global, ε^G, regional, ε^R, and country-specific, ε^C. All variables are in logarithm. The VAR model can be represented in its reduced form as follows:

$$\begin{pmatrix} \Delta y_t^G \\ \Delta y_t^R \\ \Delta y_t^C \end{pmatrix} = \begin{pmatrix} A_{11}(L) & A_{12}(L) & A_{13}(L) \\ A_{21}(L) & A_{22}(L) & A_{23}(L) \\ A_{31}(L) & A_{32}(L) & A_{33}(L) \end{pmatrix} \begin{pmatrix} \varepsilon_t^G \\ \varepsilon_t^R \\ \varepsilon_t^C \end{pmatrix} \quad (1)$$

where $A_{ij}(L) = a_{ij}^0 + a_{ij}^1 L + a_{ij}^2 L^2 + ...,$ is a polynomial function of the lag operator, *L*. The structural shocks in (1) are assumed to be uncorrelated and of unit variance – $Var(\varepsilon) = I$. Identification is obtained using Choleski decomposition with the variables ordered as above. In sum: (i) country-specific shocks have no effect on either the regional or global output; and (ii) regional shocks have no effects on the global output, that is $A_{12}(1) = A_{13}(1) = A_{23}(1) = 0$.[16] This procedure then amounts to the following economic assumptions about the effects of the shocks:

- Global shocks affect output in all countries, *i.e.* are due to global events, such as oil price shock or changes in international interest rates;
- Regional shocks affect output in the euro area, and are due to common regional events, such as EU enlargement; and
- Country-specific shocks affect output in individual countries only, and are due to, changes in macroeconomic policy, consumer sentiment, terms of trade shocks or productivity shocks, among others.

Results

Quarterly, seasonally adjusted data for 1997Q2-2008Q3 were obtained from the OECD database. In the VARs, variables included are the first differences of (the log of) quarterly real GDP. Global growth was represented by the group of OECD countries, regional growth by the euro area (as of December 2008), and the country-specific growth by Estonia.

The VAR model satisfies the standard requirements. Time series property of the data was investigated with the augmented Dickey-Fuller unit root test and the KPSS test.[17] Standard information criterion (Akaike, Schwarz, and Hannon-Quinn) was used to choose the lag length. The Lagrange Multiplier (LM) test indicates that the residuals at 1st and 4th lags show no sign of being serially correlated. Finally, the Jarque-Bera test suggests that data are from a normal distribution. Variance decomposition (using the recursive Choleski decomposition) was conducted to identify the contribution of global regional and country-specific to changes in the Estonia's growth, with the variables ordered as in (2).

Table 2 gives results at the 20th quarter horizons for the output variation of Estonia's output. Specifically, variation in the percentage change of the forecast error of changes was decomposed into global, regional and country-specific output at the 1 through 20 quarter horizons. A significant role for the regional shocks in Estonia's output fluctuations would indicate that the country meets the shock synchronization criterion of the OCA theory. However, Table 2 shows that on the basis of the 1997-2008 estimation, domestic shocks accounted for majority of the Estonian GDP growth volatility, which can be ascribed to the specificities of transition, including the impact of the Russian crises, and the relatively low share of intra-sectoral trade with the euro area.

[16] This approach follows Kim and Chow (2003) and is akin to that of IMF (2005) and Kose, Otrok and Prasad (2008).

[17] At least one of these tests confirmed the first difference stationarity at 5% confidence level (Annex I).

Specifically, in Estonia, domestic shocks accounted for most of the GDP growth volatility during 1997-2008. Euro area shocks accounted for less than 10%.[18]

As an alternative to euro area shocks, narrower regional aggregates were calculated for Sweden and Finland. The Sweden/Finland regional shocks also explained only about 4% of the Estonia's output variance, but this rises somewhat if we identify regional growth factors with the Scandinavian-Baltic aggregate. Still, local factors remain much more important in Estonia than in Finland (Table 2). The important role of Estonia-specific shocks reflects the specificities of transition, the heavy impact of the 1998 Russian crises, and the low share of intra-sectoral trade with the euro area. The results confirm that synchronization of Estonia's cycle with the euro area has been low.

Table 2. Variance decomposition of output growth

Percentage of output variation accounted for by shocks in			
	OECD	Euro area	Estonia
Estonia	14.6	4.6	80.8
	OECD	Euro area	Finland
Finland	43.3	6.9	49.7
	OECD	Scandinavian/Baltic area	Estonia
Estonia	16.0	15.8	68.2
	OECD	Sweden/Finland	Estonia
Estonia	24.1	3.8	72.0

Note: Factorisation used the Cholesky decomposition. Results are reported at the 20th quarter horizon for the variation of Estonia's output.

Source: Eurostat and OECD National Accounts databases and authors' calculations.

As the above results show, Estonia has been subject mostly to country-specific shocks. The absence of nominal exchange rate adjustment as a way of mitigating the asymmetric shocks has been quite costly and necessitated development of other adjustment mechanism. The observation that Estonia's shock synchronization with the euro zone has been low can then partly explain why the country developed more flexible labor and product markets than other new EU members with flexible exchange rate arrangements (OECD, 2009).

[18]. Results are consistent with IMF (2005), where the country-specific factors explain more than 60% volatility in about 90% of emerging market and developing countries. The global factor explains less than 10% of output volatility for more than 60% of these countries.

(ii) Synchronization of Economic Shocks

This evaluates business cycle synchronization between Estonia and the euro zone, utilizing the structural VAR model with decomposition along the lines of Blanchard and Quah (1989). More specifically, this section applies a bivariate structural VAR model to recover the underlying demand and supply shocks in Estonia and to determine the degree of their correlation with the euro area shocks. The aim is to identify the nature of the shocks affecting Estonia, their synchronization with those of the euro area and whether these shocks have become more synchronized over time. The main conclusion is that while synchronization of Estonia's business cycles with the euro zone has been relatively low, it has increased over time.

Our structural VAR model is based on the aggregate supply-aggregate demand model, which consists of two variables – output and prices. Fluctuations in these variables are assumed to be due to supply and demand shocks. Supply shocks are driven by structural changes in the economy, such as changes in oil prices, technology, and the labor force. Demand shocks consist of *i)* real shocks such as changes in consumer confidence, abrupt shifts in government spending, and *ii)* nominal shocks such as changes in expected inflation, monetary policy, or shocks in foreign exchange markets.

A positive supply shock has a permanent positive impact on output, whereas positive demand shock has only temporary positive impact on output. In contrast, both supply and demand shocks have a permanent impact on the price level – positive supply shock reduces price level while positive demand shock increases it.[19] Formally:

$$y_t^S = E_{t-1} y_t + \alpha\left(p_t - E_{t-1} p_t\right) + \varepsilon_t^S \quad (2)$$

$$y_t^D + p_t = E_{t-1}(y_t^D + p_t) + \varepsilon_t^D \quad (3)$$

$$y_t = y_t^S = y_t^D \quad (4)$$

where y_t is (the log of) output in period *t,* and $E_{t-1} y_t$ is (the log of) output expected in period *t* given information at *t-1*. Similarly, p_t is (the log of) price level in period *t,* while $E_{t-1} p_t$ is (the log of) price level expected at *t-1*. The superscripts *S* and *D* represent supply and demand, and ε_t^S and ε_t^D denote the (serially uncorrelated) structural aggregate supply and structural aggregate demand shock, respectively.

Equation (2) is the AS curve, where output increases with unexpected increases in the price level and positive supply shocks. The AD increases with its expected value and positive demand shocks (3). [20] System (2) – (4) can be solved for output and the prices, so that in the matrix form the model is described by:

[19] In Bayoumi and Eichengreen (1993), the impact of supply and demand shocks on the price level are referred to as an over-identifying condition, used in ex-post evaluation of the model.

[20] This framework has been used in, for example, Cover, Enders and Hueng (2006) or Jurgutyte (2006) for Lithuania. Sections below follow the same approach as in these articles.

$$\begin{bmatrix} y_t \\ p_t \end{bmatrix} = \begin{bmatrix} E_{t-1} y_t \\ E_{t-1} p_t \end{bmatrix} + \begin{bmatrix} \frac{1}{1+\alpha} & \frac{\alpha}{1+\alpha} \\ \frac{-1}{1+\alpha} & \frac{1}{1+\alpha} \end{bmatrix} \cdot \begin{bmatrix} \varepsilon_t^S \\ \varepsilon_t^D \end{bmatrix} \tag{5}$$

The system described by (5) exhibits a systemic relationship between prices and output in the short run, but the long-run independence of nominal and real variables continues to hold, as the short run AS curve is upward sloping, but the long-run AS curve is vertical. In this framework, the responses of output and inflation to positive demand and supply shocks are as follows:

Table 3. Predicted Dynamic Responses from the above AD-AS Framework

		Short-run	**Long-run**
Output response to positive	AS shock	positive	positive
	AD shock	positive	neutral
Inflation response to positive	AS shock	negative	negative
	AD shock	positive	positive

Identification (based on Blanchard and Quah (1989) decomposition)

A joint process of output and prices (5) can be also written as an infinite moving average representation of supply and demand shocks (as in Bayoumi and Eichengreen, 1993):

$$X_t = A_o \varepsilon_t + A_1 \varepsilon_{t-1} + A_2 \varepsilon_{t-2} + ... = \sum_{i=0}^{\infty} L^i A_i \varepsilon_t \tag{6}$$

where $X_t = \begin{bmatrix} y_t \\ p_t \end{bmatrix}$, $\varepsilon_t = \begin{bmatrix} \varepsilon_t^S \\ \varepsilon_t^D \end{bmatrix}$, and L^i is the lag operator. The matrices A_i represent the impulse response functions that transmit effects of the shocks to the variables (elements of X_t). A finite version of (6) can be estimated as VAR:

$$y_t = \sum_{j=0}^{k} b_{11(j)} y_{t-j} + \sum_{j=0}^{k} b_{12(j)} p_{t-j} + e_{yt} \tag{7}$$

$$p_t = \sum_{j=0}^{k} b_{21(j)} y_{t-j} + \sum_{j=0}^{k} b_{22(j)} p_{t-j} + e_{pt} \tag{8}$$

The matrices B_i can be estimated.[21] The regression residuals e_{yt}, e_{pt} are composed of the underlying structural supply and demand shocks $\varepsilon_t^D, \varepsilon_t^S$. Since the supply and demand shocks $\varepsilon_t^S, \varepsilon_t^D$ are not observed, they need to be identified from the VAR residuals. The equations (6), (7) and (8) give directly the relationship between the estimated residuals (e) and the original shocks (ε), which can be described by $e_t = A_o \varepsilon_t$:

$$\begin{bmatrix} e_{yt} \\ e_{\pi t} \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} . \begin{bmatrix} \varepsilon_t^S \\ \varepsilon_t^D \end{bmatrix} \tag{9}$$

where a_{ij} represents the effect of shock *j* on variable *i* (through the residuals). Therefore we need to know the elements of A_0 to calculate the underlying supply and demand shocks. From (10), the variance-covariance matrix of the VAR residuals $e_{yt}, e_{\pi t}$ is given by:

$$\begin{bmatrix} Var(e_{yt}) & Cov(e_{yt} e_{pt}) \\ Cov(e_{yt}, e_{pt}) & Var(e_{pt}) \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} . \begin{bmatrix} \sigma_S^2 & \sigma_{SD} \\ \sigma_{SD} & \sigma_D^2 \end{bmatrix} . \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \end{bmatrix} \tag{10}$$

Since estimation of the VAR yields $Var(e_{yt}), Var(e_{pt}), Cov(e_{yt}, e_{\pi t})$, the identification of the structural model requires four restrictions being imposed on the VAR. The Blanchard-Quah decomposition assumes that $\sigma_S^2 = 1, \sigma_D^2 = 1$, that is variability of the demand and supply shocks is equal and normalized to unity. Another assumption is that the shocks to aggregate demand and supply are uncorrelated with each other, $Cov(\varepsilon_S, \varepsilon_D) = 0.$ In addition, the long-run neutrality restriction implies that cumulative effect of demand shocks on output must be zero, that is $\sum_{j=1}^{\infty} a_{12}(j) = 0$ (demand shocks has no permanent impact on output). Alternatively, the last restriction can be written as $a_{12}[1 - b_{22}(1)] + a_{22} b_{12}(1) = 0.$ Finally, Table 3 posited that positive demand shock will raise prices in both short and long run, while positive supply shock will lower them. These over-identifying restrictions are below used for interpreting the results of the model.

[21] $A_i = B_i A_0$ and $\sum_{i=0}^{\infty} A_i = \sum_{i=0}^{\infty} B_i A_0$

Estimation Results – Variance Decomposition

Quarterly data was used covering the period form 1997 Q2 to 2008 Q3. Data source is OECD and Eurostat, with real GDP approximating output and GDP deflator inflation, as in other literature on the topic.[22] Table 4 presents correlation coefficients of the supply and demand shocks between several countries (including Estonia) and the euro zone. It should be noted that there is no agreed correlation coefficient benchmark that would indicate that a country is sufficiently synchronized with the currency. Still, as Table 4 and Figure 6 show, Estonia's correlation of shocks with the euro area is low. Nevertheless it has been comparable to the Nordic EU countries (Finland, Sweden).[23] Moreover, the endogeneity hypothesis of the OCA in the case of Estonia would suggest increasing symmetry with the euro area over time. Hence, two sub-samples were estimated to evaluate the changes in correlation over time. The observed improvement of the correlation of demand shocks between Estonia and the euro zone in 2003-08 suggests that the synchronization indeed increased over time. This is also confirmed in Figure (6).[24]

Table 4. Correlation of supply and demand shocks with the euro area, 1997 Q2-2008 Q3

	1997 Q2-2008 Q3		1997 Q2-2002 Q4		2003 Q1-2008Q3	
	Demand	**Supply**	**Demand**	**Supply**	**Demand**	**Supply**
Estonia	-0.20	0.31	-0.50	0.29	0.14	0.34
Finland	0.11	0.13	0.22	0.08	0.03	0.17
Sweden	0.03	0.32	-0.07	0.24	0.11	0.41

Note: Positive numbers indicate symmetry, negative numbers asymmetry of shocks. Source: Authors' calculations

[22] The VAR models satisfy the necessary requirements. Stability conditions are met, while the LM test indicates that residuals at 1st and 4th lags do not show signs of being correlated at the 5% level of significance. Standard information criteria were applied to choose the lag length.

[23] Table 3 was used in ex-post verification of the results. All Estonia's impulse responses (7 out of 8) to the positive demand and supply shocks were consistent with the predictions of the underlying model (3) – (5) and Table 3.

[24] When CPI index (HICP) is used rather than GDP deflator, the correlation coefficient between Estonia's demand shocks and those of the euro zone becomes positive, pointing to the greater synchronization of shocks affecting a "typical" consumer than the overall economy. To put differently, while specialization in production prevails, there was a greater convergence in the composition of spending between Estonia and the euro zone. According to Corsetti (2008), this makes regional policy more optimal even in the presence of uncorrelated regional shocks.

Figure 6a. Demand shocks of Estonia and the euro area, 1997 Q2-2008 Q3

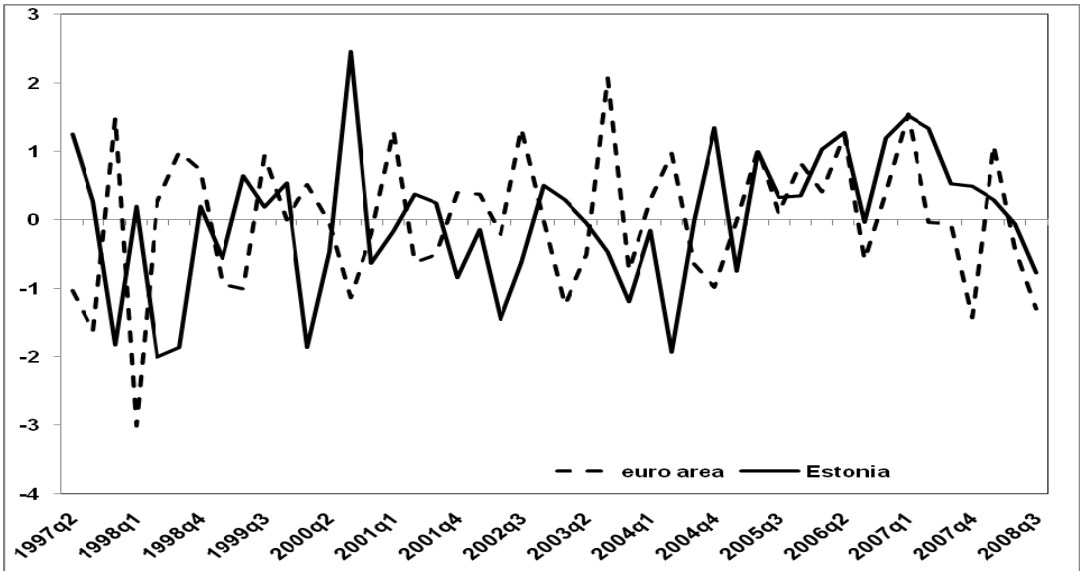
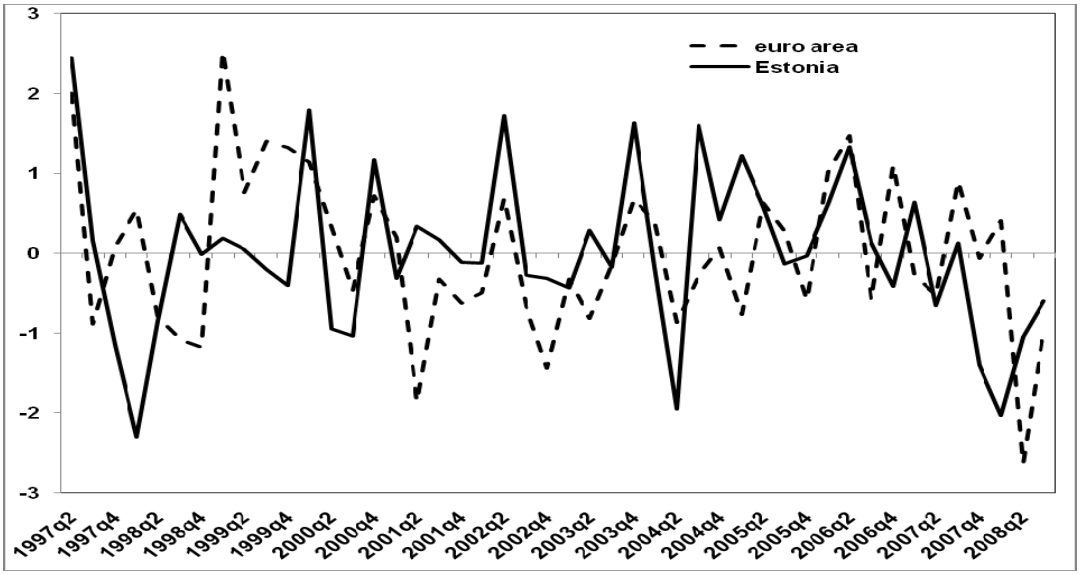


Figure 6b. Supply shocks of Estonia and the euro area, 1997 Q2-2008 Q3



Source: Authors' calculations.

Variance decomposition of the structural VAR revealed that supply shocks accounted for most of the real output variability, while demand shocks accounted for the majority of the variability in prices. Estonia's results are compared with those of Finland (Table 5).

Table 5. Variance decomposition of output growth and inflation (in percent)

	Real output		**Inflation**	
	Supply shock	**Demand shock**	**Supply shock**	**Demand shock**
Estonia	83	17	24	76
Finland	48	52	45	55

Source: Authors' calculations utilizing data from the OECD National Accounts and Eurostat databases.

The analysis above shows that country-specific, idiosyncratic shocks prevail in Estonia. The country thus needs to rely heavily on other adjustment mechanism such as flexibility of its economy and effective fiscal policy rather than on similarity of its economic shocks and business cycles with the EMU. Nevertheless, the predominance of asymmetric shocks does not seem to be too different from several current euro area members, such as Greece or Ireland, for example. The above results are consistent with those of the previous sections, namely that synchronization of Estonia's shocks and business cycles with those of the euro area is relatively low, albeit gradually increasing until 2008. However, the collapse of the Estonia's real GDP growth in 2009 has slowed the convergence, as it was notably more severe than in any of the euro area countries.

2.4 Comparison of Results with the Empirical Literature

Studies on shock synchronization of the new EU countries with the EMU, utilizing data prior to the crisis (until mid-2008) are summarized in Table 6:

Table 6. Similarity of shocks and synchronization of business cycles –Summary of literature

Study and Author(s)	Methodology	Findings
Fidrmuc and Korhonen (2003)	Correlation and structural VAR	Structural shocks were more asymmetric in EU candidate countries than the euro area.
Lättemäe (2003)	Structural VAR	Real shocks in Estonia comparable to those of some of the smaller EU members.
Trotignon (2003)	Sectoral and geographical indicators of exposure to shocks	Estonia is highly exposed to risks of external asymmetric shocks.
Fidrmuc (2004)	Correlation and structural VAR	Slowdown of 2000-2002 increased heterogeneity of demand shocks.
Horvath and Ratfai (2004)	Correlation and structural VAR	Due to asymmetric shocks that accession countries are exposed to, costly process of adjustment after EMU enlargement likely.
Demyanyk and Volosovych (2005)	Correlations of GDP, consumption growth	Economies with the most volatile and counter-cyclical growth - incl. Baltic states - would benefit from risk sharing within the EU.
Babetskii (2005)	Structural VAR	Synchronization of shocks has increased over time.
Eickmeier and Breitung (2005)	Structural factor model	Poland, Slovenia, Hungary and Estonia are more suitable for EMU than others.
Fidrmuc and Korhonen (2006)	Meta-analysis	Several current members of the euro area appear to have lower business cycle correlations than new EU members.
Darvas and Szapary (2008a)	Price level convergence panel regression; financial integration	Volatility in NMS (incl. Estonia) has been reduced, but is higher than in the euro area.
Darvas and Szapary (2008b)	Correlations of GDP and factor components analysis	Baltics not synchronised (contrary to CEEs).
Levasseur (2008)	Structural VAR	Estonia had increasingly negative correlation of supply shocks with the Euro area.
Obiora (2009)	Structural VAR	There are significant spillovers to the Baltics from key trading partners with those from the EU outweighing those from Russia.
Fadejeva and Melihovs (2009)	Dynamic factor model	After 2000, economic developments between the Baltic States and the main euro area countries became more synchronized.

Regarding methodology, the complexity of method increased over time, as more data became available. While the first strand of literature typically used a simple correlation of the aggregate output and prices, the second one examined properties of business cycles using various filters, and the third one utilized structural VAR to recover underlying structural shocks, as was done in this paper. A dynamic factor model was utilized by Darvas and Szapary (2008b) and Fadejeva and Melijhovs (2009). Despite the various methods used, many of the studies' can be broadly summarized as follows: (i) shocks of the recently acceded EU countries tend to be less synchronized with the euro area than shocks of most of the EMU members; (ii) synchronization of shocks may have increased somewhat over time, as policies pertaining to transition were replaced by policies and institutions that would facilitate convergence towards the EU. The findings for Estonia in this paper are thus broadly consistent with at least part of the empirical literature.

3. The Case for Euro Adoption

Euro adoption has been a long-standing strategic priority of the Estonian government.[25] Since joining the EU, Estonia has viewed the euro adoption as the most appropriate exit strategy from the currency board (Lättemäe and Randweer, 2006). As of early 2010, Estonia was as close to realizing this goal as ever. Even prior and during the global financial crisis (in 2009), Estonia has been meeting most of the formal criteria of the euro adoption (inflation was met in November 2009); one exception has been the interest rates criterion which cannot be assessed because Estonia is so far lacking the 10-year Kroon-denominated government bond. With the 2009 budget deficit amounting only to 1.7 percent of GDP and very low levels of government debt, the fiscal criterion has also been met. In Spring 2010, the European Commission endorsed Estonia's bid for euro adoption.

The limited synchronization of business cycles notwithstanding, there are strong economic reasons for Estonia to adopt the euro. In fact from the point of view of the limited shock synchronization, the euro adoption will *de facto* change very little – Estonia has a fixed exchange rate regime linking the local currency to the euro and the issues regarding the lack of synchronization are same in both regimes. Put differently, for Estonia the limited synchronization is not a reason against euro adoption as its economy has functioned well under this regime for a number of years, and stood the test of major crises. And from the perspective of the EMU, the cost of admitting an unsynchronized member would be limited given Estonia's small size. The costs of joining the EMU would not be high for Estonia, as the country incurred them when it gave up its independent monetary policy.[26]

In addition to limited reasons against the euro adoption, there are strong ones in its favor. As the financial crisis illustrated, with the currency board in place, joining the

[25] In addition to economic reasons, the euro adoption is viewed as a symbol of becoming a part of the core of the European Union, achieving the aims set when Estonia regained its independence.

[26] Among the neglected euro benefits are mainly the greater independence of a big central bank as well as its greater technical competence and coverage of background analysis and scope for action. However, with the currency board in place, this benefit is minimal in the case of Estonia.

euro zone would bring benefits of eliminating the costs associated with currency risk and perceived devaluation risk. In the case of Estonia these costs are high due to the substantial private debt denominated in foreign currency, and hence benefits of eliminating them are also high.[27] Moreover, with the euro adoption, transaction cost would decline as the currency exchange costs would be eliminated and interest rates on loans decrease. This point is also made by Grubel (2005), who argues that considerable benefits in small countries joining a currency area come from the elimination of currency risks and an associated reduction of the risk premium. More broadly, for a small country, the traditional benefits that come from avoiding foreign exchange transactions within the currency area (estimated to be about 0.3 to 0.4% of national income) are substantial in absolute terms. Moreover, they can generate significant growth enhancing effects, such as deeper financial market integration. Even long before the financial crisis, Berger, Jensen and Schjelderup (2001) argued that in the case of small open economies, euro adoption benefits from reducing transaction cost and deeper trade and financial integration most likely outweigh potential risks of misalignments.

In sum, in the case of Estonia adopting euro means incurring relatively minor costs while reaping major benefits. The fact that even under the difficult circumstances of the global crisis, Estonia had enough determination to adopt the challenging measures to meet the Maastricht criteria in a sustainable manner and simultaneously had an understanding electorate only strengthens its case for euro adoption. However, given the lack of synchronization with the EMU, the effective fiscal policy and flexibility of the product and the labor markets in Estonia are key for sustainability of its participation in the euro area, just as they have been essential for sustainability of the currency board. To raise the stabilizing role of fiscal policy and reduce output volatility, it is important that the country moves over the medium term to counter-cyclical stance.

4. Conclusions

When Estonia joined the European Union in 2004, it agreed to replace its national currency by the euro at some future point. In reality, euro adoption has been Estonia's long-term policy priority. With the currency board in place and the kroon pegged to the euro, the country already paid most of the cost of joining the EMU in terms of loss of independence of monetary policy. The economy has functioned well under this regime for a number of years, including during crises, and the role of the exchange rate has been replaced by flexible prices and wages and other adjustment mechanisms, such as flexible product markets. With the global financial and economic crisis posing a heavy burden on the economy, joining the EMU has become even more interesting for Estonia, especially since most of the costs have been already incurred. As the crisis illustrated, the currency board is not a substitute for the euro, adoption of which would

[27] The crisis has brought up a number of issues for EMU members. As Dambrowski (2009) writes "…One of the key questions which the core euro zone members must answer is whether offering a fast-track EMU accession opportunity to countries that remain outside the common currency area (which could help revive market confidence and incentivize them to adjust policies) is a better solution than allowing them to continue sinking into market turmoil."

protect the country from possible speculative attacks and financial destabilization. Moreover, as euro adoption would put liquidity management under the umbrella of the ECB, it would be particularly beneficial for new EU countries with a high share of foreign currency loans, such as Estonia.

Given the limited, albeit increasing, synchronization of Estonia's business cycles with those of the EMU, for sustainability of the regime Estonian policymakers would need to continue to rely on adjustment mechanisms such as prudent fiscal policy and flexible labor and product markets. Moreover, in the past Estonia's fiscal policies have amplified the cycle, especially since mid-2000s. In 2009 in particular, the tightening measures adopted were implemented despite the GDP collapse, but paid off with meeting the Maastricht fiscal criterion. To reduce output volatility in the future, the government aims at moving to balancing the budget over the cycle in the medium term. Policies stimulating rise in the knowledge and high-tech content of Estonia's production to make it more akin to that of the advanced EMU economies would be also beneficial.

Annex I

Estimations were carried out using Eviews version 6 and Stata version 10.1 for time period from 1997 Q2 to 2008 Q3, 46 observations. Data sources were Eurostat, OECD National Accounts and Statistics Estonia databases. The euro area used was the 15 members as at December 2008, namely Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovenia and Spain. First differences of the natural logarithms of level of the real GDP and its deflator were stationary for all countries or regions. Results of the stationarity tests (ADF, KPSS) are in Table 1A. Output was measured by quarterly, seasonally adjusted, real GDP, while the price level by the quarterly, seasonally adjusted, GDP deflator.

Table 1A. Stationarity tests (ADF, KPSS) /1

	First observation in levels of GDP data	**Number of observations**	**ADF**	**p values (ADF)**	**KPSS**
Real GDP (first difference of ln)					
euro area	1995Q1	54	-3.9455	0.0034	0.1399
Estonia	1995Q1	54	-4.0627	0.0024	0.1097
Finland	1995Q1	54	-2.9862	0.0428	0.2986
Finland-Sweden	1995Q1	54	-2.2405	0.1951	0.1436
Scandinavia-Baltic	1995Q1	54	-7.5597	0.0000	0.2038
OECD	1996Q1	50	-2.9911	0.0427	0.2312
GDP deflator (first difference of ln)					
euro area	1995Q1	54	-5.0600	0.0001	0.1699
Estonia	1995Q1	54	-3.8343	0.0047	0.3555
Finland	1995Q1	54	-5.3835	0.0000	0.1014

Source: Authors' calculations. 1/ Applies for VAR models described by (1) and (2)-(4). For the ADF test, bold indicates stationarity at 5% level of confidence (p values of 0.05). For the KPSS, bold indicates acceptance of the null hypothesis of stationarity.

Information criterion (Akaike, Schwarz, and Hannon-Quinn) was used to choose the lag length. The Lagrange Multiplier (LM) test indicated that the residuals at 1st and 4th lags are not serially correlated at the 5% significance level. The Jarque-Bera test suggests that most data are from a normal distribution.[28]

[28] Further information on all data sources as well as results of all tests can be found at www.oecd.org/dataoecd/48/43/43886057.xls , Tables A1- A5.

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