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Where Do the Leaders Trade?

Information Revelation and Interactions Between the Segments of Czech Capital Markets

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Where Do the Leaders Trade? Information Revelation and Interactions between the Segments of Czech Capital Markets

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Abstract:

In the present paper we concentrate on the interaction and sharing of the information between the organized markets in the Czech Republic. Moreover, the interesting principal-agent problem between the Prague Stock Exchange (PSE) and RMS (over the counter system) is studied to identify the leaders and followers in the information transmission process.

The analysis shows that new information penetrates through the main market of the PSE, and that RMS dominates on the segments with lower liquidity. The leading position of the PSE was confirmed via VAR models. Basically, a shock on the PSE affected all segments of both markets, while a shock to any segment of the RMS had an effect (if any) only on the corresponding segment of the PSE.

Because of missing links between some market segments, we conclude that the PSE-RMS do not behave as one integrated market yet.

Keywords: comovements of financial markets, emerging markets, Granger causality, integration of emerging markets.

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1. Introduction

The development of capital markets in Central and Eastern Europe has so far been highly interrelated with privatization programs. Similarly, voucher privatization in the Czech Republic resulted in the reopening of the Prague Stock Exchange (PSE) in 1993. In contrast to the standard way of creating a capital market — through a range of regulations and rules applied to securities activities, which allows a step-by-step expansion of the new financial market — the Czech Republic took a different approach. The newly emerged market was flooded with about a thousand equities coming from the first wave of the voucher privatization in 1993. Another set of about seven hundred equities entered the market after the end of second wave of voucher privatization in March, 1995.

It was shown (see Filer, Hanousek (1997) and Hanousek, Filer (1997)) that the PSE exhibits some degree of market efficiency (weak and semi-strong forms). In addition, Němeček (1997) found that insider trading is very low for liquid stocks traded on the first two tiers.

The fact that shares could be traded not only on the PSE, but on the RM-System (an over-the-counter market) as well, and more importantly, that they could be "transferred" (bought/sold) directly at the counter of the Center for Securities was one of the most significant barriers to market transparency. [1] Agents operating in this complex environment see many

[1] The Law on the Stock Exchange and Securities was adopted in 1992. Both PSE and RM-System started during the first half of 1993.

risks that would not exist on standard capital markets.[2] Prices of a single security could be (and in the beginning, indeed, were) very different on different exchanges (e.g., PSE versus RMS), offering possible arbitrage opportunities. New information entering one market would be carried over to the other exchange. This process, however, could be very different depending on the liquidity of a given security, general availability of information on the economic situation of the firm, and structure of agents holding a given asset.

In the present paper we concentrate on the interaction and sharing of information between the organized markets in the Czech Republic. Note that trading volume on PSE dominates (aproximately, 3:1) over RMS; see Table 1 following.

Table 1: The trading volume on registered capital markets

Trading volume (US$ billion)**	1993*	1994	1995	1996
PSE	0.3	2.16	7.36	14.47
RMS	0.1	0.15	1.03	3.68

* April-December (PSE), July-December (RMS)
** Average exchange rates

We omit the embryonic stage of both markets and concentrate on the time span from April 3, 1995 to December 20, 1996. Thus, we analyze the period starting after the bulk of shares from the second wave of voucher

[2] Although the Czech capital market has the highest market capitalization in Central and Eastern Europe, the PSE has quite low liquidity and between 75 to 90 per cent of all share transactions have been made off-markets, in the Center for Securities.

privatization entered the market (we allow for a one-month "settlement period") and ending before the first major delisting organized by the PSE.

Trends in prices on both the PSE and RMS have been noted by many authors, Laštovička at al. (1994) among others, but a quantitative study of the interactions of these markets is missing. Moreover, the interesting principal-agent problem between the PSE and RMS should be studied to identify the leaders and followers in the information transmission process. The analysis should help to explain the ways in which a new signal penetrates the market(s) and the role played by market transparency, liquidity, and the composition of the population of traders. As the characteristics of firms (namely size and liquidity measured by volume of trade or by probability that a given share will trade during any particular session) as well as the characteristics of agents operating on the market differ significantly both among the particular segments of the PSE or RM-System and between these two markets, we study the above sketched questions for separate segments of the PSE and RM-S. An interesting question is whether two emerging markets offering basically the same securities, but having different institutional designs, could behave as one integrated market.

The paper is organized as follows. The following section presents basic notation and data description. Section 3 uses Granger-causality on the market indices to study the relation between each tier of the PSE and RM-S, respectively. The overall Granger-causality between related segments of the PSE and RM-S is tested at the end of this section. The fourth section

investigates links among all components of both markets via impulse response function. Section 5 concludes the paper.

2. Basic Facts and Data Description

2.1 The Prague Stock Exchange

The Prague Stock Exchange (PSE), an electronic-type exchange, was re-opened on April 6, 1993 after a 55 year closure. Its founding shareholders were 12 Czech monetary institutions and five broker firms. At the end of 1995 the PSE had 101 members, at the end of 1996 it had 109, 33 of which were bank-type members and 77 broker-type companies. About one fourth of all members were those with foreign capital participation.

Trading at the PSE started with just one trading day per week and only 7 securities, most of which were government or corporate bonds. By July 13, 1993, after the introduction of stocks from the first wave of voucher privatization, the number of securities increased to 961. On November 4, 1993 and March 14, 1994 respectively, a second and third trading day per week were introduced. Since September 19, 1994, trading has taken place every weekday. Stocks from the second wave of voucher privatization have been traded since March 1, 1995, when the number of securities reached 1,699. By the end of March 1996, there were 1,641 stocks and 95 bonds offered on the market.

2.2 RM-System (electronic over-the-counter exchange)

In July, 1993, the RMS (*Registrační Místa System*, i.e., "Registration Places System"), a separate over-the-counter exchange, opened. The RMS was essentially a continuation of the registration-office infrastructure which supported voucher-bidding. The network of the RM-System share shops, located throughout the country, totalled 208 sites in 1995 (333 in 1993, 242 in 1994).

During 1994, RMS moved from so-called "periodic" auctions (clearing orders accumulated during two or three week periods) to continuous auctions. The continuous auctions started on February 2, 1994 with only one trading day per week. On March 2, 1994, April 19, 1994, and July 11, 1994 respectively, second, third, and fourth trading days were introduced. Since September 5, 1994, trading has taken place every weekday.

2.3 Definition of segments of markets by trading groups of PSE

Trading group 1 (A1)

These securities, from the main market, are traded at a fixed price upon opening, and subsequently in continuous trading at a variable price. Five main issues were included in the continual trading system introduced

in March 1996;[3] at the end of 1996 there were 11 issues available within this trading group.

Trading group 2 (A2, B2, C2)

This groups contains three segments of the market that are traded daily at a fixed price (set through the so-called Automated Trading System, which clears the orders received to maximize the number of shares traded). The main, secondary and free markets are denoted A2, B2, C2, respectively.

Trading group 3 (C3)

Group C3 denotes those securities from the free market that have very low liquidity and therefore are traded twice a week at a fixed price.

Two other trading systems were used in addition to this basic system: direct trade in blocks of securities and automated trades in blocks of securities.

Table 2: Characteristics of the particular trading groups

Date	A1	A2	B2	C2	C3	On RMS only
04/03/95						
# of stocks	7	36	48	568	1050	256
% of market cap. on PSE	14.87	13.77	3.52	65.22	2.61	-
% of market cap. on RMS	12.03	11.76	4.02	63.06	4.30	4.82

[3] SPT Telecom, Komercni banka, CEZ, KB Investicni fund and Ceska sporitelna.

02/18/97

# of stocks	8	37	52	564	1030	399
% of market cap. on PSE	30.80	27.24	10.54	30.54	0.88	-
% of market cap. on RMS	24.05	16.88	10.23	39.30	2.32	7.23

2.4 Data description

Data for this paper came directly from the PSE and RM-S, respectively. Mantaining the original data — every session was stored in a special file, and identification of the securities was changed frequently — in one big database was the first step of the project.

Following IFC methodology we created market price-indices for each segment of the PSE: A1, A2, B2, and C2.[4] All shares of the given segment were incorporated in the index base and were assigned a weight proportional to their market capitalization. The IFC methodology for developing market indices for emerging markets suggests using the following formula

$$I(t) = K(t)\frac{M(t)}{M(0)}1000, \qquad (1)$$

where

[4] We have to exclude segment C3 from our analysis because of a different frequency of trading. Basically, until October 1995, segment C3 was traded daily, then it was traded twice a week, and finally since January, 1997, it has again been traded daily.

M(t) and M(0) are the market capitalization of the base at time t and "0", i.e., at the start period. K(t) is a factor reflecting changes in the index base. As a starting period we chose April 3, 1995, four weeks after the last major transfer of shares to organized markets. For the sake of simplicity we assumed that the index base remained unchanged. Therefore,

$$I(t) = \frac{M(t)}{M(0)} 1000, \qquad (2)$$

where

M(t) and M(0), respectively, run through segments A1 to C2 on the PSE. Composed indices were evaluated on RMS, as well. In our notation, index I(t)≡A1PSE (t) represents a market index of the A1 segment computed on the PSE, B2RMS corresponds to the market index B2 of the PSE, evaluated on the RMS, etc.

3. Interrelation between markets: Granger-causality test[5]

Since Granger (1969) introduced his definition of 'causality', the test of Granger-type causality has been applied quite frequently in empirical work. We say that '$\{x_t\}$ causes $\{y_t\}$', if the present value y_t can be significantly better predicted when past values of x_t are included in all relevant information. Usually, the notion of 'causality' in econonomic systems is limited to linear relations between observed time series. The Granger causality is tested then via an autoregressive representation

[5] We used standard methodology for testing linkages between (international) markets; see Agmon(1972), Easley et al. (1996), Hiemstra and Jones (1994), Hsiao (1981), Joy et al.(1976), Kwan et al. (1995), Smith et al. (1993), among others.

$$\begin{pmatrix} x_t \\ y_t \end{pmatrix} = \begin{bmatrix} a(L) & b(L) \\ c(L) & d(L) \end{bmatrix} \begin{pmatrix} x_t \\ y_t \end{pmatrix} + \begin{pmatrix} \varepsilon_t \\ \delta_t \end{pmatrix}; \qquad (3)$$

for a review of alternative tests see Geweke et al. (1983).

Because disturbances are serially uncorrelated, the direction of causality between $\{x_t\}$ and $\{y_t\}$ can be turned into a standard test of whether $b(L)=0$ and/or $c(L)=0$.[6] The testing can proceed only if some restrictions on the autoregressive form (3) are specified before the actual estimation is done. For instance, we should identify the length of autoregression prior to estimation of (3).[7] We applied Hsiao's (1981) two-step approach to determine the length of the lag structure; the causal relationship between related segments of the RMS and the PSE were examined in the context of the following models:

$$\Delta X_t = \alpha_0 + \sum_{i=1}^{k1} \alpha_i \Delta X_{t-i} + \sum_{i=1}^{k2} \beta_i \Delta Y_{t-i} + \varepsilon_t \qquad (4)$$

$$\Delta Y_t = \chi_0 + \sum_{i=1}^{k3} \chi_i \Delta Y_{t-i} + \sum_{i=1}^{k4} \delta_i \Delta X_{t-i} + \nu_t \qquad (5)$$

where

X_t and Y_t denote price indices of the RMS and PSE, respectively.

For each segment of the market (A1, A2, B2, and C2) *k1*, *k2*, *k3* and *k4* were specified in a search method over a range of lag lengths from 1 to 30.[8] The optimal lengths were chosen invoking standard information criteria — Akaike (1969), Hannan-Quinn (1979), Schwarz (1978). Basically, Hannan-

[6] The test of the hypothesis '$\{x_t\}$ causes $\{y_t\}$', is equivalent to the test of the restriction $b(L)=0$. Similarly, the opposite direction of causality can be tested via the restriction $c(L)=0$.

[7] For instance, Thorton and Batetten (1985) show the sensitivity of the causal relationships to a chosen number of lags.

Quinn's and Schwarz's criteria provided us with the shortest specification. See Table 2 for the results for each segment of the PSE and RMS, respectively. When we looked for the maximum of a given information criterion (IC), we found that the value of the IC at the local maximum does not differ very much from the global one; nevertheless, the difference in the estimated length (i.e., memory of the model) is substantial. This phenomenon could be explained by the trading rules — the bottom and ceiling limits affect the length of the autocorrelation; it takes a few sessions to incorporate rapid changes into the price.

To test Granger-causality between different segments of the market, we estimated the autoregressive models (4) and (5) with the number of lags corresponding to the local and global maxima of the information criterion, respectively (See Table 3). For each model we verified the cointegration relationship between related segments of the PSE and RMS. Because the error terms were not autocorrelated and cointegration was not rejected for any segment, we tested the causal relationship between the segments of the markets.

$H_0 : \beta_i = 0$ for all i (i.e., no causality running from PSE to RMS)

and

$H_0 : \delta_i = 0$ for all i (i.e., no causality running from RMS to PSE).

[8] We did the search, in fact, for the range of lag lengths 1 to 10, 1 to 20, and 1 to 30, to see the sensitivity to the short and long lengths.

Table 3: Autoregressive order of the markets: using different information criteria.
# of lags — order x-lag, y-lag[9] (Durbin h alternative in parentheses)

Dependent variable		Global minimum according to IC: Hannan-Quinn	Akaike	Schwarz-Bayes	Local minimum according to IC: Hannan-Quinn	Akaike	Schwarz-Bayes
ΔPSE	A1	1, 23	13, 25	1, 23	2, 3	2, 3	1, 3
		(-0.36)	(1.84)	(-0.36)	(-0.61)	(-0.61)	(-0.68)
	A2	11, 1	11, 1	11, 1	11, 1	11, 1	11, 1
		(-0.80)	(-0.80)	(-0.80)	(-0.80)	(-0.80)	(-0.80)
	B2	29, 13	24, 29	20, 5	9, 10	9, 10	2, 10
		(-0.06)	(1.12)	(1.42)	(1.08)	(1.08)	(0.07)
	C2	19, 17	19, 17	19, 17	2, 10	6, 10	1, 6
		(-1.80)	(-1.80)	(-1.80)	(-3.80)	(-4.01)	(-1.96)
ΔRMS	A1	24, 4	29, 24	1, 3	1, 3	4, 3	1, 3
		(-1.60)	(-1.06)	(-0.80)	(-0.80)	(-1.27)	(-0.80)
	A2	1, 14	1, 14	1, 14	1, 14	1, 14	1, 14
		(-1.22)	(-1.22)	(-1.22)	(-1.22)	(-1.22)	(-1.22)
	B2	2, 13	2, 13	2, 13	1, 1	1, 1	1, 1
		(0.04)	(0.04)	(0.04)	(0.80)	(0.80)	(0.80)
	C2	1, 2	1, 2	1, 2	1, 2	1, 2	1, 2
		(-1.08)	(-1.08)	(-1.08)	(-1.08)	(-1.08)	(-1.08)

The results of consequent Granger causality tests are interesting (See Table 4).

Table 4: Granger causality between the corresponding segments of the markets:
F statistics (p-values in the parentheses)

Segment of the market:		A1	A2	B2	C2
Global minima	PSE=>RMS	6.333	2.312	3.065	0.073
		(0.0003)	(0.129)	(0.048)	(0.786)
	RMS=>PSE	1.278	56.126	3.754	2.987
		(0.259)	(0.000)	(0.000)	(0.000)
Local	PSE=>RMS	6.333	2.312	0.384	0.073

[9] Specification of lags k1, k2 means that the dependent variable is explained by k1 lags of the independent variable and by k2 lags of the dependent variable. For instance, (the first cell) of ΔPSE_A1 is 1, 23; i.e., for testing of Granger causality running from ΔRMS_A1, we have used 1 lag of ΔRMS_A1 and 23 lags of ΔPSE_A1, etc.

minima				
	(0.0003)	(0.129)	(0.536)	(0.786)
RMS=>PSE	1.874	**56.126**	**6.200**	1.846
	(0.172)	**(0.000)**	**(0.002)**	(0.175)

We found unidirectional causality for the segment of continuously traded stock (A1) running from the PSE to RMS, showing that the price of "blue chips" is primarily determined by the demand/supply of institutional investors on the PSE. For liquid stocks (segment B2) we detected causal relationships in both directions. On the other hand, because of low liquidity, the free market (segment C2) reflects primarily the supply side of the RMS (individual investors). This can be explained by the fact that the RMS serves as a source of large blocks of shares for the PSE or as a way to covertly concentrate ownership.

4. Comovements of PSE and RMS

Because PSE and RMS are very young markets, it would be interesting to look at the interdependencies over time and see if they increase. For this purpose we employed a rolling F-statistics, where the sample size is kept constant, for example 150 trading days. Results are striking; see Figure 1. We denoted by short and long response the specifications related to global and local maxima of information criteria, respectively (See Table 3). All segments but A1 were most likely affected by the change of trading frequency for C3 — the October 1995 (on the graph around 127) change from daily to

twice a week trading; the January 1997 (affecting start of the rolling window around 250-260) change from twice a week to daily trading. Another explanation of the drastic change in causal relationship may be the enactment of a new law on investment companies (effective July 15, 1995).

By and large, rolling Granger causality tests confirmed the leading position of the PSE on the segment of continuously traded stocks, A1. An interesting collateral hypothesis is how information (shock) is shared by these segments, and what the possible linkages across markets are. Because of the previous results, we expect to see a leading position of the A1 segment of the PSE.

To study inter-segments along with inter-market links we applied the VAR model. We used information criteria to choose an optimal lag structure. Not surprisingly, Schwarz's criteria (Schwarz (1978)) provided us with the shortest specification —3 lags.[10] Nevertheless, the results were quite robust to the number of lags used. Results are presented in Figure 2.

The key finding is probably a confirmation of the leading position of the PSE segments — basically, a shock on the PSE affected all segments on both markets, while a shock on any segment of the RMS has an effect (if any) only on the corresponding segment of the PSE.

5. Conclusions

The relationship between the PSE and RMS has not been seriously studied yet. The present paper has tried to provide the first deep insight into

the interactions and sharing of information between the organized markets in the Czech Republic.

The empirical results indicate that new information appearing on the market of continuously traded stocks (A1) of the PSE strongly dominates the corresponding segment of the RMS. On the other hand, the RMS dominates on the segments with lower liquidity. The leading position of the PSE was confirmed via VAR models. Basically, a shock on the PSE affected all segments on both markets, while a shock on a segment of the RMS has an effect (if any) only on the corresponding segment of the PSE.

Because of missing links between some market segments, we conclude that the PSE-RMS do not behave as one integrated market yet. This market inefficiency is due partly to different transaction costs, partly to different institutional designs (supply on the RMS is primarily formed by individual investors) and partly to the concentration of ownership on the RMS.

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[10] The other criteria suggest picking the lag length 9 and more.

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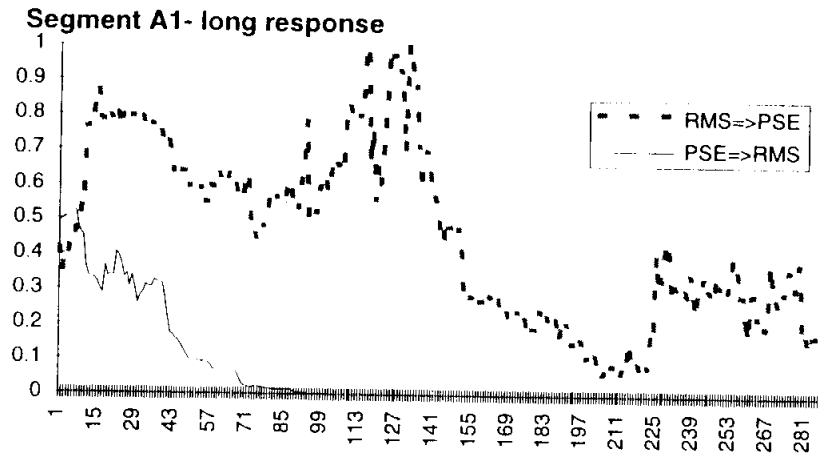
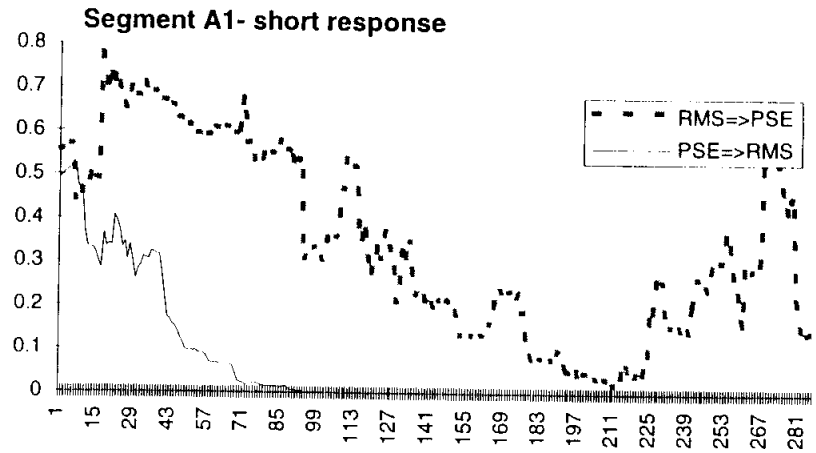
Figure 1. Rolling Granger causality tests





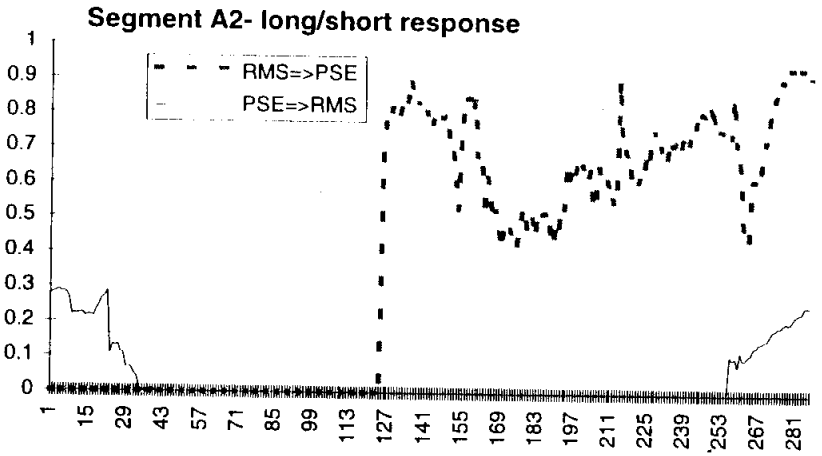
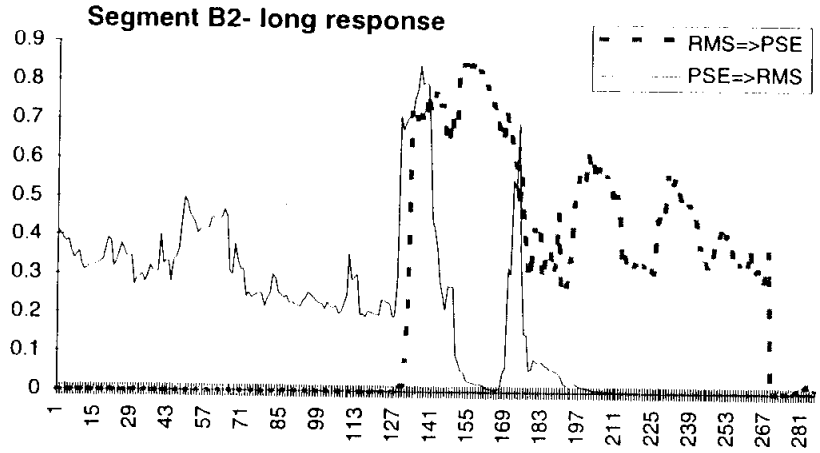
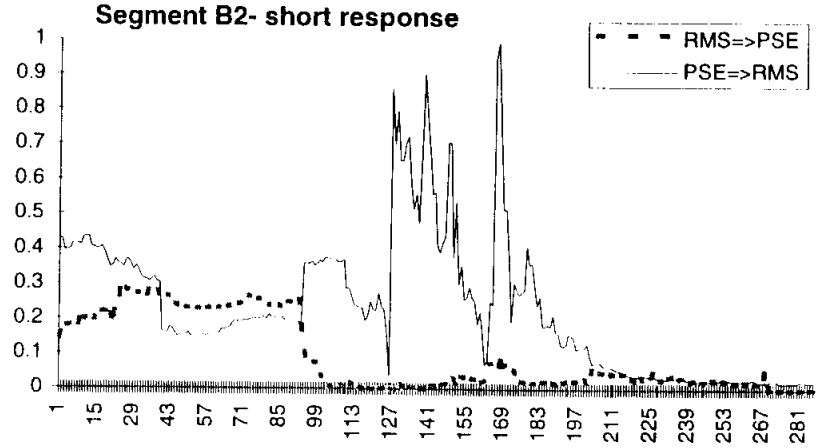
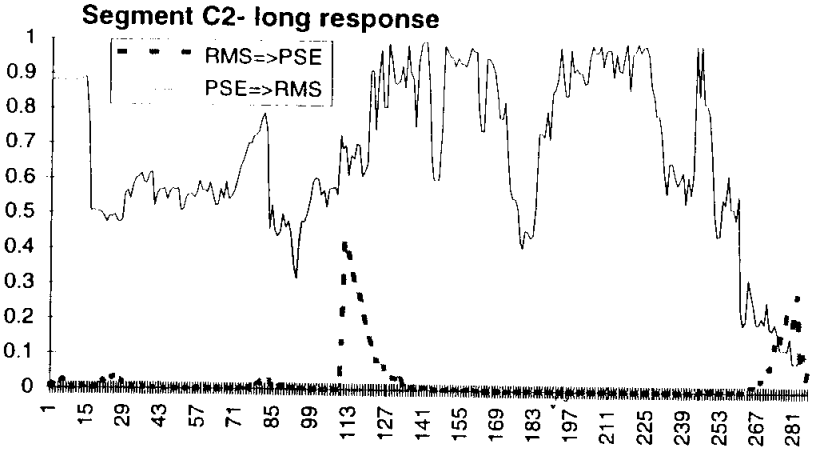


Figure 1. Rolling Granger causality tests, cont.







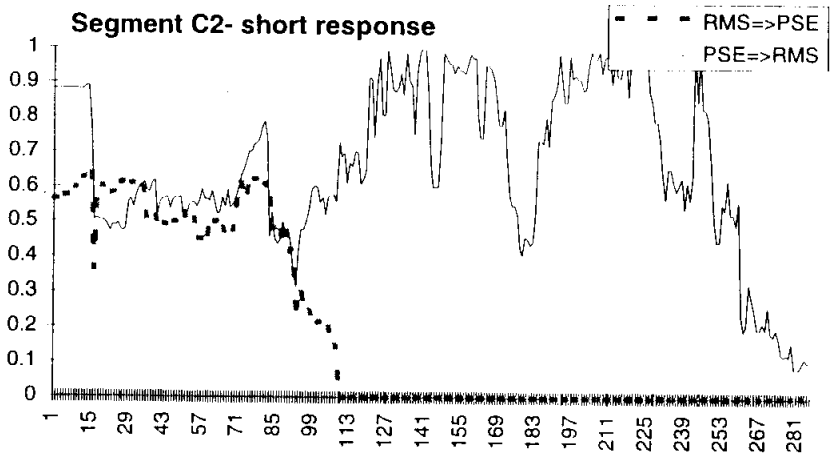
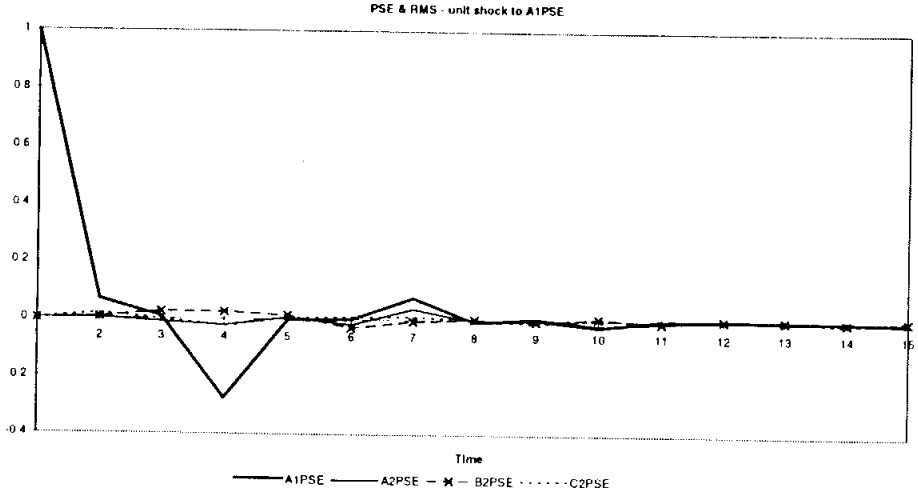
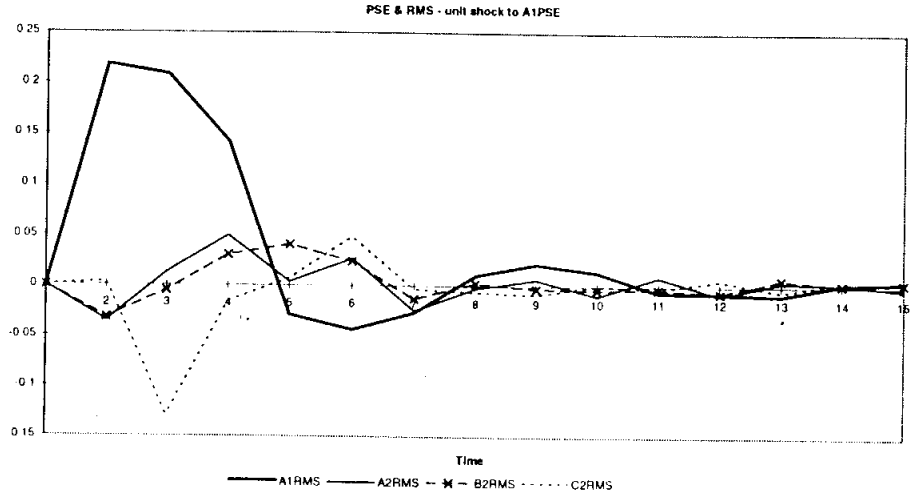
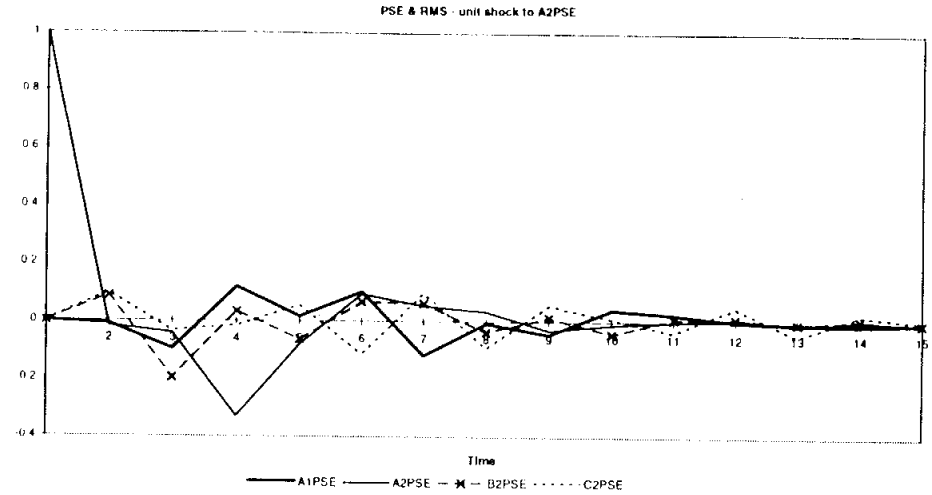


Figure 2. Impulse Response Functions







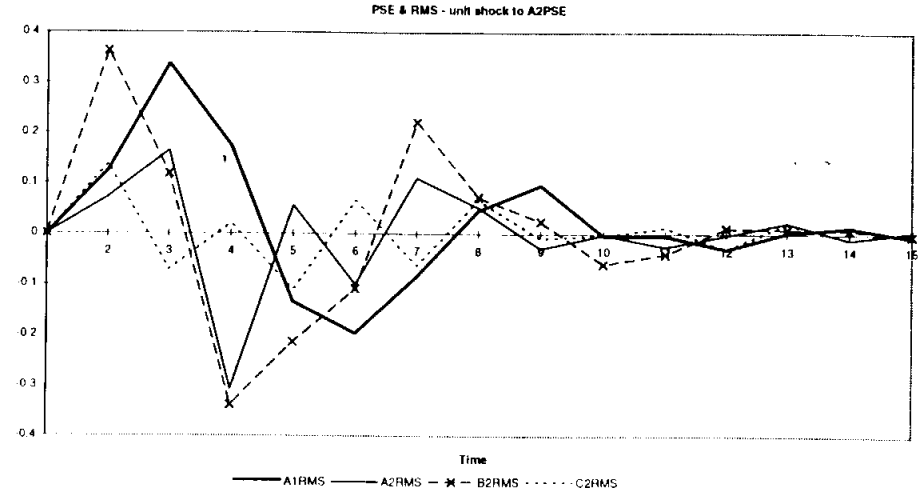
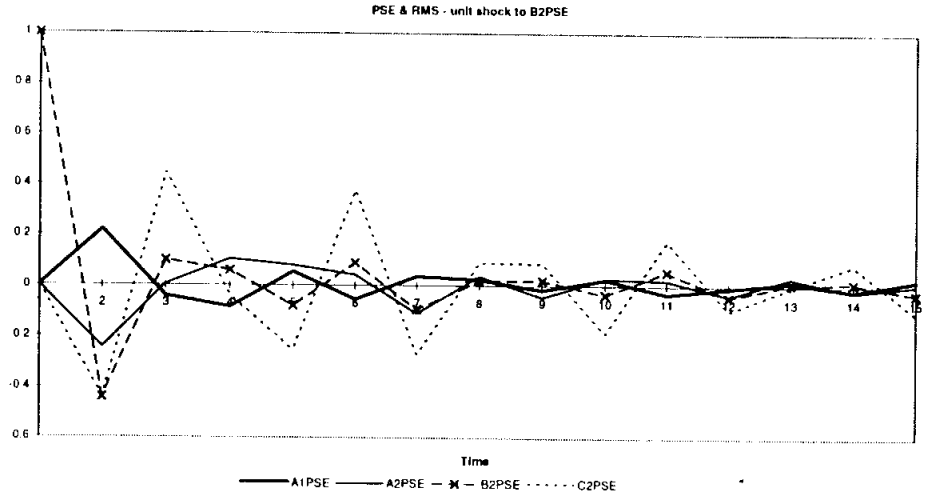
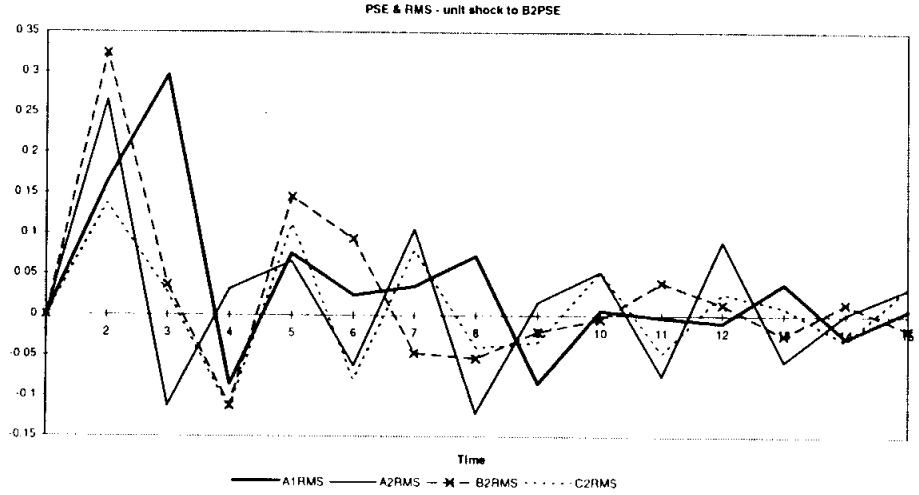
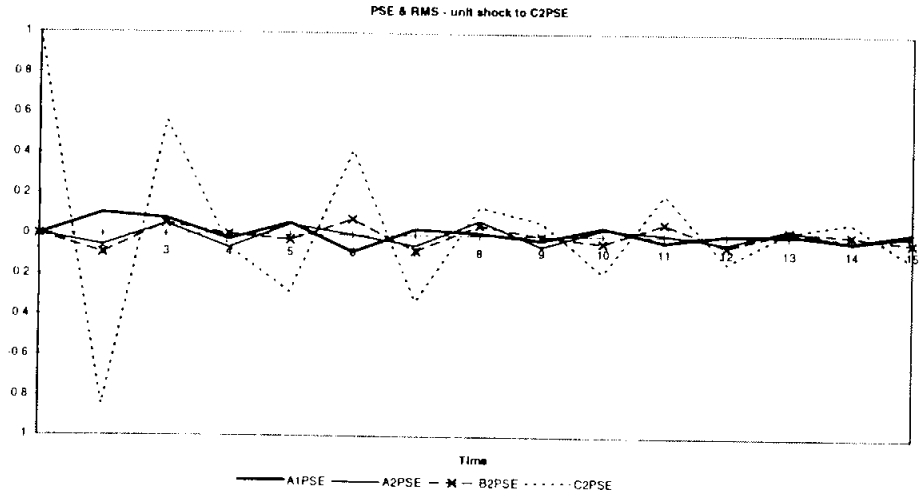


Figure 2. Impulse Response Functions - cont.







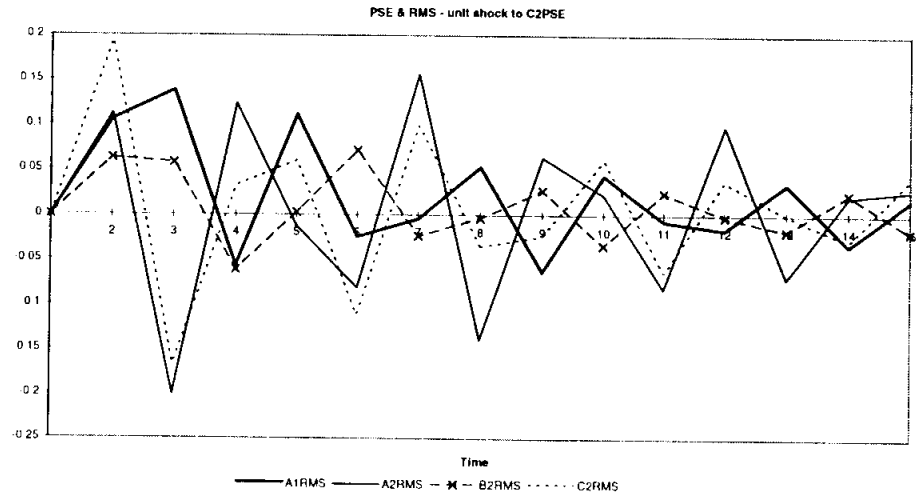
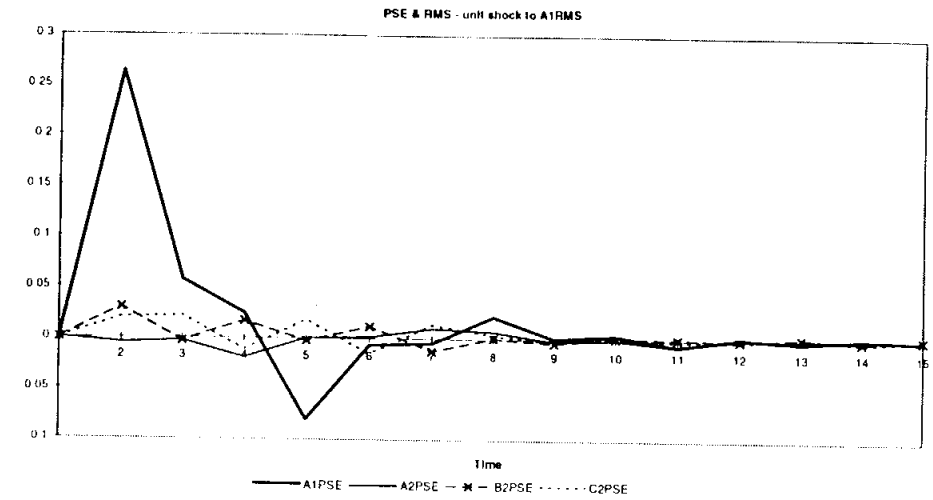
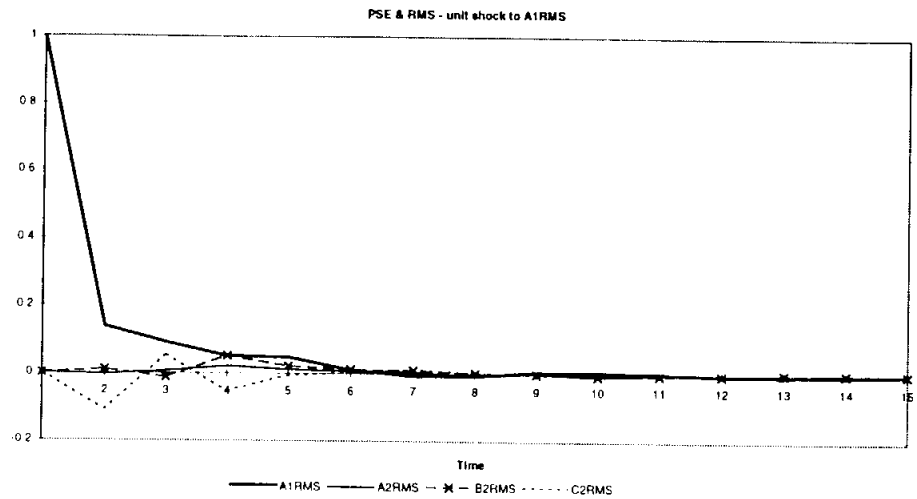
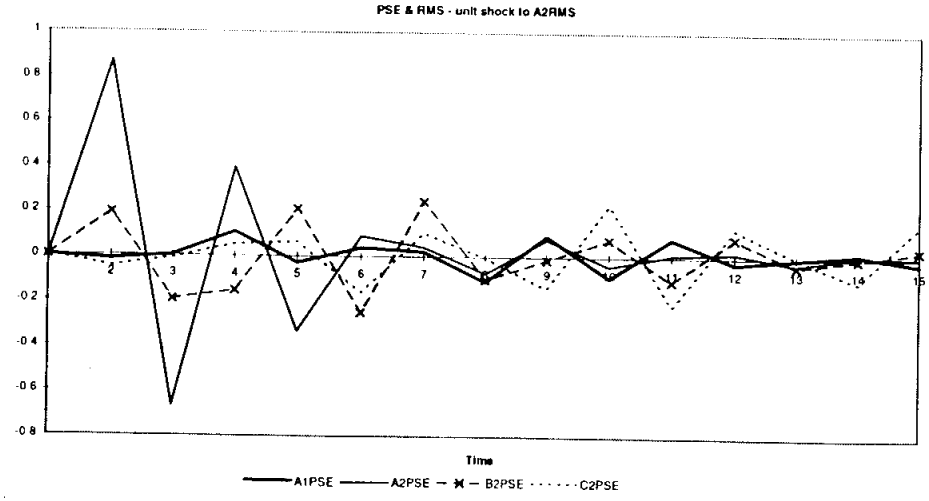


Figure 2. Impulse Response Functions - cont.







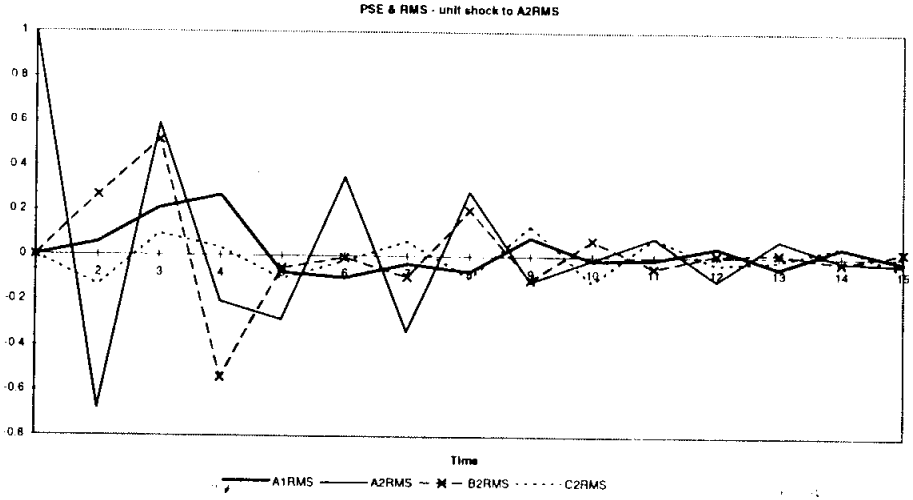
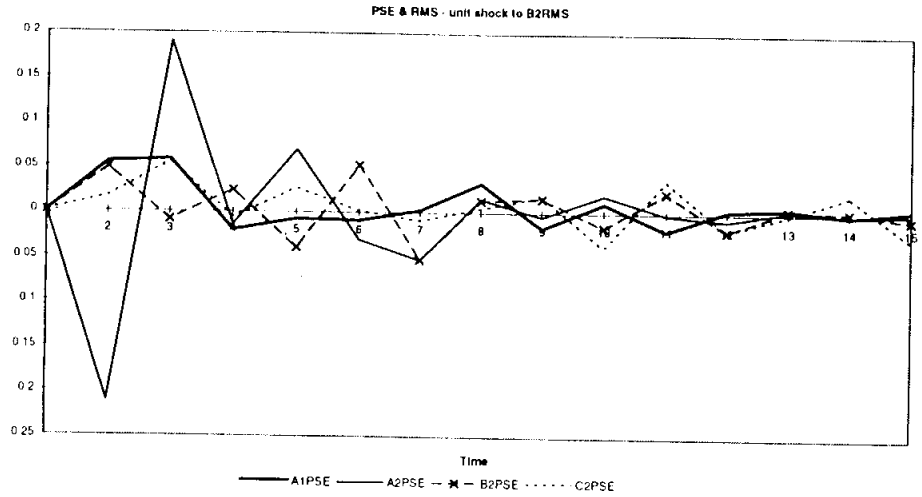
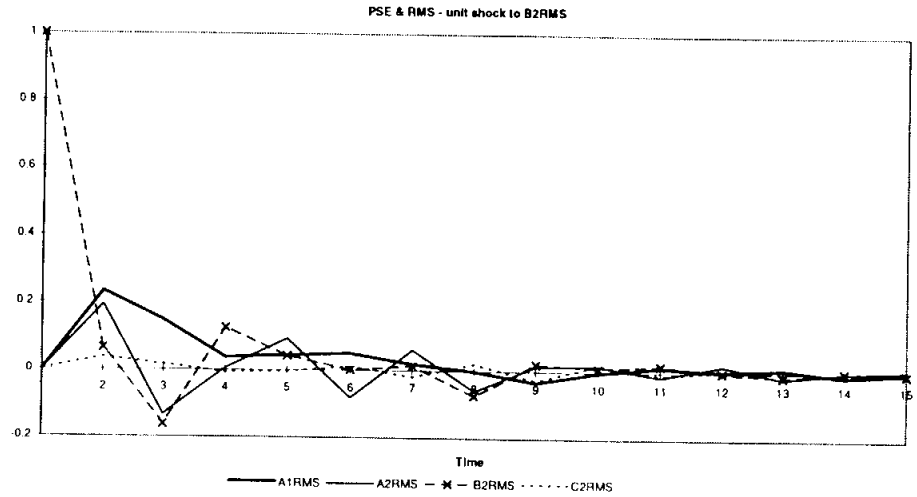
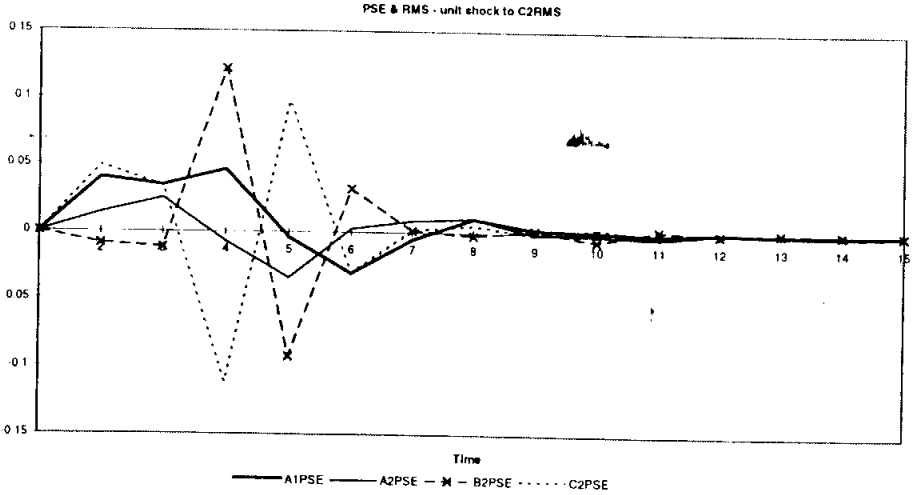
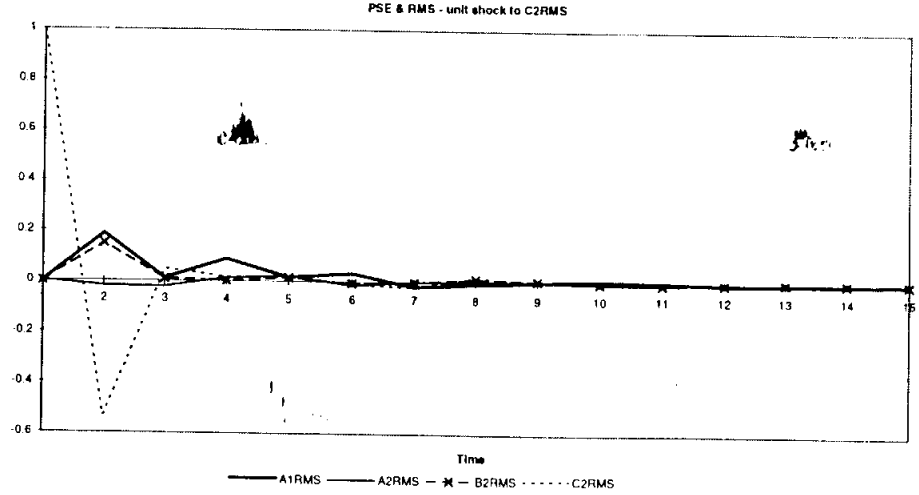


Figure 2. Impulse Response Functions - cont.


PSE & RMS - unit shock to B2RMS
Time
A1PSE
A2PSE
B2PSE
C2PSE


PSE & RMS - unit shock to B2RMS
Time
A1RMS
A2RMS
B2RMS
C2RMS


PSE & RMS - unit shock to C2RMS
Time
A1PSE
A2PSE
B2PSE
C2PSE


PSE & RMS - unit shock to C2RMS
Time
A1RMS
A2RMS
B2RMS
C2RMS