Croatian Equity Market in Perspective of European Integration

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1. Introduction

In recent years Croatian equity market has had a terrific performance. CROBEX, the Zagreb Stock Exchange index, has risen by 70 percent (measured in US dollar terms) from the beginning of 1998 to the end of 2004. Except that, in this period equity market capitalization and turnover has also risen significantly. This performance is comparable with that of countries that joined European Union in 2004. Amazing thing is that Croatian accession to the EU is still not completely certain and negotiations only started in the October of 2005. Probably the part of the reason is that financial industry in Croatia developed significantly in this period as well. The question is whether this performance was kind of learning behaviour, that was caused by observed price rise in former accession countries and ameliorated by development of financial industry. In that case, it may be that prices have achieved their fair value and that future price rise is unlikely.

Most of the literature that explores phenomena similar to this one (either on European Union or international level) finds that because of diminished (usually) political or currency risks, markets become more integrated. This improved market integration leads to repricing effects. This means that (in this case) stocks are not priced anymore according to local, but according to international market risk.

The goal of this paper is to find out, in context of European integration, how much Croatian equity market is integrated and how much it is subject to global influences as well as what most likely future developments are.

The rest of the paper is organised as follows. Chapter 2 reviews some of the most important papers on financial market integration, Chapter 3 deals with equity market in Croatia, while Chapter 4 conducts econometric analysis of equity market integration. Chapter 5 is oriented to future developments and last Chapter concludes.

2. Literature review on equity market integration

We can divide literature with respect to the cause of market integration. The euro has brought about papers that deal with financial market integration as a result of common currency. But before that, a lot of work has been done with integration of financial markets in the world. Here are presented some of those papers. As this paper deals with equity markets, the weight in this short review is on equity market integration.

Adjaoute and Danthine (2003) explore integration of European equity markets after the euro was introduced. They use three types of indicators in order to assess degree of equity market integration. First they find that after the introduction of euro there is an increase in European cross border equity holdings and also in the number of funds that pursue some sort of wide European strategy. Second, authors argue that in recent years proportion of return variance that can be explained by sectors has increased. In contrast to that, not so long ago country effects dominated sector effects, i.e. the proportion of variance that could be explained by country differences was higher than proportion of variance that could be explained by differences among sectors. But, as authors argue, the importance and value of this indicator should be treated with caution. The problem is that in the last decade similar results can be obtained for all markets, not only European. Also, when used on historical series, this type of indicator shows increased integration in the past (in second part of 1970s), so this recent findings could just be consequence of the state of the world markets. Third, authors use mean variance type portfolio analysis where inputs are sector and country indices. They show that portfolios based on sectors as input units outperform those based on countries as input units – they use Sharpe's alpha risk return ratio as an indicator of performance. These results also confirm increased integration of the euro area countries.

Similar methodology is used in ECB (2005). Authors find decrease in difference of dispersion of country and sector returns in the euro area. In recent years sector return dispersion is a bit higher, which could lead to better performance when choosing to diversify among sectors not countries, and thus corroborate Adjaoute and Danthine

(2003) results. But as it is noted in ECB (2005), we should be cautious with these results because in recent years (from 2000 on) there was a fall in country and sector dispersion. Except this, another method was used in ECB (2005): measure of shock spillover intensity between the euro area and the US was estimated. The idea is to measure the impact of the euro area and the US shocks on individual markets in the euro zone. The results show that, comparing to period from 1973 to 1985, the euro area shocks have become more important in the later periods. But, impact of the US shocks has diminished. However, it should be also noted that the biggest increase in importance of the euro area shocks has happened from period 1973-85 to 1986-91 and although there was steady rise in the degree of integration, there was no sudden jump since the introduction of euro.

Accession countries that joined EU in 2004 had a big increase in values of their stock indices. There are not a lot of papers about this phenomenon. Dvorak and Podpiera (2005) claim that price increase of equities in the EU accession countries, that happened after accession was certain, has been caused by increased market integration. The idea is that markets in accession countries were segmented and firms were priced with respect to local market, i.e. their betas were calculated on the basis of covariance with local market. Opposite to that, after increased integration with world capital markets, relevant benchmark was no longer local market, but the world market. Change of benchmark causes repricing effects. Authors argue that this integration was a result of the EU accession. That is, once the EU accession was certain, political, liquidity or corporate governance risk may have been alleviated. With empirical analysis of stock market data for 8 accession countries and 3 more transition economies as a control group authors found that this effect (change in betas) explains 22 percent of the price increase.

Adam, Jappelli, Menichini, Padula and Pagano (2002) use various indicators in order to assess evolution of capital market integration within European Union. For equity markets they use correlation of stock market returns and some quantity based indicators like holdings of European assets by investment and pension funds and insurance companies. As for the correlations, they find that there is increase in correlation of returns from 1997

to 1999, but after 1999 correlation is falling. They don't put much weight on that indicator given the instability of indicator and dubious economic interpretation of the correlation of ex post returns.

Research has also been done on determining the degree of integration of emerging markets with global markets. Some authors have found the evidence of time varying world market integration. Among the first works in this area was one by Bekaert and Harvey (1995) who devised a model where world market integration is time varying. They find that a number of emerging markets exhibit time varying integration. When explaining possible reasons behind time varying integration of world markets, Bekaert and Harvey (1995) use political crises, imposition of restrictions on capital flows and size of the market.

Carrieri, Errunza and Hogan (2005) who use methodology similar to Bekaert and Harvey (1995) find substantial cross market differences in the degree of integration on the sample of 8 emerging markets in the period from 1977 to 2000. They also find a general trend towards more integration, especially in the nineties, but there are also some reversals.

Portes and Rey (2005) explore determinants of cross-border equity flows. They find that gravity model explains international transactions in financial assets. Transaction flows depend on the market size in source and destination country and trading costs. By trading costs they mean both the transaction costs and information gathering costs – asymmetry of information between domestic in foreign investors.

3. Equity market in Croatia

In Croatia, there are currently two stock exchange markets in operation; those are Zagreb and Varaždin stock exchanges. Zagreb Stock Exchange (ZSE) was founded in 1991 to continue the tradition of Zagreb Exchange for Goods and Valuables that operated from 1918 to 1946. Varaždin Stock Exchange (VSE) was founded in 1993 as an OTC market

in order to facilitate trading of newly privatized companies' shares. In 2002 Varaždin market was transformed into Varaždin Stock Exchange. Modern trading in Croatia started in 1997 when first electronically operated trading systems were introduced and first indices started being calculated.

Croatian equity market is still very small in terms of GDP and market capitalization compared to other markets in the world and Europe. Following figures (Figure 1 and Figure 2) illustrates this.

Figure 1 European Markets Market Capitalization as of 30.12.2005

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World Market Cap Page 1/ 4

	Current (Mil USD)	1 Month % Change	YTD % Change	Pct Of World	Pct Of GDP
Europe					
1) United Kingdom	3053394 12/30	3.60%	10.83%	7.46%	129.16%
2) France	1860920 12/30	4.75%	12.83%	4.55%	80.60%
3) Germany	1285699 12/30	4.14%	4.75%	3.14%	44.56%
4) Switzerland	797157 12/30	3.64%	12.12%	1.95%	198.62%
5) Italy	812144 12/30	4.74%	1.75%	1.98%	47.51%
6) Spain	669587 12/30	1.39%	3.53%	1.64%	62.11%
7) Netherlands	341784 12/30	5.39%	-16.41%	.84%	67.30%
8) Sweden	418993 12/30	8.37%	8.13%	1.02%	111.69%
9) Russia	544621 12/30	8.90%	110.53%	1.33%	44.47%
10) Finland	213485 12/30	6.82%	15.47%	.52%	99.32%
11) Belgium	283199 12/30	3.39%	2.11%	.69%	78.73%
12) Denmark	184018 12/30	7.53%	16.57%	.45%	65.31%
13) Greece	141760 12/30	7.69%	16.84%	.35%	59.04%
14) Norway	202260 12/30	5.87%	35.86%	.49%	59.36%
15) Ireland	106665 12/30	7.90%	2.80%	.26%	56.18%
16) Austria	140609 12/30	4.27%	36.29%	.34%	35.01%
17) Turkey	161344 12/30	4.79%	63.99%	.39%	32.52%
18) Portugal	71396 12/30	4.68%	-3.65%	.17%	44.12%
19) Poland	95419 12/30	8.50%	35.28%	.23%	29.12%

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Source: Bloomberg

Figure 2 European Markets Marked Capitalization as of 30.12.2005, part 2

Source: Bloomberg

In terms of size, ZSE is bigger than VSE, as following table shows. Also in the table we can see that Croatian equity market has expanded significantly in the last couple of years.

Table 1 Market capitalization and turnover for Zagreb and Varaždin Stock Exchange from 1999 to 2004

	market capitalization (EUR million)		turnover (EUR million)	
year	ZSE	VSE	ZSE	VSE
2004	8.047,5	5.441,2	341,5	170,2
2003	4.855,6	3.055,3	195,5	82,5
2002	3.805,3	2.097,3	157,4	173,3
2001	3.502,8	1.943,4	131,4	128,9
2000	2.918,9	894,2	201,3	55,2
1999	2.503,6	1.008,9	68,7	58,3

Source: ZSE and VSE yearly reports
Notes: end of period data; market capitalization and turnover refers only to equities trading

Nowadays almost all stock trading is done electronically. Clearing and settlement is done by Central Depositary Agency (Središnja Depozitarna Agencija, SDA), where all traded share certificates data are held. Settlement date is T+3, that is, 3 working days after the trade date.

There are no derivative contracts traded on the exchange. Securities borrowing / lending is possible, but there are no common providers, so it is done on bilateral basis and depends on availability. Short selling can be done, but one first must borrow securities and then sell them. Borrowing / lending is not available to ordinary investors, even among institutional investors only few can do it in practice.

Foreign citizens are in general allowed to buy and sell Croatian equities. Croatian National Bank issued a regulatory note that required foreign nationals to hold shares for at least one year after purchase date. This note was probably devised in order to limit the possibility of capital flight. However, as Croatia already signed bilateral treaties for protection of investments with the large number of countries, and according to those treaty limits this kind of limits on capital mobility are not allowed, this note has had limited impact. Croatian nationals and permanent residents are allowed to trade foreign equity and investment funds. Legal entities can trade via foreign brokers but private persons must trade via domestic brokers. Only one share (PLIVA) is also listed abroad, at the London Stock Exchange as GDR.

A potentially important factor in this paper is also exchange rate. Croatian equity prices are in Croatian Kuna (HRK). Kuna has maintained a band around Deutsche Mark and latter on around the euro. In practice, Croatian National Bank (Central Bank of Croatia) intervenes now and then to keep the exchange rate inside a desired band so there are no large swings of the exchange rate.

In terms of supervision, financial services industry, securities dealing and trading are regulated by three bodies. All foreign transactions are under supervision of Croatian National Bank. Croatian Securities Commission monitors trading, supervises financial

institutions (brokerages and investment funds) and issues licenses for securities trading and investment advisory. Agency for Supervision of Pension Funds and Insurance monitors pension funds and insurances. As of 1.1.2006 these last two supervision agencies were joined together and new agency – Croatian Agency for Supervision of Financial Services is founded as their legal adherent.

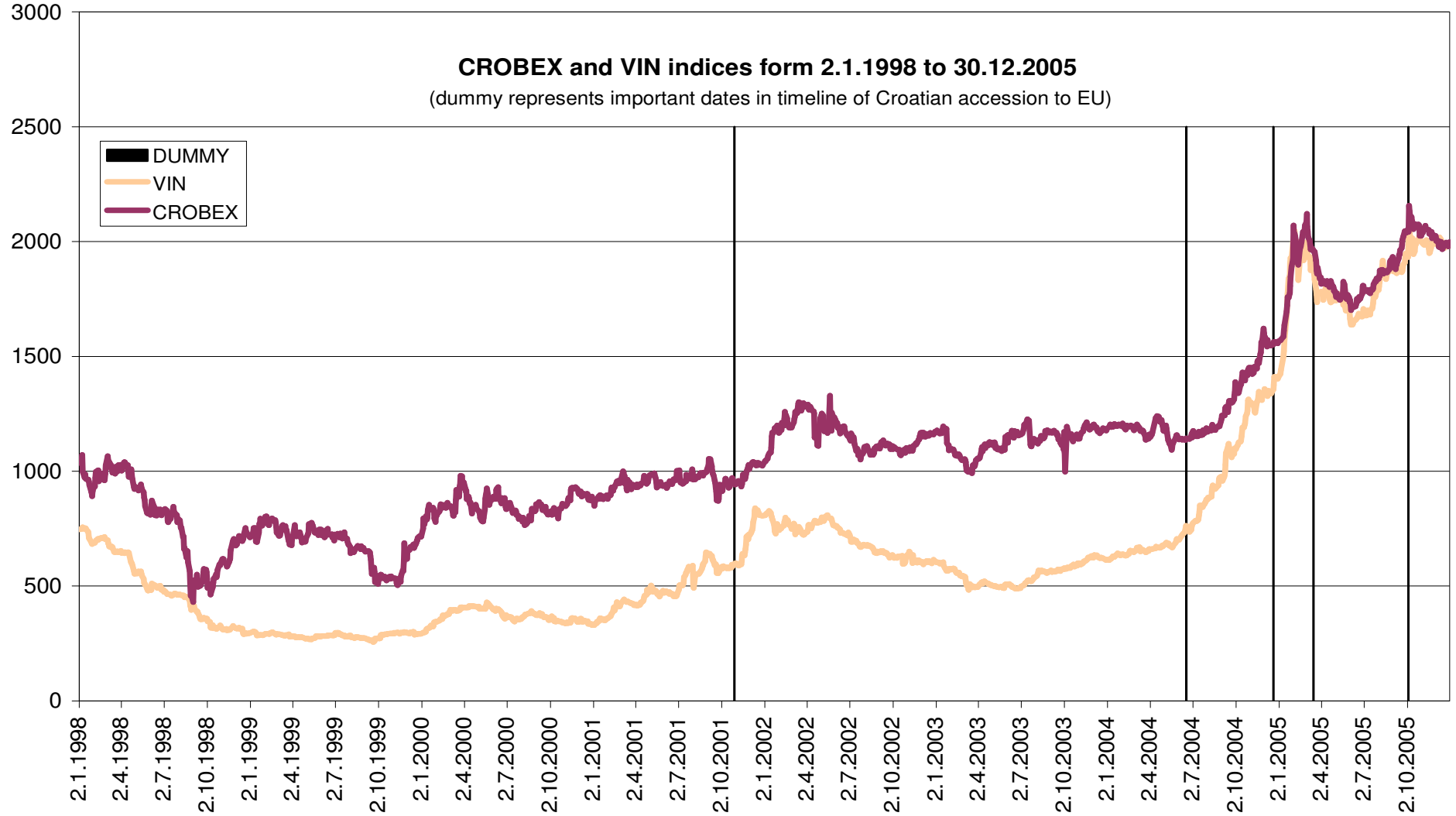
Generally we can say that the laws that regulate equity trading / investment in Croatia are similar to European and that there are no important differences, except above stated rule which prohibits sale of equities for certain foreign nationals within one year. Much more limits for foreign nationals are introduced for short term capital, but this is not a topic of our discussion.

As for the tax side of the story, gains from equity trading made by private individuals are not taxed in Croatia. Gains from trading made by companies are taxed at rate of corporate tax.

Figure 3 shows performance of VIN and CROBEX indices from 2.1.1998 to 30.12.2005. As we can see, both indices doubled in value from the beginning of 1998 to the end of 2005.

Performance of Croatian indices in the period from the beginning of the 1999 to the beginning of 2004 is comparable to that of accession countries that entered EU in the 2004. As shown by Dvorak and Podpiera (2005), dollar values of stock market indices in those countries increased roughly by 20 to 400 percent in this period. In the same period Croatian markets rose by 70 percent (ZSE) and 110 percent (VSE) in dollar values. If we move the start of our observation to the announcement of the accession date, markets in the accession countries increased even more. Picture for Croatian market in that period is pretty much the same, as there was virtually no growth in value of indices from the beginning of 1998 to the end of 2001.

Figure 3 CROBEX and VIN from 2.1.1998 to 30.12.2005



Source: Bloomberg and www.vse.hr

At least in terms of publicity, the most important events for the development of Croatian equity market in last couple of years were new law on securities markets and European accession process. But except that, Croatia has seen drastic development of financial sector in general.

The new law on securities market brought about obligatory listing on one of the stock exchanges in Croatia all companies with more than 100 shareholders and 30 million HRK (approximately 4 million EUR) in share capital. Except that, companies were obliged to deliver reports on a regular basis (quarterly and one final once every year). These rules were introduced in order to protect small shareholders and the above mentioned companies were required to list their shares on July 11th 2003 at the latest. Before the introduction of this law, some of the companies whose shares were traded in the past (usually after the privatization) had been delisted or even had limited trade in their shares. Common reason was to preserve control of major shareholders and / or management. It seems that the new law has had positive impact on markets, because after the introduction, some of the most traded companies nowadays have been listed. For example, in 2004 on ZSE, Adris group share, which was listed after the introduction of the law had 24.3 percent share in total turnover on that market and was single most traded share in that market. Similarly, on VSE, Ericsson Nikola Tesla, that was relisted after the introduction of the new securities trading law had turnover of 20.2 percent of total market turnover in 2004.

Important development in Croatia in the last couple of years was also emergence of investment funds as important players on the domestic market. Following table shows funds total assets. Unfortunately, there is no subdivision between investments in equity and other instruments. Also, subdivision between domestic and foreign assets would be interesting, however it is not available.

Table 2 Total assets of investment funs in Croatia from 31.12.1999 to 30.11.2005

	31.12.99	31.12.00	31.12.01	31.12.02	31.12.03	31.12.04	30.11.05
Total assets (EUR million)	3.1	22.2	177.2	330.9	384.7	590.2	1,173.2
Period to period change		612.41	697.90	86.66	16.25	53.42	98.78

Source: Croatian Securities Commission register

Pensions system in Croatia was also changed in this period. Government managed pay as you go system was scraped and new system based on combination of obligatory but private managed pension funds and one government fund was set in place. This change created new players on the market. Although most of the investment of pension funds at this point of time is in government bonds (around 66 percent on November 30th 2005) investments in domestic equity are also present. On November 30th 2005 pension funds invested 2.6 percent of their assets in domestic equity. This equals around 300 million HRK or 40 million EUR. Because first significant payouts from pension funds are not expected in at least 10 years from now, but cash inflows are constant, pension funds could become more important players on domestic equity market.

However, except the developments in domestic market, process of integration into the European Union must have had some effects on Croatian equity market. Here is the timeline of Croatian European integration:

- 29.10.2001 Accession and Stabilization Agreement
- 21.2.2003 Initial application and submittal of the answers to the questionnaire
- 20.4.2004 European Commission replies with positive opinion
- 18.6.2004 European Council – Croatia is official candidate
- 20.12.2004 European Council – entry negotiations begin on 17.3.2005
- 16.3.2005 negotiations postponed
- 3/4.10.2005 the beginning of negotiations

On the Figure 3 we can see, by pure visual inspection, that EU accession has had some influence on Croatian equity markets. It seems that the bull run that started in the summer of 2004 can be attributed to the accession process as it started after the announcement that Croatia became the official candidate for EU accession. The bull run continued by even stronger pace after the date for beginning of negotiations was set. The bull run suddenly ended and bears came into show as it was obvious that negotiations are going to be postponed. Final start of negotiations was followed by momentary significant increase in both indices.

Following table shows Croatian international investment position for equity portfolio investment. Both Croatian investments abroad, but also investments of foreign nationals in Croatia increased significantly in observed period. The table implies that Croatia has become more integrated with the world in terms of equity ownership in the observed period. The biggest increase in foreign investments to Croatia was between the end of 2003 and the end of 2004. As it was shown, in that period most of events important for accession to the EU took place.

Table 3 International Investment Position – Portfolio Investment, end of period data (EUR million)

	1998	1999	2000	2001	2002	2003	2004	3Q of 2005
Foreign investments into Croatian stocks and business shares	74.6	127.7	116.8	164.8	173.6	172.3	283.4	331.7
Croatian investment into foreign stocks and business shares	25.4	25.9	15.3	25.5	39.3	40.6	39.8	43.8

Source: Croatian National Bank
Note: Data for 3Q of 2005 are preliminary

4. Equity market integration

The evidence presented above is descriptive. In order to complement it, VAR analysis is used, which will help us to investigate how Croatian equity market reacts to shocks originating in developed European and world markets. In this way we will be able to see whether Croatian equity market is influenced by the European and world equity markets.

First we made the analysis using daily data and then using weekly data. The data used are differences in logarithms of respective indices on a daily and weekly basis in the period from September 2nd1997 to January 2nd 2006. Indices included are Dow Jones Industrial Average (DJIA) - the New York Stock Exchange major index, FTSE (London Stock Exchange index), DAX, (Frankfurt Stock Exchange major index), SBI (Ljubljana Stock Exchange index), BUX (Budapest stock index) and CROBEX (Zagreb Stock Exchange index). Our analysis includes quite simple tests and it has its flaws, but is a good starting point to get the picture about equity market integration. If markets are integrated, a shock originating in one market should be transmitted to the other markets.

4.1 Analysis using daily data

With daily returns, we used indices that were not converted to common currency. The reason is that if markets are integrated, shocks on a daily basis are going to be transmitted to another market no matter the currency denomination of another index. The idea is, if markets are integrated and if for what ever reason equity becomes more desirable investment on a world scale, it is not going to be influenced by a foreign exchange rate change on a daily basis. Except that, in our sample, changes in the exchange rate of selected currencies were not that large on a day to day basis.

Before the start, we note that the possible problem with tests performed in this paper is composition of indices. It is possible that one index has more, for example, telecommunication sector shares and other, for example, has more utilities. Although in

the case described above the transmitting of shocks will not be perfect, as long as indices have representatives of common industries as their constituents, there should be some response. Nevertheless, effects of general shocks should be visible, as shocks that affect equity as an asset class are going to be felt in all markets, if markets are integrated. Hence, test will be informative.

In order to estimate VAR, we conducted lag length analysis. Table 4 shows lag selection criteria. There are five criteria used in the analysis of determining lag length. Asterisk indicates lag order selected by the criterion. As it is noticeable from Table 4, not all results show the same estimated lag length. Final prediction error and Akaike information criterion suggest 3 lags, Schwarz information criterion and Hannan-Quinn information criterion suggest 1 lag, while likelihood ratio test statistics suggests 8 lags. Schwarz information criterion is usually smaller than others, because it imposes larger penalty for additional coefficients (Brooks, 2002 and EViews user guide, 2004). Beside that, Akaike information criterion is one of the most used in the research. For that reason lag length of 3 is used in further VAR analysis. Next table (Table 5) shows VAR estimates and those estimates are used in supplementary VAR analysis. Table 6, which shows test for residual autocorrelations, indicates that there are no correlations among residuals, so in that sense model is correctly specified.

From the impulse responses (Figure 4) we can observe that there is some connection in terms of shocks between major world markets, but the US equity market, as measured by DJIA has central position in the world. Shocks originating in the US are transmitted to Europe (measured by FTSE and DAX), while shocks originating in Europe are not transmitted to US[1].

Impulse response functions also imply that Croatian equity market seems to be pretty much isolated from the rest of the world markets as represented by selected indices.

[1] As Cholesky decomposition is used in computation of impulse responses, ordering of variables may be important. Because of that, impulse response functions were also constructed with different variable ordering but major results did not change. Only change was that with different ordering DAX had some influence on DJIA, as shown in Figure 5.

There is some small response to DJIA, but this is still small in absolute terms. In order to test whether this relationship changes after Croatian accession to the EU officially started, shorter subsample (from June 18th 2004 – the day when Croatia become official candidate) was also used, but there was no change in the result.

These results are also confirmed by variance decomposition (see Figure 7) – almost none of the variance in CROBEX is explained by variance of other indices. It seems that, at least for now, Croatian integration into the EU does not make equity markets in Croatia integrated in a way that they would respond to common world shocks daily on a more significant level, but as Granger causality test shows (Table 7), lags of changes in the world markets are significant for explaining current changes in CROBEX. This means that there exists a correlation between the past values of world market indices and current value of CROBEX. Possible explanation of these results would be that Croatian market is still isolated from the world market but, important changes are also translated to Croatian market.

The question is will this change when Croatia enters the EU. For that reason, we included Slovenian equity market index in our analysis. Slovenian market is quite interesting example for comparison as it is also small like Croatian (Slovenian market is 0.2 percent of the world market cap and Croatian market is 0.3 percent and the share of market cap in GDP is almost the same), countries share the same history (both were part of Yugoslavia before) and Slovenia is member of the EU now. Results of the impulse responses for Slovenia are like Croatian one. This implies that sole EU accession will not increase market integration per se. But, this does not mean that we can claim that there will be no integration with world market for Croatia in the future. If we substitute Slovenian market with Hungarian one (Hungarian market is much bigger than Slovenian – see Figure 2) and then construct impulse responses, we will find that its responses to world market shocks are greater in the absolute sense (Figure 6). This test also in a way confirms results of Portes and Rey (2005), who claim that market size is also important for cross border transactions.

4.2 Analysis using weekly data

In the analysis of weekly data, we used stock exchange indices in US dollars. Even though we used more European indices, since the euro was introduced only in 1999, we could not obtain the data on euro value of the indices before that period.

Starting point in the analysis of weekly data was also determining lag length which will be used in further VAR analysis. As Table 8 shows, three out of five criteria suggest using lag length of 3. Hence, VAR was constructed with lag length of 3 (Table 9). As for the daily data, test for residual autocorrelations with weekly data indicates no correlation among residuals (Table 10).

We used weekly data in order to try to capture major shocks, which have the influence on different markets and not only small ones. However, we did not find any major difference between results on impulse response functions on a daily and weekly data (Figures 8, 9 and 10). CROBEX did not show any response with change of frequency of data, which confirms that Croatian equity market is quite isolated from the rest of the world.

On the other hand, results on variance decomposition using weekly data (Figure 11) suggest that percentage variance from FTSE and especially DAX that can be explained with variance from DJIA is much higher with weekly data than with daily data. This confirms that not all shocks can be transmitted immediately on other markets, but that time factor can also be important. This would also suggest that the developed equity markets, even though they are highly integrated, are not perfectly integrated.

Granger causality test (Table 11) with 5 percent rejection level suggests that FTSE does Granger causes DJIA[2] and, what is more important for this analysis that DAX and FTSE do Granger cause CROBEX, which indicates that changes of past values of major European indices are significant for explaining current changes in CROBEX when weekly data are examined. There is another interesting observation regarding CROBEX

[2] In Granger causality test with daily data, those indices showed endogeniety problem.

and that is that CROBEX does Granger cause SBI, which could be explained with the fact that there are many Slovenian investor in Croatia or it could mean CROBEX and SBI are influenced together by some other index.

5. The future

The Corporation of London (2003) devised study under the name The Future of Stock Exchange in European Union Accession Countries. The study concludes that generally speaking, with few possible exceptions, stock exchanges in accession countries are too small to live on their own. The key, it seems, is in cross border mergers of stock exchanges. This would have positive effects for investors (better risk sharing) and listed companies as well (more capital accessible).

Croatian market is very small at this point of time and jet segmented in two markets – Zagreb and Varaždin. On its own, its future is uncertain. Although some initiatives are under way (some talks about some way of integration with Vienna Stock Exchange and regional exchanges in former Yugoslavia are under way) it is still a long way to go. Government is planning to privatize few big state owned companies by IPO and to list them immediately on domestic and foreign stock exchanges. Moves like this would definitely make Croatian market bigger and more integrated with world markets, but the future would still remain uncertain.

6. Conclusion

In this paper developments in the equity market in Croatia were presented in perspective of European integration. As it was shown, European integration has had some impact on Croatian market, but also development of domestic financial industry and regulation was important. Most probable conclusion is that development of domestic financial industry brought in large amount of savings and European integration decreased risk of domestic shares and made them interesting investment opportunities. Very large shifts in equity returns that were obviously connected with the delay in the start of accession negotiations signalize that EU integration is important. In that sense, future political shocks on the road to European integration will obviously be important, but now, the fine details (details in negotiation process for various industries) will also matter. The EU integration development were / are important for Croatian equity market probably because some of the players expect similar performance of Croatian stock market to the performance of accession countries. As for the finer measure of financial integration – transfer of shocks between markets, it seems Croatia is still pretty much isolated from the world, as shown by VAR analysis. In the future, this type of integration will depend on development of the market in terms of size and international integration.

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Appendix

Variable definitions:

indu – Dow Jones Industrial Average, New York Stock Exchange Index

ukx – FTSE 100, London Stock Exchange Index

dax – DAX, Frankfurt Stock Exchange Index

bux – BUX, Budapest Stock Exchange Index

sbi – SBI, Ljubljana Stock Exchange Index

cro – CROBEX, Zagreb Stock Exchange Index

Table 4 Results of VAR lag order selection tests – daily data

VAR Lag Order Selection Criteria
Endogenous variables: INDU UKX DAX SBI CRO
Exogenous variables: C
Date: 10/01/06 Time: 08:11
Sample: 2/09/1997 2/01/2006
Included observations: 2147

Lag	LR	FPE	AIC	SC	HQ
0	NA	4.18e-20	-30.43256	-30.41935	-30.42772
1	598.5428	3.23e-20	-30.68883	-30.60958*	-30.65983*
2	78.35602	3.19e-20	-30.70222	-30.55693	-30.64907
3	99.14759	3.12e-20*	-30.72546*	-30.51412	-30.64814
4	36.97841	3.14e-20	-30.71957	-30.44218	-30.61808
5	40.46896	3.15e-20	-30.71536	-30.37193	-30.58971
6	39.17488	3.16e-20	-30.71058	-30.30111	-30.56077
7	30.44930	3.19e-20	-30.70172	-30.22621	-30.52775
8	44.05200*	3.20e-20	-30.69935	-30.15779	-30.50121

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Authors' calculation

Table 5 VAR parameter estimates – daily data

Vector Autoregression Estimates
Standard errors in ( ) & t-statistics in [ ]

	INDU	UKX	DAX	SBI	CRO
INDU(-1)	-0.052206	0.384654	0.345842	0.044932	0.238788
	(0.04018)	(0.03993)	(0.05722)	(0.02138)	(0.07056)
	[-1.29914]	[9.63291]	[6.04458]	[2.10173]	[3.38403]
INDU(-2)	-0.074538	0.131056	0.111266	0.047348	0.130771
	(0.04301)	(0.04274)	(0.06123)	(0.02288)	(0.07552)
	[-1.73318]	[3.06669]	[1.81708]	[2.06943]	[1.73164]
INDU(-3)	0.022305	0.126374	0.165648	0.034931	0.013849
	(0.04230)	(0.04203)	(0.06023)	(0.02250)	(0.07428)
	[0.52732]	[3.00659]	[2.75044]	[1.55226]	[0.18645]
UKX(-1)	0.013310	-0.272730	-0.042707	0.022216	-0.074278
	(0.04906)	(0.04875)	(0.06985)	(0.02610)	(0.08615)
	[0.27131]	[-5.59456]	[-0.61141]	[0.85120]	[-0.86224]
UKX(-2)	-0.046220	-0.128015	-0.091270	-0.014330	0.118425
	(0.04975)	(0.04944)	(0.07084)	(0.02647)	(0.08736)
	[-0.92903]	[-2.58945]	[-1.28848]	[-0.54140]	[1.35558]
UKX(-3)	0.072930	-0.119351	-0.016569	-0.004967	0.116059
	(0.04773)	(0.04743)	(0.06796)	(0.02539)	(0.08382)
	[1.52788]	[-2.51628]	[-0.24379]	[-0.19559]	[1.38467]
DAX(-1)	0.012903	0.031378	-0.161933	-0.008916	0.026812
	(0.03704)	(0.03680)	(0.05273)	(0.01970)	(0.06504)
	[0.34837]	[0.85260]	[-3.07081]	[-0.45248]	[0.41227]
DAX(-2)	0.009347	-0.026284	-0.027630	0.013306	-0.084612
	(0.03766)	(0.03742)	(0.05362)	(0.02003)	(0.06612)
	[0.24823]	[-0.70244]	[-0.51533]	[0.66422]	[-1.27961]
DAX(-3)	-0.059118	-0.028971	-0.070168	0.008721	-0.008497
	(0.03747)	(0.03723)	(0.05335)	(0.01993)	(0.06580)
	[-1.57772]	[-0.77808]	[-1.31522]	[0.43750]	[-0.12913]
SBI(-1)	0.078669	0.055084	0.091460	0.267439	0.120893
	(0.06259)	(0.06219)	(0.08911)	(0.03330)	(0.10990)
	[1.25697]	[0.88571]	[1.02636]	[8.03209]	[1.10003]

SBI(-2)	-0.243515	-0.104988	-0.282777	-0.132473	-0.021242
	(0.06759)	(0.06716)	(0.09623)	(0.03596)	(0.11868)
	[-3.60288]	[-1.56319]	[-2.93845]	[-3.68414]	[-0.17898]
SBI(-3)	0.020736	-0.052077	0.055148	-0.042658	0.131096
	(0.06629)	(0.06587)	(0.09438)	(0.03526)	(0.11640)
	[0.31282]	[-0.79063]	[0.58432]	[-1.20965]	[1.12629]
CRO(-1)	0.028224	-0.011309	-0.005622	-0.005958	-0.271291
	(0.01882)	(0.01870)	(0.02679)	(0.01001)	(0.03305)
	[1.49976]	[-0.60473]	[-0.20982]	[-0.59509]	[-8.20954]
CRO(-2)	0.021667	-0.006682	0.024293	0.002530	-0.093477
	(0.01993)	(0.01981)	(0.02838)	(0.01060)	(0.03500)
	[1.08709]	[-0.33739]	[0.85604]	[0.23862]	[-2.67089]
CRO(-3)	0.025045	0.011004	0.022695	-0.001850	-0.091164
	(0.02217)	(0.02203)	(0.03156)	(0.01179)	(0.03892)
	[1.12994]	[0.49959]	[0.71912]	[-0.15686]	[-2.34226]
C	0.000228	-0.000208	-0.000319	0.000427	0.000183
	(0.00039)	(0.00039)	(0.00055)	(0.00021)	(0.00068)
	[0.58724]	[-0.53994]	[-0.57587]	[2.06491]	[0.26894]
R-squared	0.031554	0.137604	0.055175	0.104360	0.087480
Adj. R-squared	0.015967	0.123724	0.039968	0.089945	0.072793
Sum sq. resides	0.129907	0.128274	0.263351	0.036768	0.400559
S.E. equation	0.011806	0.011732	0.016810	0.006281	0.020731
F-statistic	2.024426	9.914005	3.628382	7.239777	5.956478
Log likelihood	2871.212	2877.212	2536.253	3469.497	2337.470
Akaike AIC	-6.023655	-6.036312	-5.316990	-7.285858	-4.897617
Schwarz SC	-5.941725	-5.954382	-5.235060	-7.203928	-4.815687
Mean dependent	0.000138	-8.88E-05	-0.000222	0.000467	0.000402
S.D. dependent	0.011902	0.012533	0.017156	0.006584	0.021530

Determinant resid covariance (dof adj.)	2.70E-20
Determinant resid covariance	2.48E-20
Log likelihood	14671.48
Akaike information criterion	-30.78372
Schwarz criterion	-30.37407

Source: Authors' calculation

Table 6 Test for residual autocorrelations – daily data

VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	4.559993	NA*	4.564809	NA*	NA*
2	9.885093	NA*	9.901166	NA*	NA*
3	15.20974	NA*	15.24272	NA*	NA*
4	30.12977	0.2195	30.22597	0.2159	25
5	52.37197	0.3821	52.58610	0.3742	50
6	73.63283	0.5230	73.98238	0.5115	75
7	88.14684	0.7956	88.60435	0.7855	100
8	119.3129	0.6266	120.0357	0.6087	125
9	135.0373	0.8039	135.9108	0.7886	150
10	155.6534	0.8506	156.7467	0.8354	175
11	172.3672	0.9218	173.6567	0.9109	200
12	189.5427	0.9588	191.0523	0.9512	225

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

Source: Authors' calculation

Table 7 Granger Causality tests – daily data

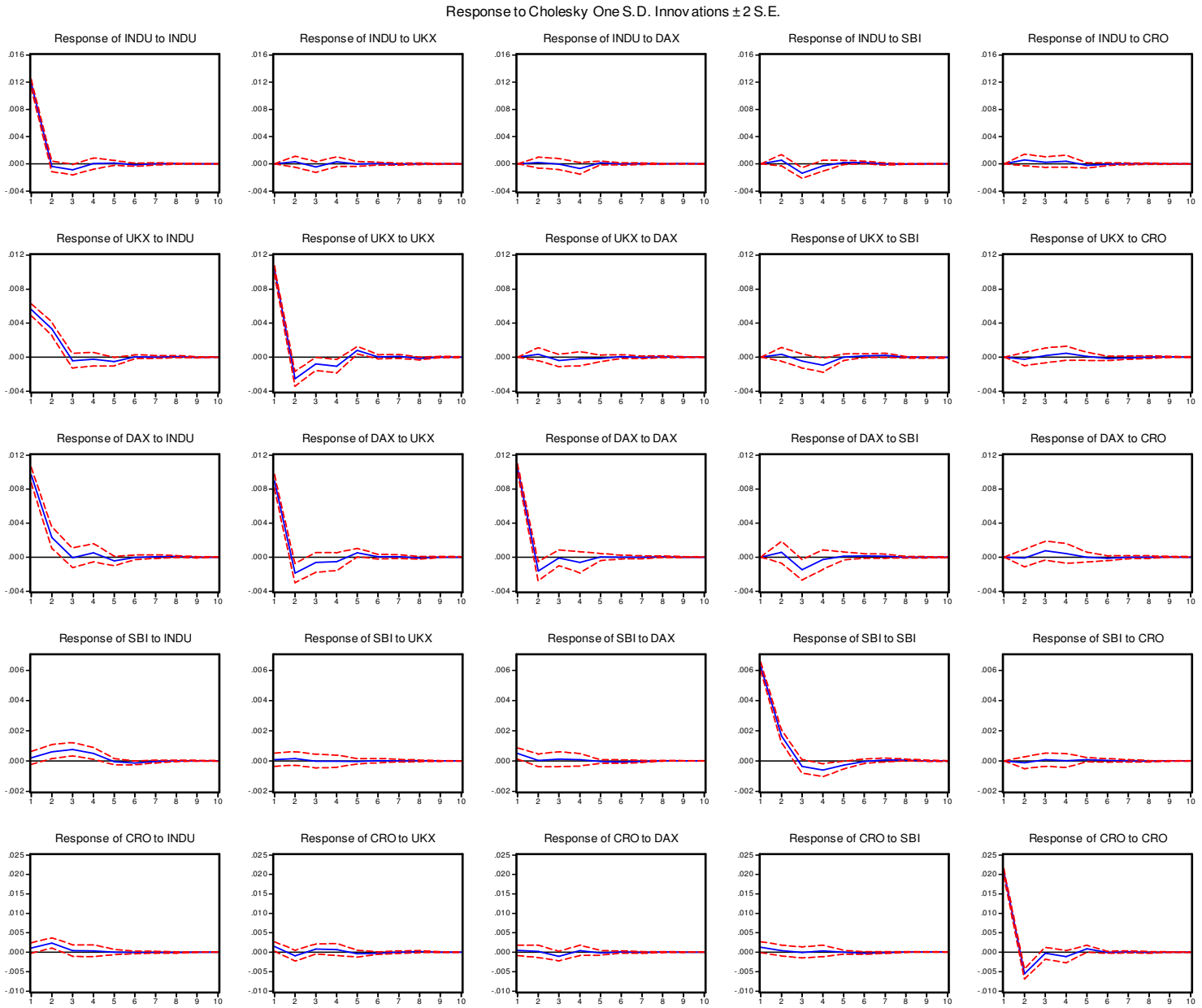
Pairwise Granger Causality Tests
Date: 10/01/06 Time: 17:43
Sample: 2/09/1997 2/01/2006
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Probability
DAX does not Granger Cause CRO	2152	5.85645	0.00056
CRO does not Granger Cause DAX		1.67129	0.17113
INDU does not Granger Cause CRO	2152	26.1000	1.4E-16
CRO does not Granger Cause INDU		2.31605	0.07388
SBI does not Granger Cause CRO	2152	1.68434	0.16830
CRO does not Granger Cause SBI		4.13680	0.00620

UKX does not Granger Cause CRO	2152	7.89026	3.1E-05
CRO does not Granger Cause UKX		0.47623	0.69885
INDU does not Granger Cause DAX	2152	49.2323	9.1E-31
DAX does not Granger Cause INDU		2.94463	0.03181
SBI does not Granger Cause DAX	2152	3.58236	0.01332
DAX does not Granger Cause SBI		7.18530	8.5E-05
UKX does not Granger Cause DAX	2152	1.22329	0.29967
DAX does not Granger Cause UKX		4.23614	0.00540
SBI does not Granger Cause INDU	2152	2.42908	0.06359
INDU does not Granger Cause SBI		22.0731	4.5E-14
UKX does not Granger Cause INDU	2152	2.73363	0.04230
INDU does not Granger Cause UKX		82.6395	1.4E-50
UKX does not Granger Cause SBI	2152	8.99415	6.4E-06
SBI does not Granger Cause UKX		4.54699	0.00350

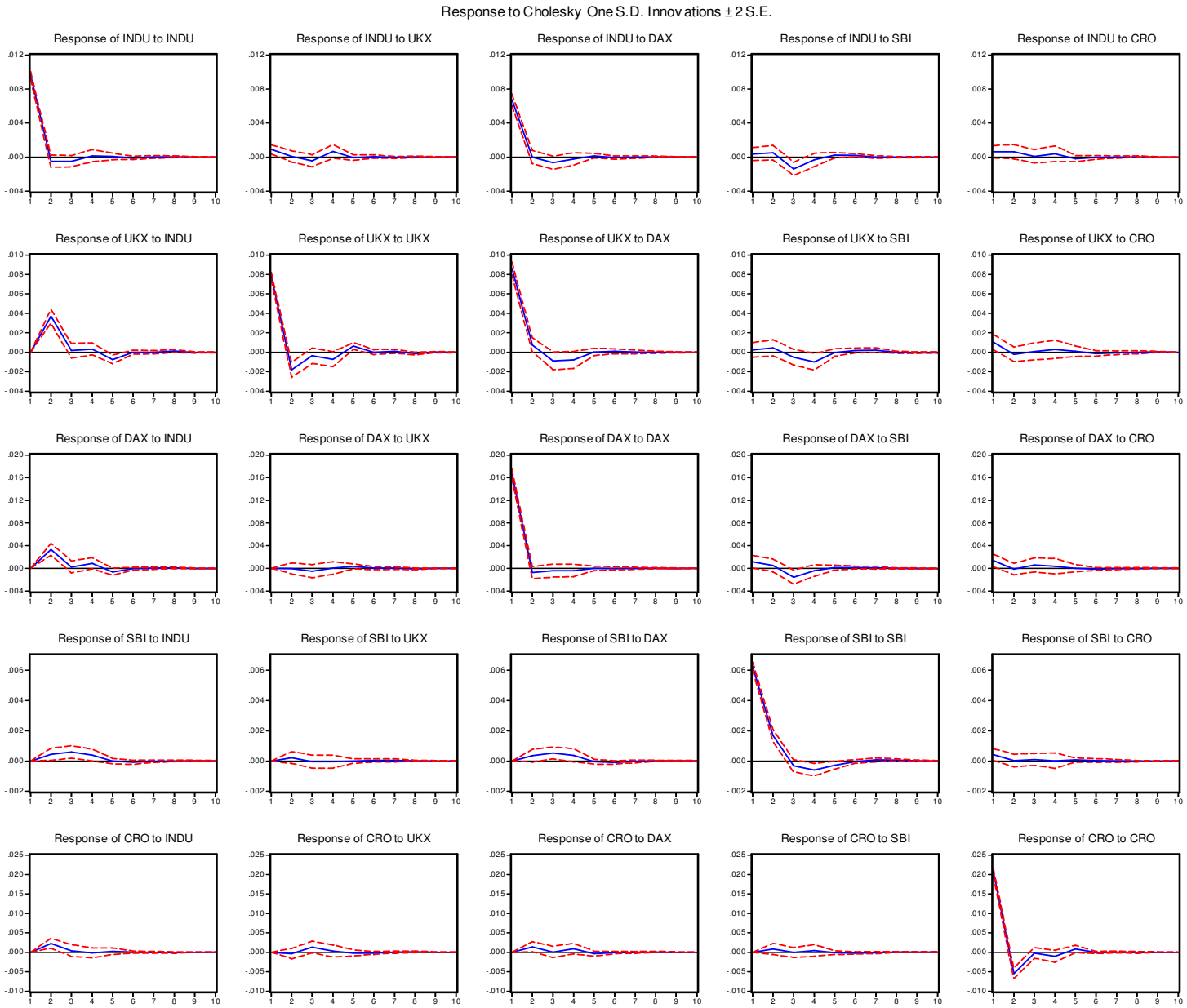
Source: Authors' calculation

Figure 4 Impulse response functions (ordering: indu, ukx, dax, sbi, cro) – daily data



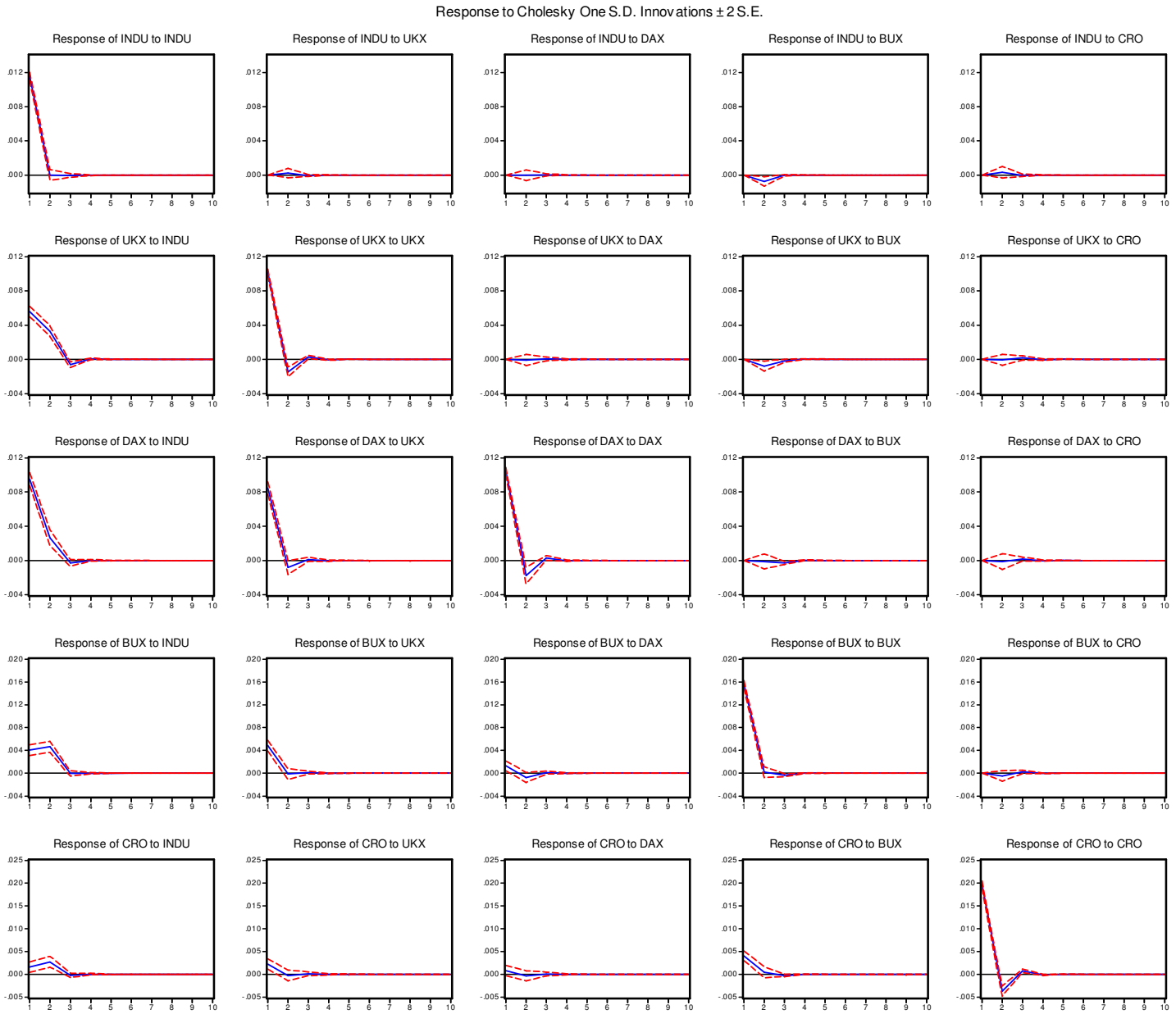
Source: Authors' calculation

Figure 5 Impulse response functions (ordering: cro, sbi, dax, ukx, indu) – daily data



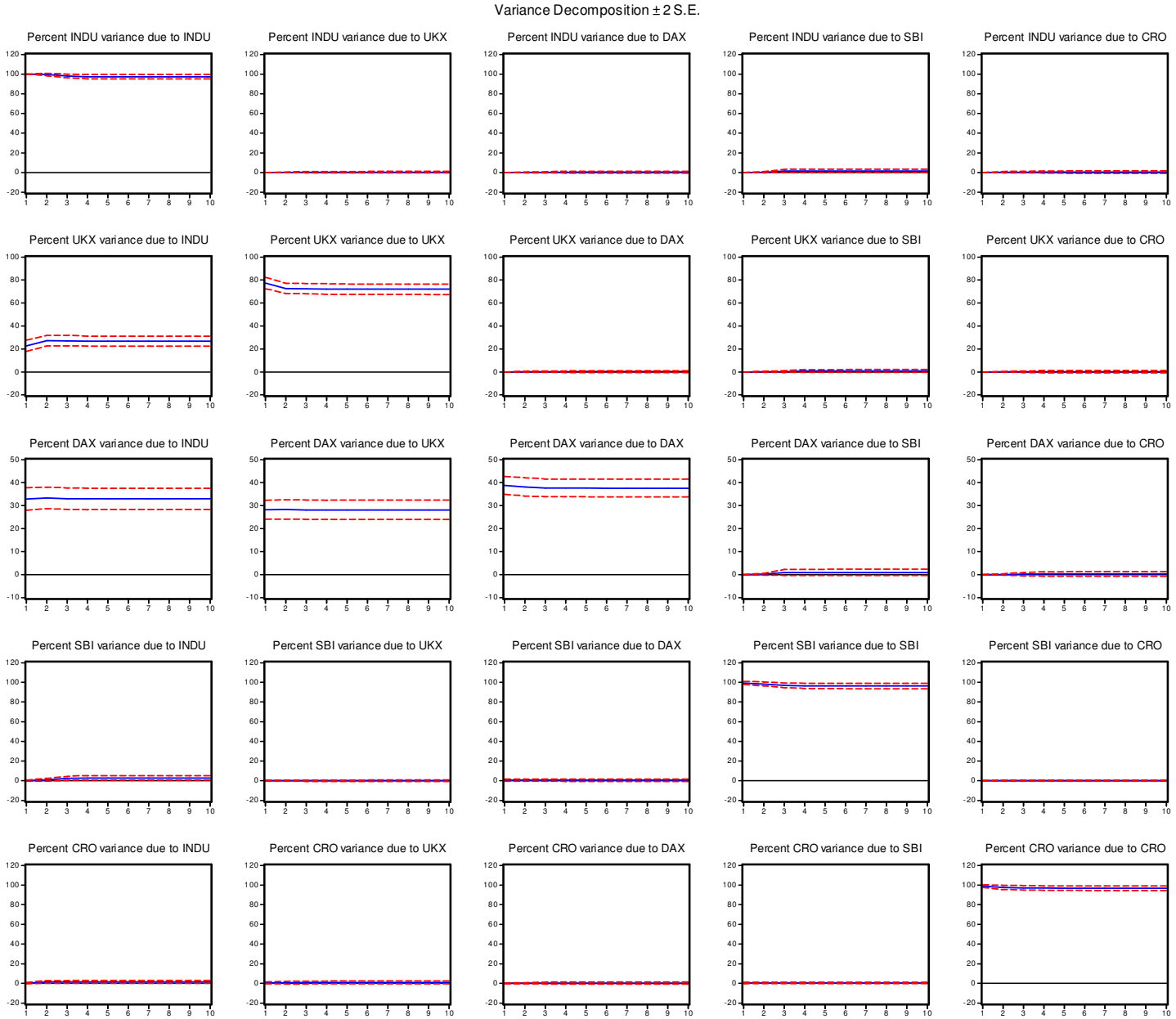
Source: Authors' calculation

Figure 6 Impulse response functions from a VAR including Hungary instead of Slovenia – daily data



Source: Authors' calculation

Figure 7 Variance decomposition – daily data



Source: Authors' calculation

Table 8 Results of VAR lag order selection tests – weekly data

VAR Lag Order Selection Criteria
Endogenous variables: INDU UKX DAX SBI CRO
Exogenous variables: C
Date: 10/01/06 Time: 21:03
Sample: 2/09/1997 2/01/2006
Included observations: 426

Lag	LR	FPE	AIC	SC	HQ
0	NA	8.47e-17	-22.81810	-22.77052*	-22.79931*
1	56.53839	8.32e-17	-22.83535	-22.54983	-22.72256
2	43.42376	8.43e-17	-22.82261	-22.29915	-22.61584
3	63.19981*	8.13e-17*	-22.85939*	-22.09799	-22.55862
4	29.57813	8.50e-17	-22.81505	-21.81572	-22.42029
5	23.18832	9.02e-17	-22.75565	-21.51838	-22.26690
6	27.29568	9.47e-17	-22.70738	-21.23218	-22.12465
7	32.97856	9.80e-17	-22.67457	-20.96143	-21.99785
8	11.65775	1.07e-16	-22.58748	-20.63640	-21.81677

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Source: Authors' calculation

Table 9 VAR parameter estimates – weekly data

Vector Autoregression Estimates
Standard errors in ( ) & t-statistics in [ ]

	INDU	UKX	DAX	SBI	CRO
INDU(-1)	-0.097364	0.050700	0.024090	-0.051275	0.046462
	(0.06747)	(0.07000)	(0.10328)	(0.06868)	(0.11563)
	[-1.44299]	[0.72434]	[0.23325]	[-0.74659]	[0.40182]
INDU(-2)	-0.108256	-0.008463	-0.074391	0.153325	-0.005573
	(0.06704)	(0.06954)	(0.10261)	(0.06823)	(0.11488)
	[-1.61486]	[-0.12169]	[-0.72496]	[2.24705]	[-0.04851]
INDU(-3)	-0.124434	-0.095599	-0.058225	-0.017252	-0.083538
	(0.06686)	(0.06936)	(0.10234)	(0.06805)	(0.11458)

	[-1.86112]	[-1.37832]	[-0.56892]	[-0.25351]	[-0.72910]
UKX(-1)	0.150598	-0.097000	0.107479	-0.053527	0.112119
	(0.07454)	(0.07732)	(0.11409)	(0.07587)	(0.12773)
	[2.02049]	[-1.25450]	[0.94205]	[-0.70555]	[0.87777]
UKX(-2)	0.276989	0.044174	0.221483	0.048342	0.316109
	(0.07505)	(0.07785)	(0.11487)	(0.07639)	(0.12861)
	[3.69087]	[0.56741]	[1.92805]	[0.63286]	[2.45792]
UKX(-3)	0.336498	0.125116	0.238324	-0.010005	0.089149
	(0.07337)	(0.07611)	(0.11230)	(0.07468)	(0.12573)
	[4.58641]	[1.64387]	[2.12212]	[-0.13397]	[0.70905]
DAX(-1)	-0.083751	-0.090287	-0.172470	0.085210	-0.010558
	(0.05283)	(0.05481)	(0.08087)	(0.05378)	(0.09054)
	[-1.58521]	[-1.64735]	[-2.13266]	[1.58454]	[-0.11661]
DAX(-2)	-0.084676	-0.010977	0.005741	-0.086895	-0.001597
	(0.05295)	(0.05493)	(0.08105)	(0.05390)	(0.09074)
	[-1.59913]	[-0.19984]	[0.07083]	[-1.61226]	[-0.01760]
DAX(-3)	-0.066881	0.003131	-0.001749	0.033456	0.147132
	(0.05290)	(0.05487)	(0.08097)	(0.05384)	(0.09065)
	[-1.26439]	[0.05706]	[-0.02160]	[0.62139]	[1.62311]
SBI(-1)	0.008165	0.063345	-0.060352	-0.013637	-0.006106
	(0.04914)	(0.05097)	(0.07522)	(0.05002)	(0.08421)
	[0.16615]	[1.24267]	[-0.80238]	[-0.27265]	[-0.07251]
SBI(-2)	-0.115666	-0.066392	-0.091328	0.053214	-0.136293
	(0.04907)	(0.05090)	(0.07511)	(0.04994)	(0.08409)
	[-2.35725]	[-1.30431]	[-1.21595]	[1.06547]	[-1.62084]
SBI(-3)	-0.118274	-0.024123	-0.098574	0.144352	-0.104958
	(0.04876)	(0.05059)	(0.07464)	(0.04963)	(0.08356)
	[-2.42551]	[-0.47688]	[-1.32065]	[2.90837]	[-1.25602]
CRO(-1)	0.011041	-0.036149	0.000908	0.062989	-0.072687
	(0.02962)	(0.03073)	(0.04534)	(0.03015)	(0.05077)
	[0.37273]	[-1.17632]	[0.02002]	[2.08904]	[-1.43183]
CRO(-2)	-0.001106	-0.002556	-0.005423	-0.029260	-0.042806
	(0.02976)	(0.03088)	(0.04556)	(0.03030)	(0.05101)
	[-0.03715]	[-0.08277]	[-0.11903]	[-0.96581]	[-0.83921]
CRO(-3)	0.010215	0.020771	-0.016490	0.055221	0.063966

	(0.02960)	(0.03070)	(0.04530)	(0.03012)	(0.05072)
	[0.34515]	[0.67656]	[-0.36401]	[1.83314]	[1.26122]
C	0.001253	0.000546	0.001334	0.001526	0.001422
	(0.00114)	(0.00118)	(0.00174)	(0.00116)	(0.00195)
	[1.10253]	[0.46327]	[0.76676]	[1.31921]	[0.73014]
R-squared	0.091415	0.051378	0.044545	0.081650	0.053109
Adj. R-squared	0.058575	0.017090	0.010010	0.048457	0.018884
Sum sq. resids	0.225137	0.242281	0.527502	0.233246	0.661173
S.E. equation	0.023292	0.024162	0.035652	0.023707	0.039915
F-statistic	2.783610	1.498438	1.289866	2.459831	1.551766
Log likelihood	1017.004	1001.189	833.5181	1009.379	784.8449
Akaike AIC	-4.645031	-4.571644	-3.793587	-4.609648	-3.567726
Schwarz SC	-4.494085	-4.420698	-3.642641	-4.458702	-3.416780
Mean dependent	0.000723	0.000379	0.000820	0.002125	0.001167
S.D. dependent	0.024005	0.024371	0.035832	0.024303	0.040297

Determinant resid covariance (dof adj.)	6.80E-17
Determinant resid covariance	5.63E-17
Log likelihood	5005.297
Akaike information criterion	-22.85521
Schwarz criterion	-22.10048

Source: Authors' calculation

Table 10 Test for residual autocorrelations – weekly data

VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	1.069947	NA*	1.072435	NA*	NA*
2	3.130597	NA*	3.142692	NA*	NA*
3	5.260954	NA*	5.287981	NA*	NA*
4	31.50593	0.1728	31.77881	0.1645	25
5	50.26698	0.4628	50.76006	0.4434	50
6	81.10754	0.2946	82.03602	0.2704	75
7	117.4664	0.1120	118.9951	0.0946	100
8	133.5437	0.2842	135.3765	0.2480	125

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

Source: Authors' calculation

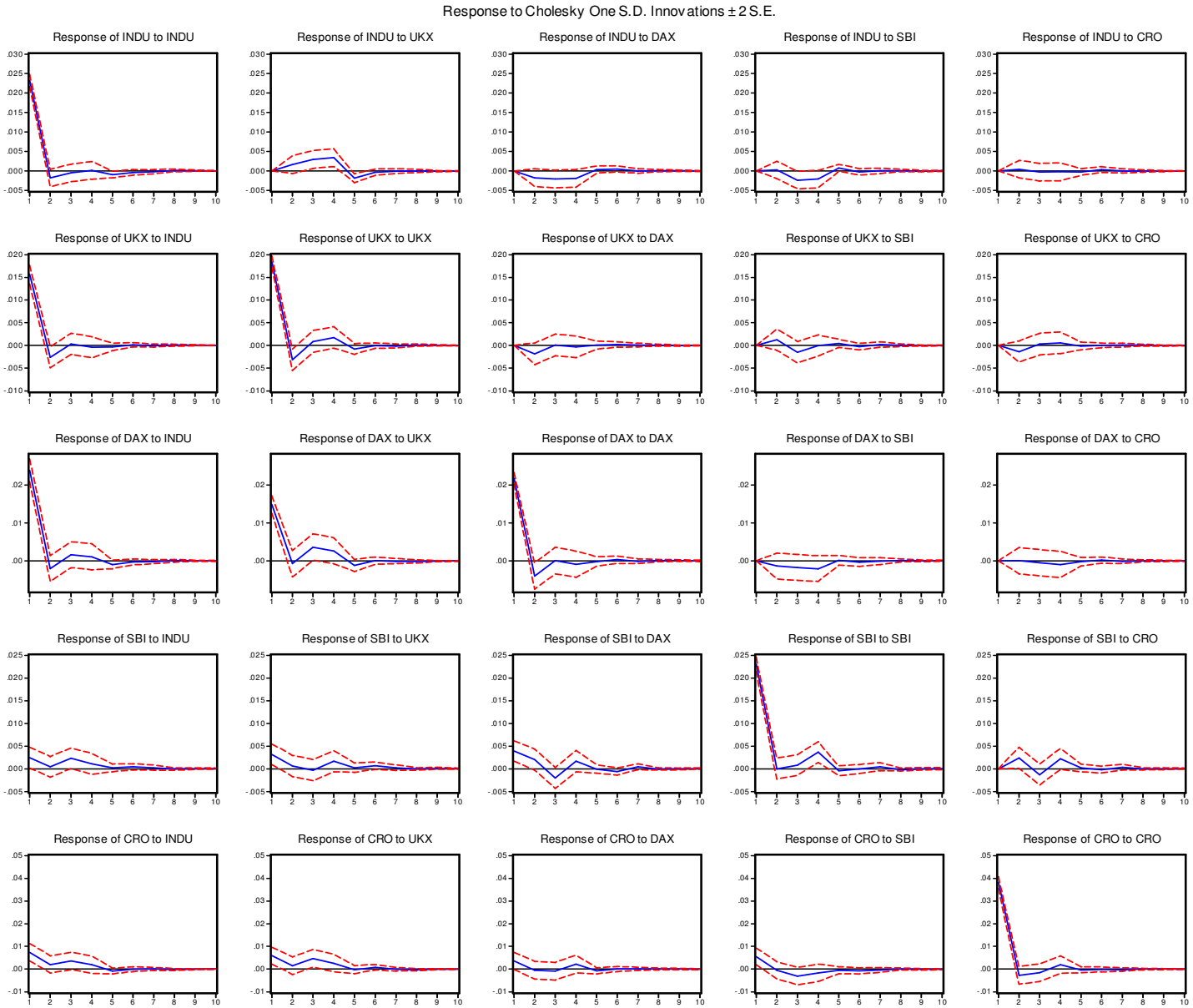
Table 11 Granger causality test – weekly data

Pairwise Granger Causality Tests
Date: 03/05/06 Time: 21:13
Sample: 1 434
Lags: 3

Null Hypothesis:	Obs	F-Statistic	Probability
DAX does not Granger Cause INDU	431	0.13348	0.94009
INDU does not Granger Cause DAX		0.29509	0.82895
CRO does not Granger Cause INDU	431	0.31453	0.81488
INDU does not Granger Cause CRO		2.33315	0.07349
SBI does not Granger Cause INDU	431	2.42417	0.06523
INDU does not Granger Cause SBI		1.65325	0.17649
UKX does not Granger Cause INDU	431	6.83586	0.00017
INDU does not Granger Cause UKX		0.60060	0.61491
CRO does not Granger Cause DAX	431	0.22458	0.87930
DAX does not Granger Cause CRO		3.31407	0.01999
SBI does not Granger Cause DAX	431	1.25435	0.28965
DAX does not Granger Cause SBI		1.59434	0.19009
UKX does not Granger Cause DAX	431	2.22986	0.08411
DAX does not Granger Cause UKX		0.78659	0.50188
SBI does not Granger Cause CRO	431	0.56395	0.63906
CRO does not Granger Cause SBI		3.84834	0.00973
UKX does not Granger Cause CRO	431	4.95339	0.00217
CRO does not Granger Cause UKX		0.47831	0.69754
UKX does not Granger Cause SBI	431	0.90012	0.44109
SBI does not Granger Cause UKX		0.53790	0.65655

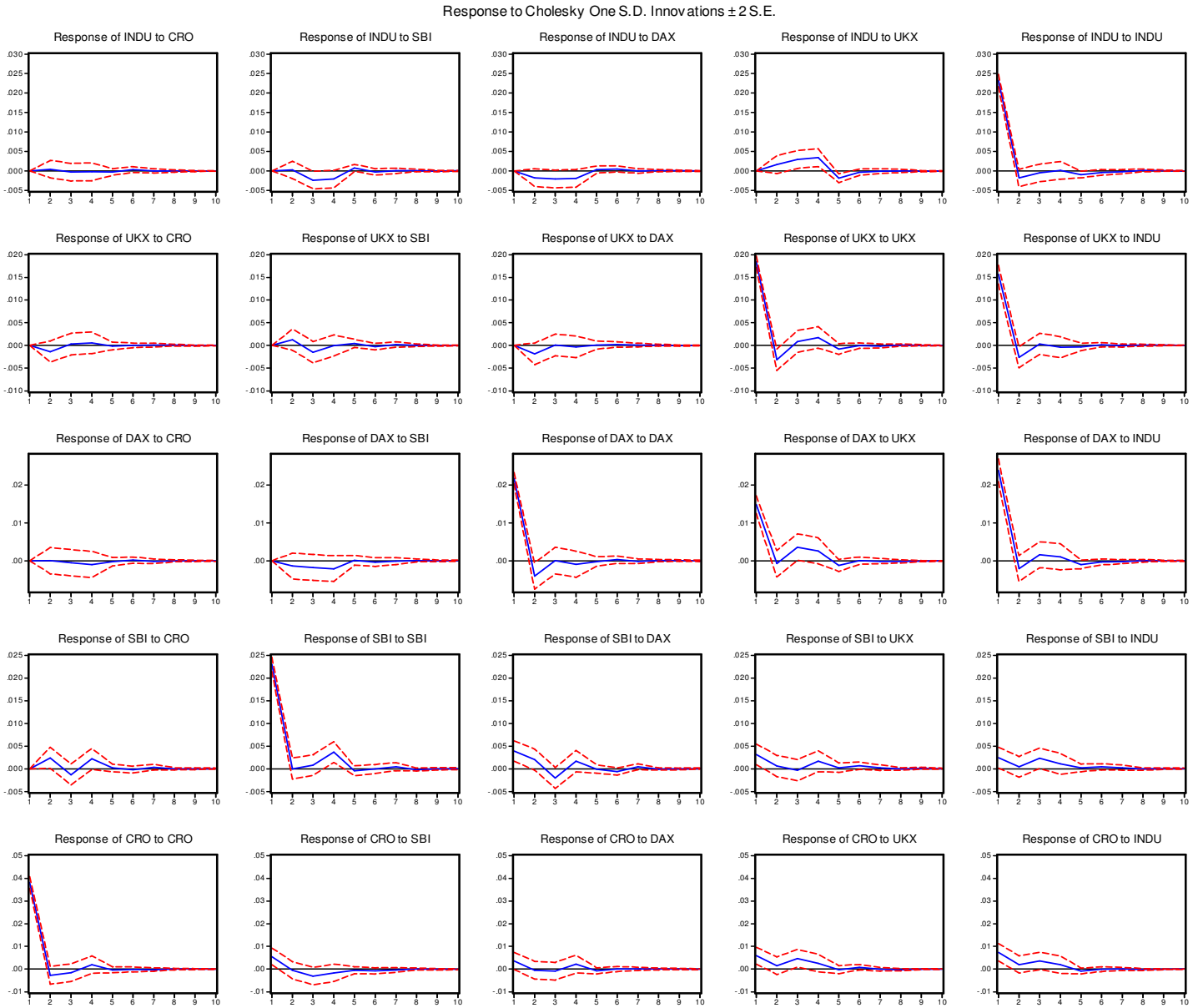
Source: Authors' calculation

Figure 8 Impulse response functions (ordering: indu, ukx, dax, sbi, cro) – weekly data



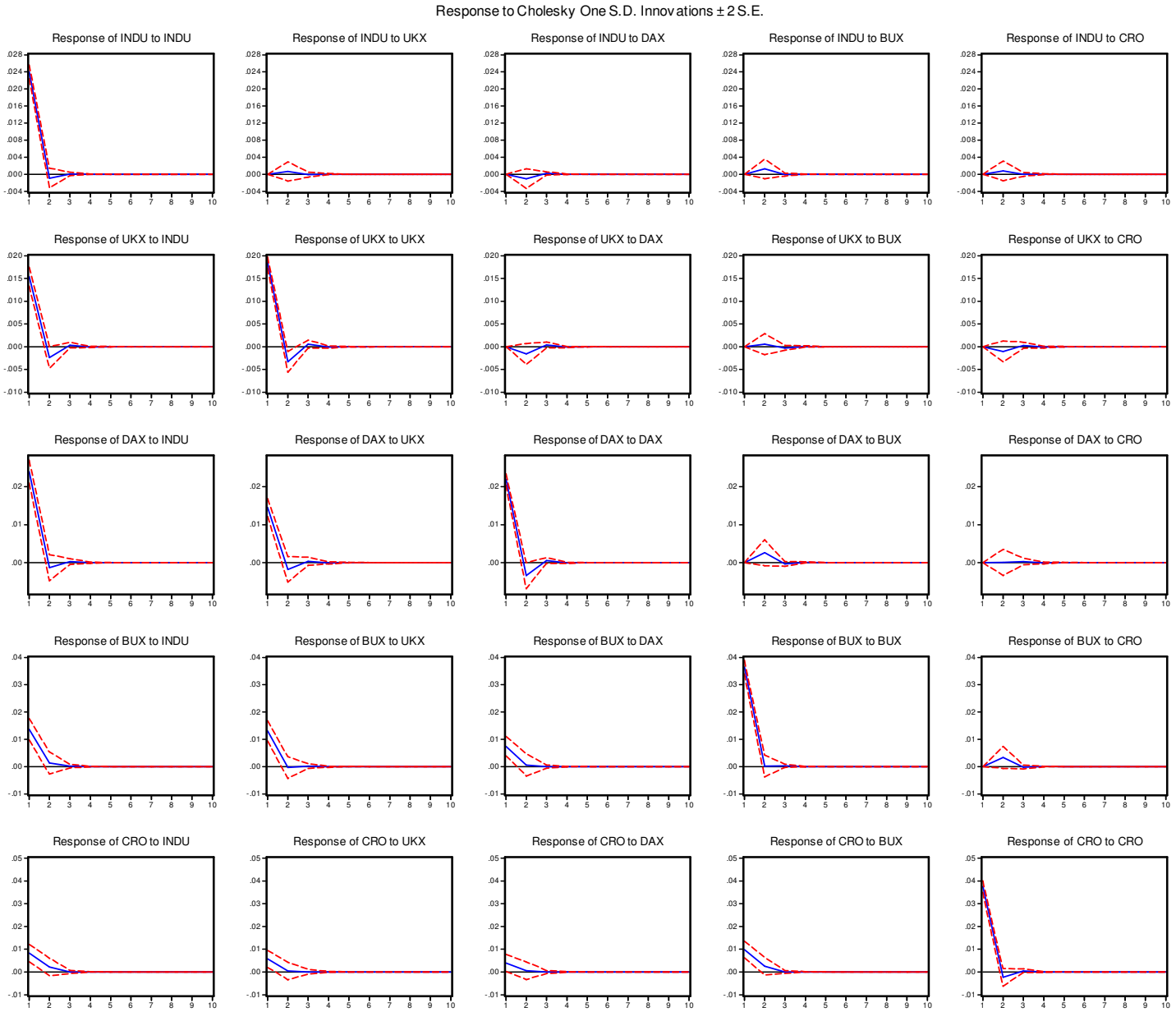
Source: Authors' calculation

Figure 9 Impulse response functions (ordering: cro, sbi, dax, ukx, indu) – weekly data



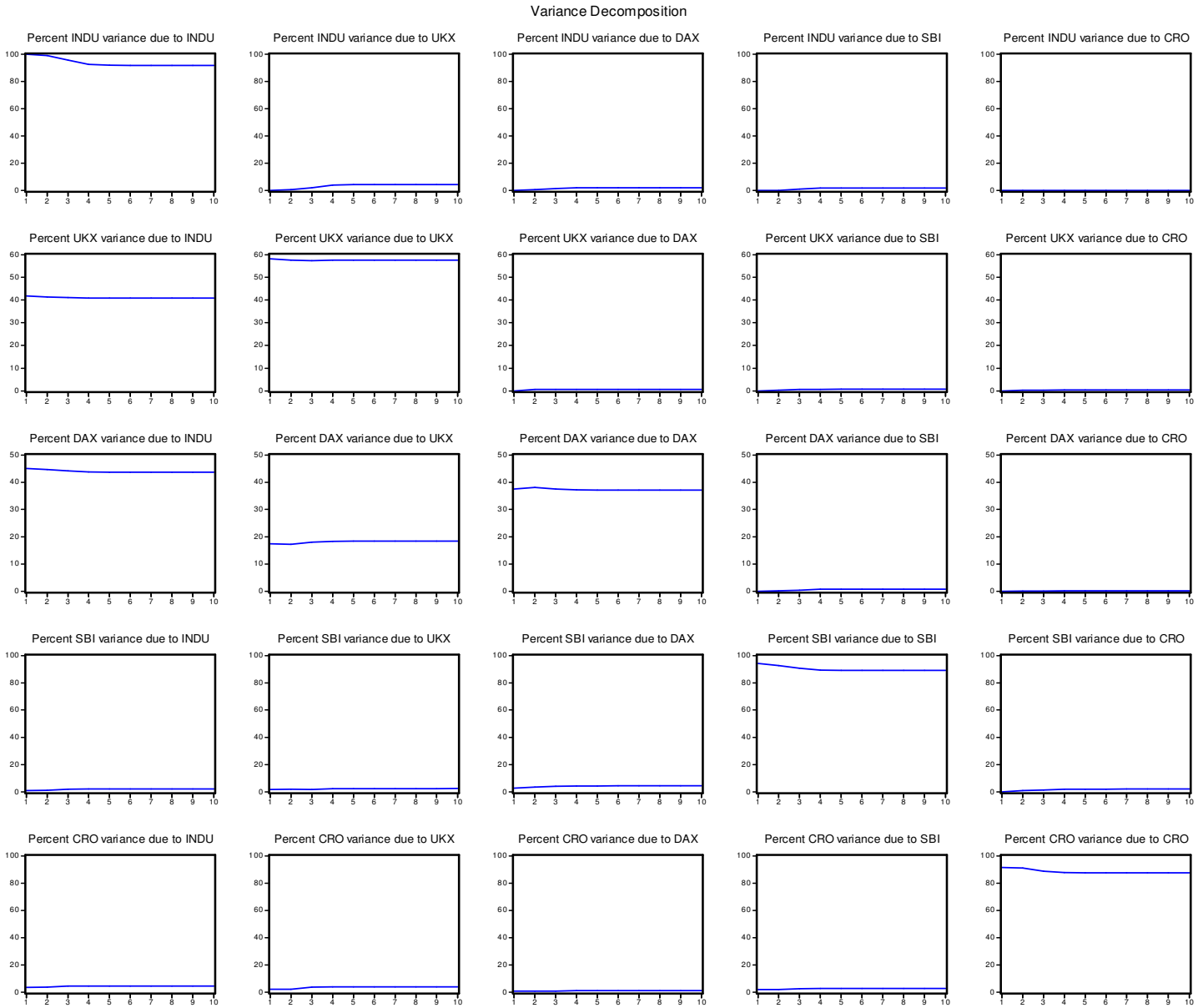
Source: Authors' calculation

Figure 10 Impulse response functions from a VAR including Hungary instead of Slovenia – weekly data



Source: Authors' calculation

Figure 11 Variance decomposition – weekly data



Source: Authors' calculation