Journal of Stock & Forex Trading
ISSN: 2168-9458

Hegerty and Marfatia, J Stock Forex Trad 2015, 4:1
DOI: 10.4172/2168-9458.1000138

Research Article Open Access

Using Dynamic Principal Components to Estimate an Alternative Measure of Exchange Market Pressure

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Abstract

Measures of Exchange Market Pressure (EMP) combine exchange-rate depreciations, reserve losses, and interest-rate hikes into a single index, for the purpose of explaining or predicting currency crisis. The standard measure assigns variance-smoothing weights that are fixed throughout the sample periods. Here, we extend the static PCA analysis of Hegerty (2013) to model EMP using the Dynamic Principal Components (DPCA) approach of Forni et al. While the DPCA and the: "standard" measure match in certain cases, they diverge widely in others, suggesting that this alternative must be refined before it can be used in wider practice.

Keywords: Exchange market pressure; Dynamic principal components; Time series

Introduction

In studies of currency crises, "crisis" episodes are often calculated as periods in which a currency depreciates or a central bank intervenes to defend it. A weighted measure of both possibilities is termed an Exchange Market Pressure (EMP) Index. Extreme values are deemed to be "crisis" periods, with a binary variable equaling one during these times, although continuous EMP measures are also used in econometric studies.

One criticism of the calculation of EMP measures is the weighting scheme for each component. Most are not based on underlying theory and may be biased. Girton and Roper [1] assigned equal weights to currency depreciations and reserve losses, while Weymark [2] estimated a structural model to calculate them. In the most common EMP measure, Eichengreen, Rose and Wyplosz [3], (hereafter referred to as ERW) simply deflate each of three components—they also include interest-rate increases—by its own standard deviation so that the most volatile component will not dominate the series. Pentecost et al. [4] apply Principal Components Analysis (PCA) to assign weights, without much success. In a more detailed study, Hegerty [5,6] uses PCA to generate monthly EMP series for 21 countries. He arrives at two key conclusions. First, in no case is the first principal component valid, since the weights are often of the "wrong" sign. Secondly, when the second or third component is used in empirical analyses and compared with the ERW measure, "crisis" periods and estimation results differ. So far, no study has come up with a credible alternative to the ERW measure of EMP.

This study can be considered a brief extension of Hegerty [5,6], except that here, the Dynamic Principal Components Analysis of Forni et al. [7] is used. Calculating DPCA measures for 19 emerging markets in Latin America, Central Europe, and Asia, we find that these often differ greatly from a parallel ERW measure both in terms of the properties of the data series and the results of a basic estimation. We conclude that DPCA is not statistically superior to the much-criticized ERW measure.

Methodology

Using monthly data from the International Financial Statistics of the International Monetary Fund, we generate two EMP series for each of 19 countries over the period from 2001 m01 to 2009 m08. The ERW measure is calculated as per Equation (1):

$$EMP_t = \frac{1}{\sigma_{\Delta e}}\left(\frac{\Delta e_t}{e_{t-1}}\right) - \frac{1}{\sigma_{\Delta RES}}\frac{\Delta RES_t}{MB_{t-1}} + \frac{1}{\sigma_{\Delta r}}\Delta\left(r_t - r_t^{US}\right) \quad (1)$$

Reserve losses are scaled by the lagged monetary base, and each interest-rate differentials (money market rate) are, like nominal exchange rates, taken vis-à-vis the U.S. dollar. The second measure, using DPCA, assigns time-varying weights to the same three components.

Following Hegerty [5,6] for each of the three geographic areas, we enter all relevant countries' EMP series in a single regional vector. This vector also includes world commodity prices and the U.S. Standard and Poor's stock index to capture external events. We do this separately for the ERW and DPCA measures, for a total of six vectors. This allows us to conduct Granger causality tests for spillovers. Examining the time-series plots, basic descriptive statistics, and Granger causality tests, we can assess how each series pair differs, and whether one series is more sensitive and more likely to point to a currency "crisis."

Finally, we generate Impulse Response Functions (IRFs) for the DPCA vectors to address how each EMP series responds to shocks to the other variables. Since all IRFs' results depend on the ordering of the variables in a VAR, a choice must be made regarding this issue. Traditionally, the variables are placed in order of endogeneity, as per the "orthogonal" VARs of Sims [8]. Here, however, we use the Generalized VAR approach of Pesaran and Shin [9], which is invariant to the ordering of the variables. Our results are explained below.

Results

Figure 1 depicts our two EMP measures for each country. While the two measures for Hong Kong clearly are dissimilar, other countries—such as Mexico, Uruguay, Bulgaria, Ukraine, and the Philippines—have DPCA measures that appear to match the ERW measures quite closely. Little consistent pattern emerges. Malaysia's ERW measure

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Received January 16, 2015; **Accepted** January 30, 2015; **Published** February 06, 2015

Citation: Hegerty SW, Marfatia HA (2015) Using Dynamic Principal Components to Estimate an Alternative Measure of Exchange Market Pressure. J Stock Forex Trad 4: 138. doi:10.4172/2168-9458.1000138

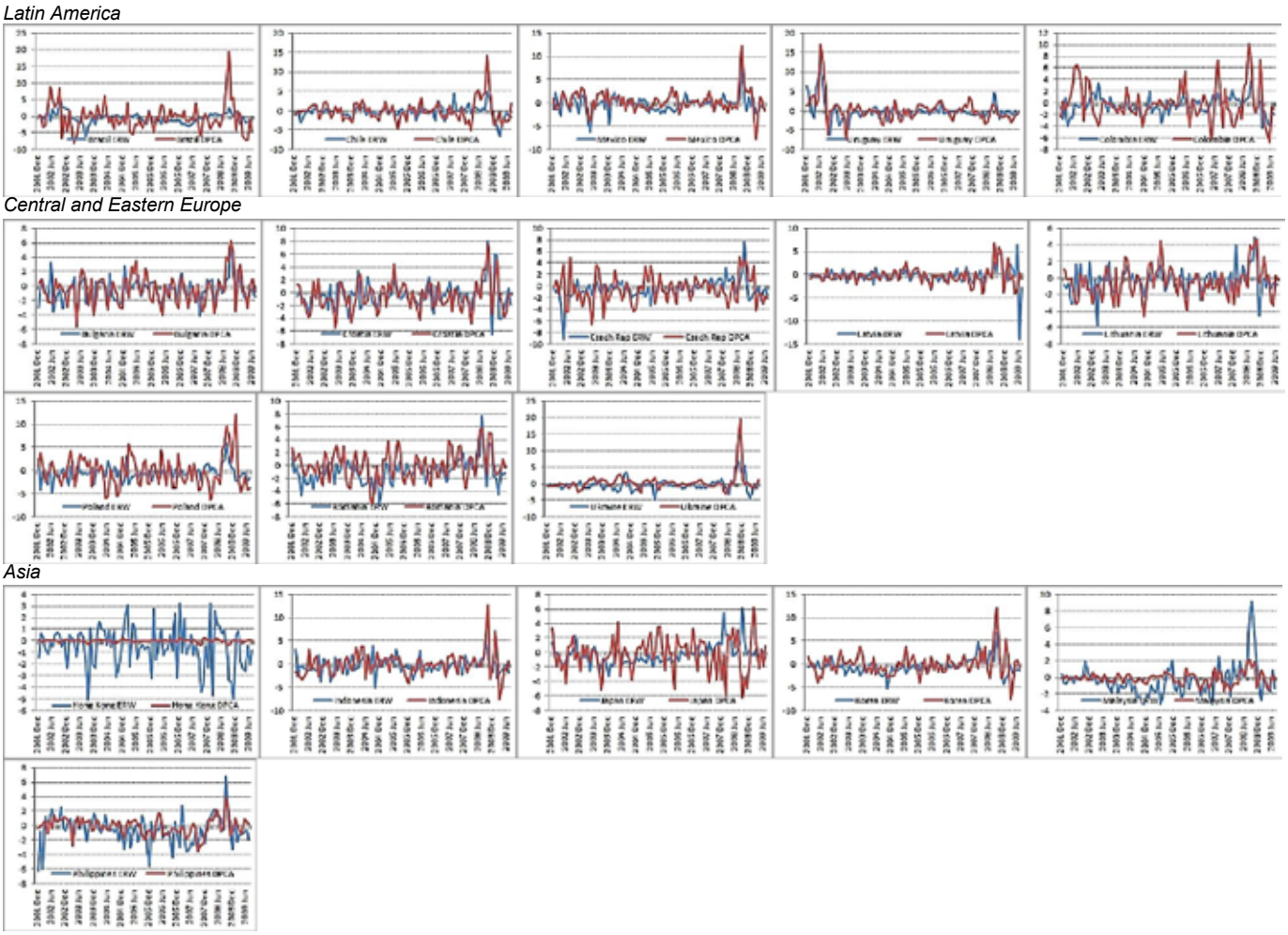


Figure 1: ERW and DPCA Measures of EMP.

fluctuates more than its DPCA measure, while Brazil and Ukraine register "spikes" that are much larger for the new measure. Table 1 suggests that the DPCA series tend to have larger standard deviations than their ERW counterparts.

Tables 2-4 show that the differences also persist when VAR models are estimated that use each EMP measure. Poland's ERW measure, to name one example, registers a spillover from world commodity prices but not U.S. stocks, but these are exactly reversed when the DPCA measure is used. Clearly, the DPCA measure of EMP is not a reliable alternative to the traditional ERW measure until the technique is further refined.

What results do these relatively novel DPCA measures provide, when applied to our model? We generate GIRFs for our Latin American, Central/East European, and Asian vectors in Figures 2-4. In general, the U.S. S and P index has a negative effect on EMP; in other words, stock-price declines result in increased EMP in most of these emerging markets. Changes in world commodity prices have more limited effects. The other effects, particularly bilateral linkages, vary from country to country.

For example, Brazil's exchange market is highly sensitive; EMP is affected by shocks to nearly all Latin American economies. Uruguay's EMP responds to Brazilian shocks as well. Chile is particularly impacted by Colombia. Colombia's EMP responds to Uruguayan EMP, and vice versa. Mexico is only weakly affected by Chile, Colombia, and Brazil.

On the other hand, CEE countries are less affected by their neighbors. Ukraine is the main exception; its EMP responds positively to all neighbors (and negatively to world commodity prices). Interestingly, Latvia responds negatively to Ukrainian EMP; similar findings have been found in Hegerty [10]. Likewise, the Asian countries in our study show limited effects, even to world commodity prices. Only Indonesia seems to be affected by these prices, as well as the U.S. stock market. In all, these limited results, like those of our Granger Causality tests, suggest that the DPCA measure of EMP fails to uncover results that were shown in earlier studies that use standard approaches. Future research will have to refine this method.

Conclusion

While the weighting scheme of the EMP measure popularized by Eichengreen et al. [6] - often used in studies of currency crises—has been criticized, few studies have been able to come up with a feasible alternative. This study builds upon Hegerty's [5,6] use of Principal Components Analysis (PCA) to assign weights to a set of countries' exchange-rate depreciations, reserve losses, and interest-rate hikes. A

Panel A: DPCA Exchange Market Pressure						Panel B: ERW Exchange Market Pressure					
	Mean	Median	Max	Min	S.D.		Mean	Median	Max	Min	S.D.
Latin America						**Latin America**					
Brazil	-0.354	-0.803	19.339	-7.948	4.08	Brazil	-0.521	-0.492	5.319	-6.008	1.569
Chile	-0.029	-0.228	14.247	-5.14	2.561	Chile	-0.301	-0.16	4.831	-6.653	1.556
Colombia	-0.031	-0.435	10.26	-6.699	3.048	Colombia	-0.408	-0.412	3.693	-4.331	1.492
Mexico	0.39	0.226	12.323	-7.859	2.197	Mexico	-0.213	-0.049	7.857	-6.301	1.671
Uruguay	0.181	0.022	17.201	-7.488	3.01	Uruguay	-0.048	-0.337	11.173	-6.155	2.347
Central and Eastern Europe						**Central and Eastern Europe**					
Bulgaria	-0.436	-0.442	6.267	-5.583	2.038	Bulgaria	-0.501	-0.504	6.278	-5.535	1.672
Croatia	-0.512	-0.884	7.533	-5.562	2.277	Croatia	-0.358	-0.48	8.007	-6.55	2.089
Czech Republic	-0.489	-0.715	5.12	-6.596	2.359	Czech Republic	-0.383	-0.397	7.752	-9.064	1.704
Latvia	-0.262	-0.357	6.774	-4.132	1.728	Latvia	-0.314	-0.301	6.533	-13.869	2.043
Lithuania	-0.466	-0.408	4.73	-4.682	1.87	Lithuania	-0.353	-0.393	4.886	-5.828	1.561
Poland	-0.204	-0.628	12.07	-6.339	3.387	Poland	-0.459	-0.45	5.788	-4.74	1.58
Romania	0.036	0.01	5.729	-6.357	2.337	Romania	-0.876	-0.945	7.746	-6.265	1.93
Ukraine	0.355	-0.023	19.669	-3.24	2.767	Ukraine	-0.325	-0.45	6.762	-4.906	1.778
Asia						**Asia**					
Hong Kong	-0.008	0.001	0.261	-0.345	0.104	Hong Kong	-0.484	-0.446	3.253	-5.132	1.82
Indonesia	0.025	-0.087	12.709	-7.615	2.574	Indonesia	-0.292	-0.463	4.785	-5.146	1.666
Japan	-0.196	0.003	6.311	-6.257	2.382	Japan	-0.228	-0.401	6.113	-3.274	1.402
Korea	-0.016	-0.219	12.075	-7.681	2.502	Korea	-0.509	-0.567	6.768	-5.261	1.615
Malaysia	-0.119	-0.163	2.156	-1.733	0.739	Malaysia	-0.375	-0.5	9.16	-3.307	1.906
Philippines	-0.053	-0.011	3.905	-3.535	1.156	Philippines	-0.538	-0.418	6.886	-6.334	1.973

Table 1: Descriptive Statistics.

Brazil	**DPCA**	**ERW**	**Mexico**	**DPCA**	**ERW**
Excluded	**Prob.**	**Prob.**	**Excluded**	**Prob.**	**Prob.**
CHIL	0.915	0.942	BRA	0.383	0.848
COL	0.174	0.265	CHIL	0.816	0.722
MEX	0.915	0.582	COL	0.276	0.535
URU	0.198	0.761	URU	0.809	0.639
WCP	0.119	0.591	WCP	0.636	0.92
S&P	0.011	0.035	S&P	0.058	0.001
All	0.006	0.436	All	0.128	0.016
Chile	**DPCA**	**ERW**	**Uruguay**	**DPCA**	**ERW**
Excluded	**Prob.**	**Prob.**	**Excluded**	**Prob.**	**Prob.**
BRA	0.978	0.677	BRA	0.048	0.536
COL	0.05	0.192	CHIL	0.214	0.971
MEX	0.089	0.63	COL	0.57	0.002
URU	0.633	0.773	MEX	0.856	0.787
WCP	0.875	0.581	WCP	0.605	0.575
S&P	0.208	0.72	S&P	0.599	0.032
All	0.262	0.858	All	0.356	0.021
Colombia	**DPCA**	**ERW**			
Excluded	**Prob.**	**Prob.**			
BRA	0.415	0.726			
CHIL	0.821	0.279			
MEX	0.828	0.726			
URU	0.142	0.602			
WCP	0.486	0.475			
S&P	0.012	0.522			
All	0.087	0.724			

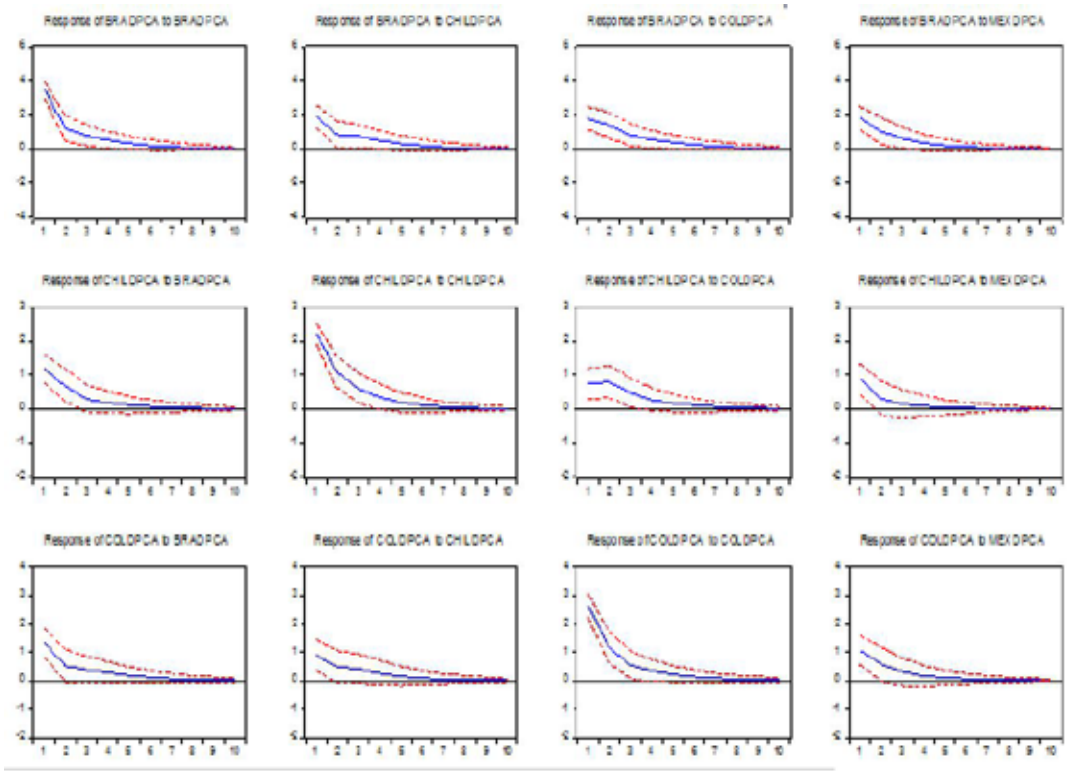
Table 2: VAR Granger Causality/Block Exogeneity Wald Tests: Latin America.

Bulgaria Excluded	**DPCA Prob.**	**ERW Prob.**	**Latvia Excluded**	**DPCA Prob.**	**ERW Prob.**
CRO	0.636	0.068	BUL	0.494	0.839
CZE	0.706	0.154	CRO	0.89	0.98
LAT	0.494	0.781	CZE	0.234	0.724
LIT	0.509	0.13	LIT	0.734	0.976
POL	0.557	0.161	POL	0.877	0.25
ROM	0.377	0.272	ROM	0.999	0.723
UKR	0.416	0.103	UKR	0.173	0.019
WCP	0.699	0.091	WCP	0.252	0.049
S&P	0.066	0.121	S&P	0.034	0.06
All	0.801	0.05	All	0.274	0.205
Croatia Excluded	**DPCA Prob.**	**ERW Prob.**	**Lithuania Excluded**	**DPCA Prob.**	**ERW Prob.**
BUL	0.964	0.863	BUL	0.343	0.742
CZE	0.63	0.905	CRO	0.837	0.109
LAT	0.342	0.83	CZE	0.124	0.609
LIT	0.183	0.757	LAT	0.952	0.622
POL	0.755	0.259	POL	0.486	0.574
ROM	0.692	0.169	ROM	0.195	0.281
UKR	0.805	0.041	UKR	0.929	0
WCP	0.702	0.207	WCP	0.691	0.03
S&P	0.023	0.143	S&P	0.132	0.079
All	0.571	0.455	All	0.476	0.005
Czech R. Excluded	**DPCA Prob.**	**ERW Prob.**	**Poland Excluded**	**DPCA Prob.**	**ERW Prob.**
BUL	0.699	0.439	BUL	0.208	0.099
CRO	0.267	0.562	CRO	0.612	0.846
LAT	0.89	0.81	CZE	0.284	0.087
LIT	0.038	0.874	LAT	0.711	0.553
POL	0.706	0.425	LIT	0.342	0.122
ROM	0.335	0.317	ROM	0.488	0.596
UKR	0.872	0.209	UKR	0.84	0.618
WCP	0.818	0.989	WCP	0.122	0.006
S&P	0.061	0.886	S&P	0.016	0.483
All	0.311	0.94	All	0.189	0.023
Romania Excluded	**DPCA Prob.**	**ERW Prob.**	**Ukraine Excluded**	**DPCA Prob.**	**ERW Prob.**
BUL	0.896	0.922	BUL	0.022	0.601
CRO	0.201	0.385	CRO	0.599	0.686
CZE	0.375	0.992	CZE	0.179	0.607
LAT	0.197	0.298	LAT	0.008	0.187
LIT	0.245	0.095	LIT	0.615	0.751
POL	0.536	0.139	POL	0.036	0.156
UKR	0.904	0.622	ROM	0.92	0.261
WCP	0.24	0.44	WCP	0.044	0.486
S&P	0.541	0.747	S&P	0.008	0.392
All	0.58	0.493	All	0	0.275

Table 3: VAR Granger Causality/Block Exogeneity Wald Tests: Central and Eastern Europe.

Hong Kong Excluded	**DPCA Prob.**	**ERW Prob.**	**Korea Excluded**	**DPCA Prob.**	**ERW Prob.**
INDO	0.129	0.349	HK	0.673	0.863
JPN	0.977	0.881	INDO	0.577	0.112
KOR	0.798	0.329	JPN	0.301	0.816
MALA	0.029	0.003	MALA	0.644	0.244
PHI	0.708	0.807	PHI	0.115	0.142
S&P	0.57	0.748	S&P	0.08	0.092
All	0.163	0.015	All	0.297	0.163
Indonesia Excluded	**DPCA Prob.**	**ERW Prob.**	**Malaysia Excluded**	**DPCA Prob.**	**ERW Prob.**
HK	0.489	0.366	HK	0.671	0.802
JPN	0.227	0.951	INDO	0.196	0.954
KOR	0.039	0.995	JPN	0.125	0.302
MALA	0.888	0.228	KOR	0.009	0.02
PHI	0.889	0.625	PHI	0.004	0.628
WCP	0.347	0.932	WCP	0.549	0.413
S&P	0	0.248	S&P	0.028	0.236
Japan Excluded	**DPCA Prob.**	**ERW Prob.**	**Philippines Excluded**	**DPCA Prob.**	**ERW Prob.**
HK	0.664	0.549	HK	0.32	0.742
INDO	0.511	0.711	INDO	0.074	0.67
KOR	0.266	0.141	JPN	0.085	0.677
MALA	0.844	0.787	KOR	0.463	0.535
PHI	0.357	0.027	MALA	0.548	0.021
WCP	0.761	0.92	WCP	0.086	0.038
S&P	0.735	0.078	S&P	0.902	0.54
All	0.718	0.234	All	0.069	0.069

Table 4: VAR Granger Causality/Block Exogeneity Wald Tests: Asia



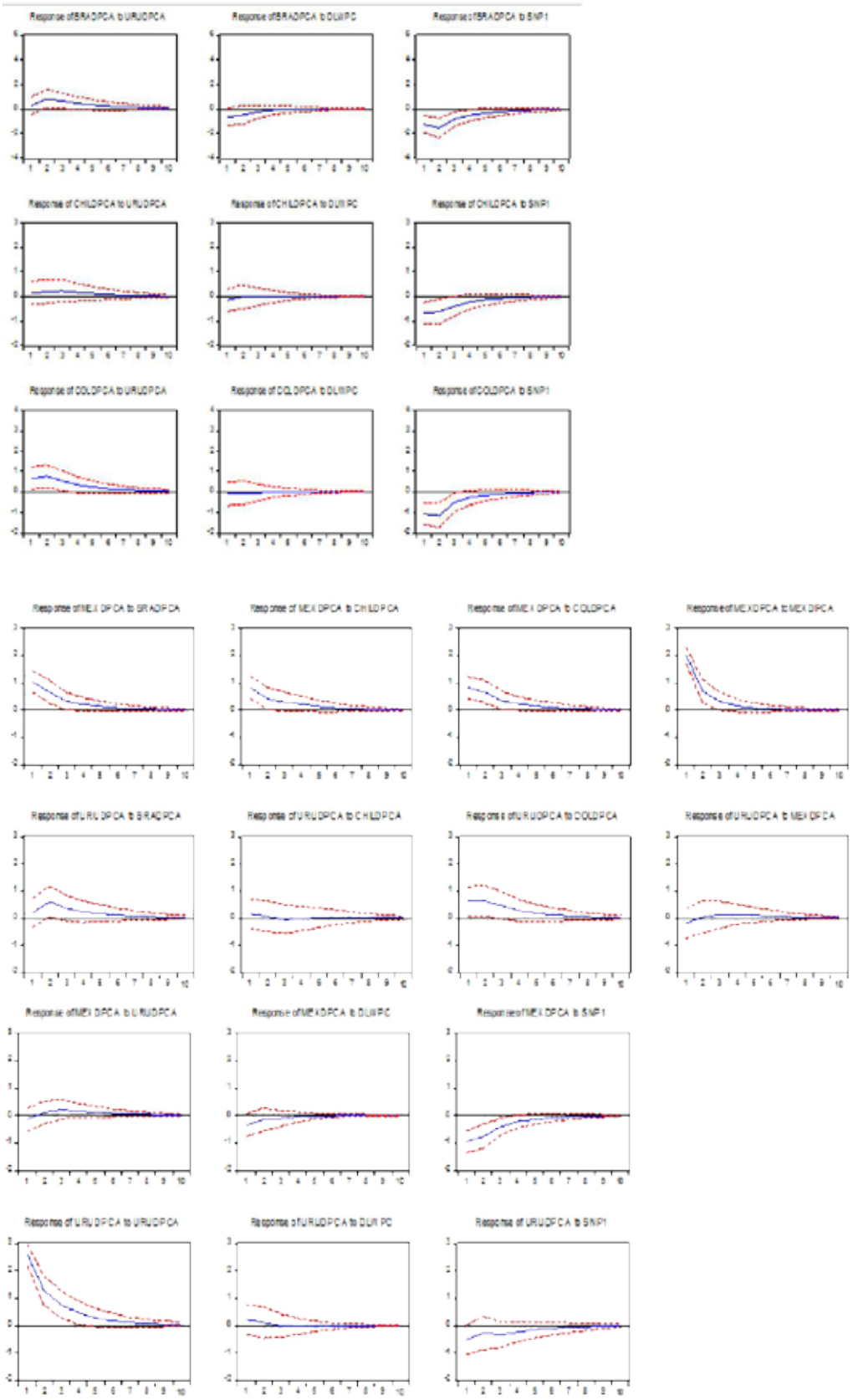
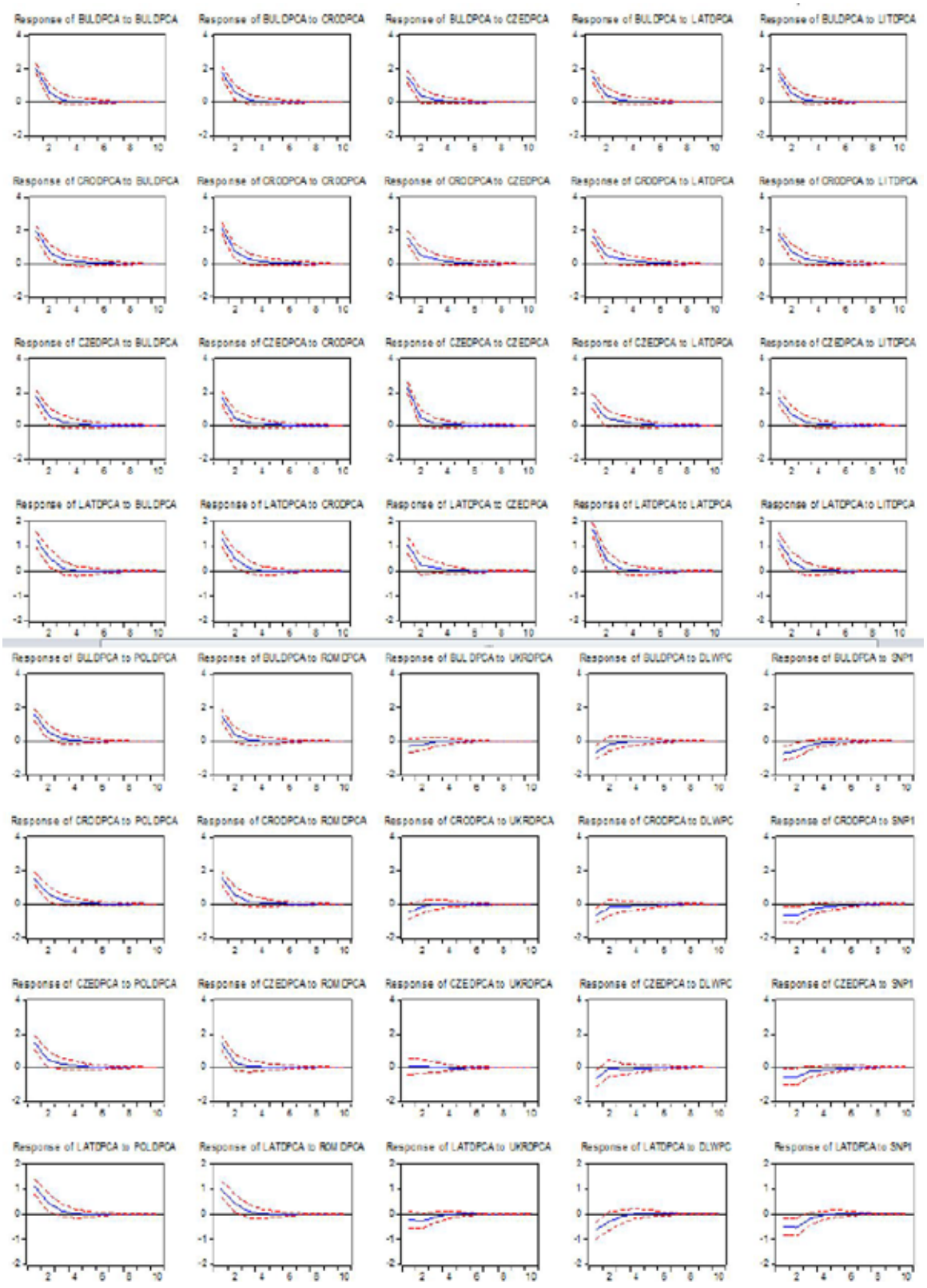


Figure 2: Impulse Responses, Latin America (Including ±2 Standard-Error Bands).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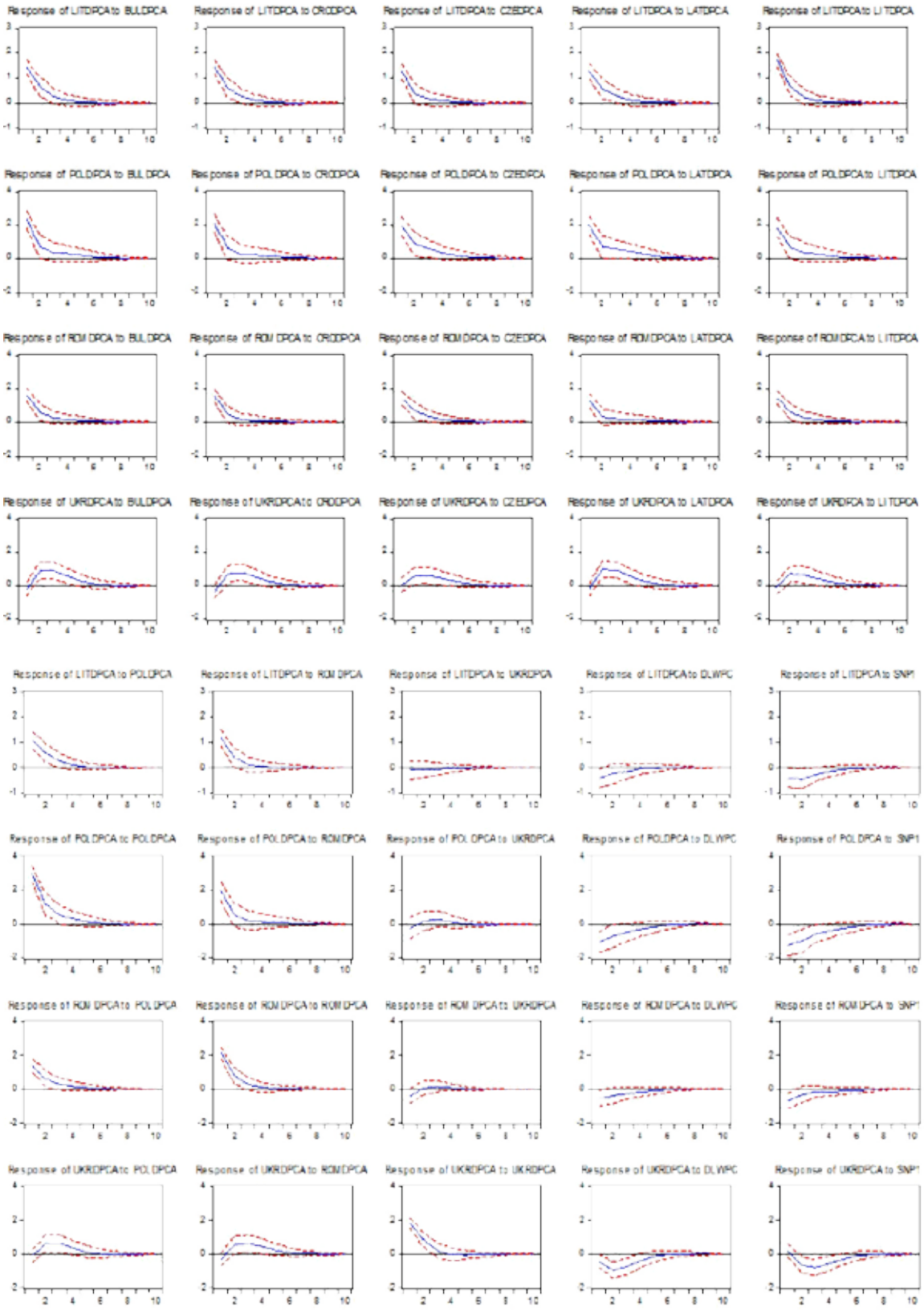
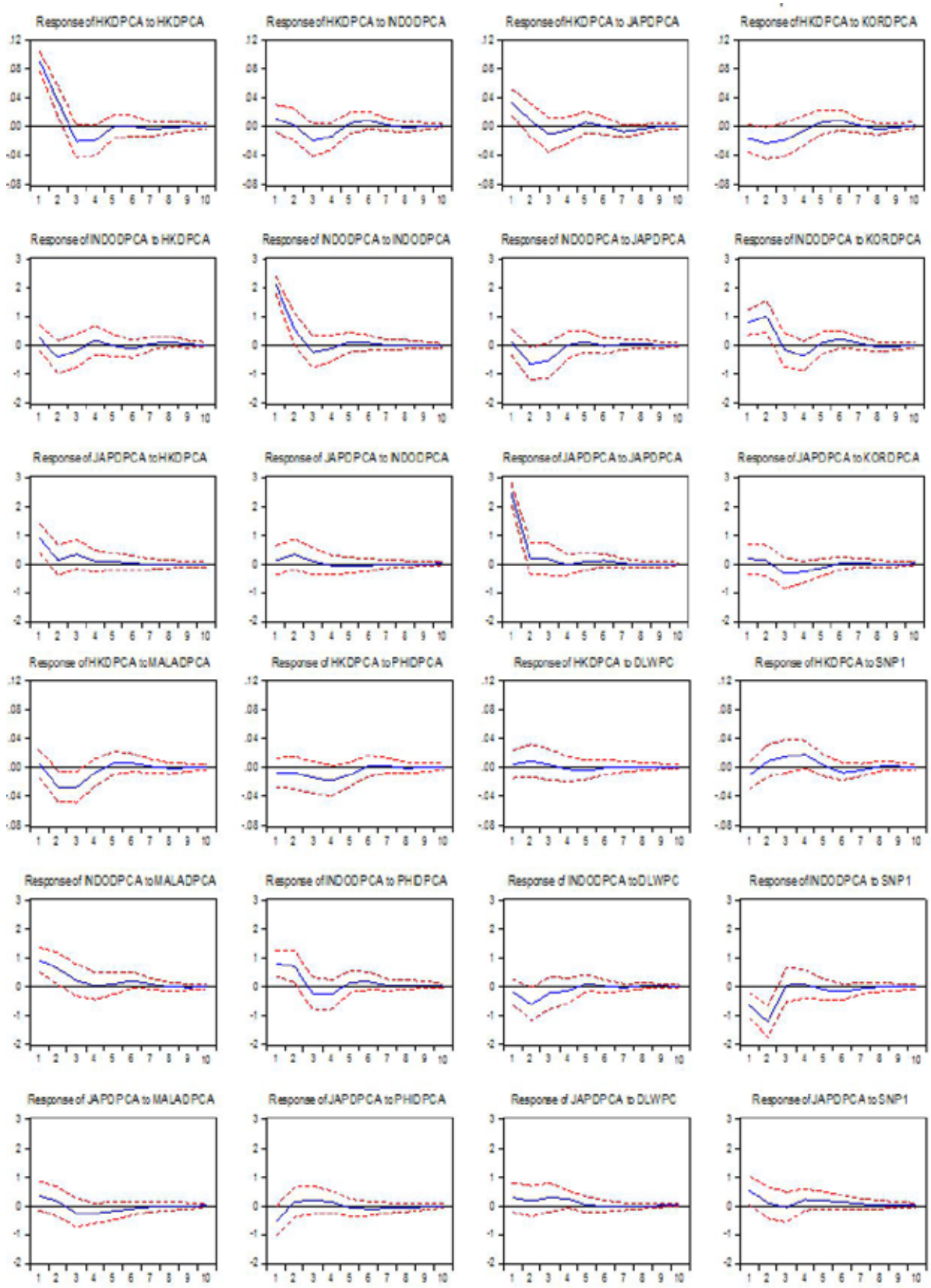


Figure 3: Impulse Responses, Central & Eastern Europe (Including ± 2 S.E. Bands).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Response of JAPDPCA to KORDPCA
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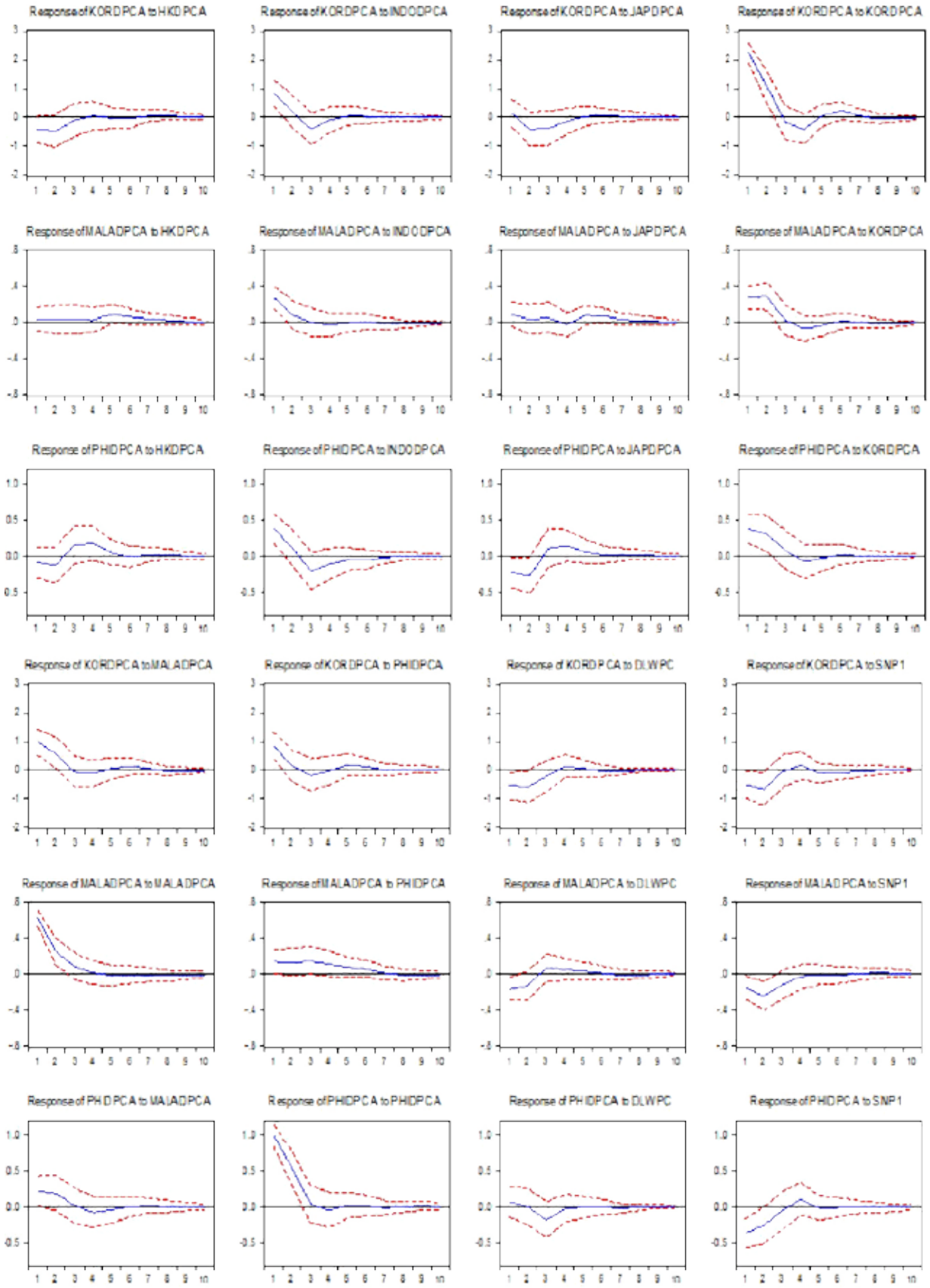

Figure 4: Impulse Responses, Asia (Including ± 2 Standard-Error Bands).

graphical depiction, basic statistics, and the results of a set of Granger causality tests for regional spillovers show that this new measure does not provide an alternative. Results between the two measures differ too much for DPCA to be reliable without further work being done.

Generalized Impulse Response Functions, generated for VARs that use this new measure, also provide weaker evidence for international exchange-market "contagion" than had been found in earlier studies. While Latin American exchange markets appear to experience international EMP spillovers, Central and Eastern Europe (except Ukraine) and Asia do not.

It is interesting to note that Ukraine's DPCA EMP measure closely matches its ERW measure—and that this country shows meaningful evidence of spillovers. We therefore attribute these differences to the method by which DPCA calculates these indices. These failures must be addressed for DPCA to become standard in the literature. Further research must investigate whether higher-order components might provide a more useful measure when the first dynamic principal components did not.

References

1. Girton L, Roper D (1977) A Monetary Model of Exchange Market Pressure Applied to the Postwar Canadian Experience. American Economic Review 67: 537-548.
2. Weymark DN (1998) A General Approach to Measuring Exchange Market Pressure. Oxford Economic Papers 50: 106-121.
3. Eichengreen B, Andrew R, Wyplosz C (1996) Contagious Currency Crises: First Tests. Scandinavian Journal of Economics 98: 463-484.
4. Pentecost EJ, Hooydonk CV, Poeck AV (2001) Measuring and Estimating Exchange Market Pressure in the EU. Journal of International Money and Finance 20: 401-418.
5. Hegerty SW (2013) Principal Component Measures of Exchange Market Pressure: Comparisons With Variance-Weighted Measures. Applied Financial Economics 23: 1483-1495.
6. Hegerty SW (2013) Exchange Market Pressure, Stock Prices, and Commodity Prices in West Africa. International Review of Applied Economics 27: 750-765.
7. Forni M, Hallin M, Lippi M, Reichlin L (2000) The Generalized Dynamic-Factor Model: Identification and Estimation. Review of Economics & Statistics 82: 540-554.
8. Sims CA (1980) Macroeconomics and Reality. Econometrica 48: 1-48.
9. Pesaran MH, Shin Y (1998) Generalised Impulse Response Analysis in Linear Multivariate Models. Economics Letters 58: 17-29.
10. Hegerty SW (2011) Is Exchange-Market Pressure Contagious Among Transition Economies? Applied Financial Economics 21: 707-716.