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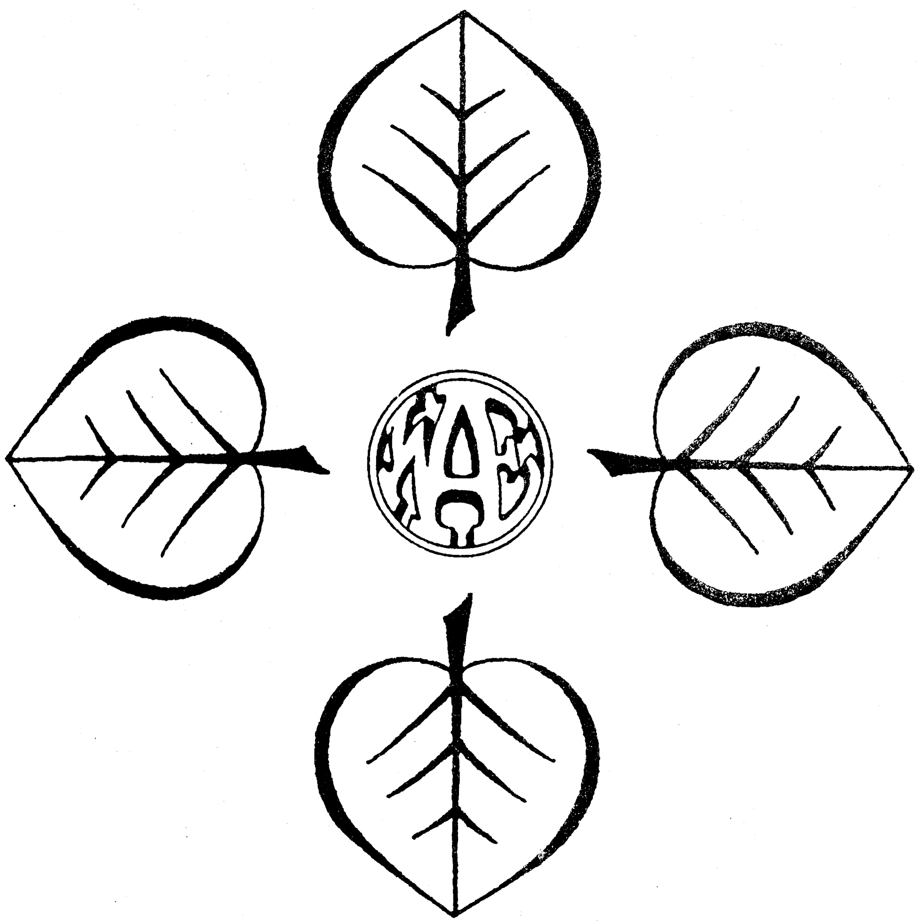

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Weekly Price Dynamics in International Wheat Markets

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Abstract

A vector autoregressive model was used to evaluate weekly wheat price dynamics in international wheat markets. The effects of exchange rates and ocean freight rates were also investigated. The results suggest that there are significant dynamic relationships among prices in different international wheat markets, and between the prices and ocean fright rates and exchange rates.

The world wheat market is characterized by noncompetitive trade behavior and an imperfect market structure. Five major exporters-the U.S., E.C., Canada, Australia, and Argentina-make up about 35-45 percent of total world production, but about 90 percent of world exports. An imperfect market structure has contributed to highly volatile prices in the international wheat market. However, weekly prices in major international wheat markets show almost the same fluctuations. This is due mainly to substitutability among wheats of different countries of origin, and the resulting interactions among their prices.

An analysis of the price discovery process may ensure the better capture of reality than the analysis of price determination in international commodity markets because the price discovery process includes the diverse activities of individual traders, futures markets, spot and forward cash markets, market news services, and commodity speculation. International price linkages may be better understood through an evaluation of the dynamic elements influencing international commodity markets. The dynamic price adjustment paths in individual markets in response to shocks to exogenous variables, such as ocean freight rates and exchange rates, as well as to price shocks in alternative markets, may have important implications for the overall performance of international commodity markets. The main objectives of this paper are to evaluate the dynamic elements of spatial price linkages in international wheat markets and to analyze the time path of exchange rate and transportation cost effects on the wheat prices.

As Rosensweig and Koch (1988) noted, export prices in dollar terms are expected to remain more or less stable in response to changes in dollar exchange rates in the short-run, even though the prices might rise slightly in the longer run. However, changes in the dollar's value against other exporters' currencies would affect competitors' export prices due to risk with exchange rate changes when competitors transfer their earnings into domestic currency to reimburse producers and meet other non-dollar expenses. Importers also face risk with exchange rate changes between the time they sign the sales contract and the time when importers convert their currencies into U.S. dollars. Freight rates are also an important component of international price linkages for traded commodities. In a situation of perfect arbitrage, commodity prices in corresponding import and export markets should differ by no more than the transportation costs of trade between the two markets. Changes in freight rates should thus be reflected by equilibrating changes to price in trading markets.

The exact nature of price relationships in international wheat markets has been addressed in several investigations. Spriggs et al. (1982) estimated the price leader-follower relationships between U.S. and Canadian wheat prices using the concept of Granger causality. Binkley (1983) evaluated the effects of freight charges and other marketing costs on wheat price stability. Roe et al. (1986) evaluated price responsiveness in light of governmental interventions using price transmission elasticities. Gilmour and Fawcett (1987) examined relationships between the U.S. and Canadian wheat prices. Bessler and Babula (1987) examined the effects of real exchange rates on real wheat prices by an using unrestricted vector autoregression model. Bradshaw and Orden (1990) examined whether the real trade-weighted agricultural exchange rate helps predict monthly real prices and export sales of wheat, corn, and soybeans by using in-sample and out-of-sample Granger causality. Goodwin and Schroeder (1991) evaluated dynamic relationships among international wheat prices by using an eight-variable VAR model Their results suggest significant dynamic relationships in different international wheat markets and between the prices and exchange rates and ocean freight rates. Except for Spriggs et al., and Goodwin and Schroeder, relatively little attention has been focused upon the price dynamics of international markets.

Empirical Model Development

To examine weekly dynamic relationships among wheat prices in six important trading countries, a eight-variable VAR model is developed. A VAR system for n variables can be defined as:

$$Y_t = \sum_{k=1}^{K} \begin{bmatrix} b_{11}(k) . & . & .b_{1n}(k) \\ . & . & . \\ b_{n1}(k) . & . & .b_{nn}(k) \end{bmatrix} Y_{t-k} + \epsilon_t \tag{1}$$

where t refers to time (t = 1, ... T), Y_t is an n x 1 vector of economic variables, K is the lag order of the system, the $b_{ij}(k)$'s are the parameters to be estimated, and ϵ_t is a white noise innovation vector having the properties: $E(\epsilon_t)$ is nx1 null vector for all t, and $E(\epsilon_t \epsilon_t')$ is nxn null matrix for $t \neq s$ or a nxn positive definite covariance matrix, Σ for $t=s$.

Each equation in the VAR system is estimated by OLS estimation, respectively. Because each autoregressive equation has the same right-hand-side regressors, OLS provides an efficient estimation procedure. An orthogonalizing transformation of the innovation vectors is performed using Choleski decomposition. Impulse response functions are used to examine the dynamic response of the prices to shocks in prices, exchange rates, and an ocean freight rate index. Standard errors of the impulse responses are calculated using the Monte-Carlo integration technique outlined in Doan and Litterman (1987). Decomposition of forecast error variances is used to infer the magnitude and sequence of influence among all the variables in the model. Forecast error variances are used to evaluate innovations in each series.

Data Development

The following weekly prices are used: export prices for U.S. No. 2 Dark Northern Spring wheat (DNS 14% protein, Gulf); No.1 Canadian Western Red Spring wheat (CWRS 13.5% protein, Vancouver); Australian Standard Wheat (ASW); Argentinean Trigo Pan wheat; Japanese import prices of No.1 CWRS wheat (13.5% protein); and Rotterdam import price of the U.S. No. 2 DNS (14% protein, Gulf).[1] These prices are obtained from the Review of World Wheat Situation (IWC) and from unpublished IWC data. These price data are expressed in U.S. dollar terms because world prices of grains are likely to be invoiced in terms of in U.S. dollars (McCalla and Schmitz; Bilson;

[1]Weekly data may provide certain advantages over monthly data. They allow an increased number of observations from any given data period. Weekly data may also allow more effective modeling of the short-run variations in quantities and prices. With such finely sampled data, greater detail in modeling the direction and strength of causal relationships between variables can be achieved.

Hathaway; Carter and Pick). For a small number of missing observations of Japanese and Rotterdam import prices, predicted values from regressions of these prices on the other export prices are used. To provide a measure of exchange rate effects in each of the dollar-denominated commodity markets, the IMF dollar/SDR (Special Drawing Rights) exchange rate index is used in this study. The exchange rates are obtained from the International Financial Statistics. The weekly grain freight rate index from the Chartering Annual is used as an aggregate measure of transportation rates.

Empirical Results

The unrestricted VAR model was applied to the weekly price, exchange rate, and ocean freight rate data from July 1978 through June 1986. Akaike's Information Criterion and Hannan-Quinn Criterion suggested that a 2-week lag order was appropriate while Schwartz's Criterion suggested a one-week lag order. However, with a one-week lag order, the Ljung-Box Q statistic indicated the presence of autocorrelation in residuals of one equation in the system. Therefore, a two-week lag order is used in this study. Strong contemporaneous correlation indicates that markets respond rapidly (i.e., within the one-week sampling period) to new information. The correlation coefficients for prices range in magnitude from 0.04 to 0.61.[2] Residual correlation coefficients are highest between individual markets and U.S., and Canada, indicating dominant roles of these two markets in world wheat price discovery. The forecast error variance decompositions were performed on the basis of the ordering which was determined by theoretical considerations and Granger causality tests.[3] The results of the in-sample forecast error variance decompositions indicate that Canada, U.S., and Australia are the most dominant markets (Table 1).

Impulse response functions illustrate price adjustments to one standard deviation shocks to each variable. Figure 1 illustrates the price adjustments of six international wheat markets to one standard deviation shocks to \$/SDR rate. The shock has little effect on the prices in terms of magnitude, even though the impulse responses are statistically significant at the 5 percent level. The shock has dominant effects on the prices at third week. The shock has long-lasting effects on Argentine export prices. This may be due mainly to Argentina's deliberate manipulation of its exchange rate against the U.S. dollar. A positive shock to ocean fright rate index immediately raises all prices and the positive responses are persistent over 24 weeks (Figure 2). Ocean freight rates have a more significant impact on the prices than exchange rates. Rotterdam and Japanese import prices rise more quickly than all export prices except Argentine price. Adjustments to innovations in the ocean freight rate index appear to take place over a significant length of time for the variables, as shown in Goodwin and Schroeder's study. This implies that adjustments to shocks in freight rate index are quite slow to occur.

Innovations in the U.S. and Canadian prices have significant positive effects on all the prices (Figures 3 and 4). In Figure 3, the U.S. price immediately rises to the shock and shows the largest response at the first week while the other prices have the largest responses at the second week. In

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[2]The correlation coefficients are lower than those in Goodwin and Schroeder's study (from 0.28 to 0.79) in which monthly data from June 1975 to December 1986 are used. This may reflect the fact that the use of weekly data better captures dynamic effects that occur within a month but across weeks.

[3]The causal ordering is \$/SDR Rates, ocean freight rate index, the U.S. price, Canadian price, Australian price, Japanese price, Argentine price, and Rotterdam price.

Figure 4, Japanese import price has the largest responses and impulse responses of all the prices are the highest at the second week. Impulse responses of all prices to shocks in the U.S. and Canadian prices are statistically significant over a 24-week period at the 5 percent level. This indicates the dominant roles for the two markets in the world wheat price dynamics.

A shock in the Australian price has fairly long lag effects over a 24-week period (Figure 5). The Australian price has the largest response to the shock. Argentine export prices respond more significantly than any other prices to the shock. In Figure 6, a shock in the Argentine price has significant effects on Australian export prices as conversely in Figure 5. This implies that Argentine and Australian export prices rigorously interact with each other. Interestingly, only the Australian price responds to the shock in a positive manner. Shocks to Japanese import prices have minimal effects on U.S., Australian, and Argentine export prices while Rotterdam import prices have significant effects on the prices (Figures 7 and 8). Most export prices steadily decline in response to positive shocks in Rotterdam and Japanese import prices.

Summary and Conclusions

An eight-variable vector autoregressive model is used to evaluate dynamic relationships among international wheat prices. The effects of exchange rates and ocean freight rates on prices are also investigated. Forecast error variance decomposition and impulse response functions are used to analyze price dynamics in six important international wheat markets. The results suggest that there are significant dynamic relationships among prices in different international wheat markets and between the prices and ocean fright rates and exchange rates. Ocean freight rates have more significant impacts on the prices than exchange rates. Canadian, the U.S., and Rotterdam prices have dominant effects on the prices. Australian prices also have significant effects on the prices, but less so than the U.S. and Canadian prices. Argentine and Japanese prices have noticeable effects on the other prices. These results indicate that an evaluation of weekly prices captures much more vigorous interactions than those revealed in an analysis of monthly prices by Goodwin and Schroeder.[4]

Table 1. In-Sample Forecast Error Variance Decompositions Attributed to Innovation in Each Price, July 1978 through June 1986.

Variables	Months Ahead	Standard Errors	USA	Canada	Australia	Japan	Argentina	Rotterdam
USA	1	4.794	99.2	0.0	0.0	0.0	0.0	0.0
	24	13.614	63.4	8.4	13.5	0.5	1.3	1.6
Canada	1	2.588	13.0	86.5	0.0	0.0	0.0	0.0
	24	11.284	9.9	63.2	0.5	0.8	0.5	4.3
Australia	1	3.374	7.9	10.5	80.4	0.0	0.0	0.0
	24	11.256	11.8	25.0	39.7	0.3	8.2	5.6
Japan	1	4.353	8.3	28.8	0.2	62.2	0.0	0.0
	24	14.403	11.1	54.6	1.0	13.4	0.3	3.7
Argentina	1	7.110	0.0	0.2	0.2	0.0	99.4	0.0
	24	19.572	8.2	4.9	6.9	2.0	59.8	1.3
Rotterdam	1	4.826	12.0	6.4	0.0	0.0	0.0	81.1
	24	12.951	36.8	19.1	5.3	1.3	1.4	15.0

[4]Particularly, innovations in Rotterdam, Japanese, Canadian, and Argentine prices have more significant impacts on all the prices in this study.

Figure 1 Impulse Responses to Standardized Shock in $/SDR Rates

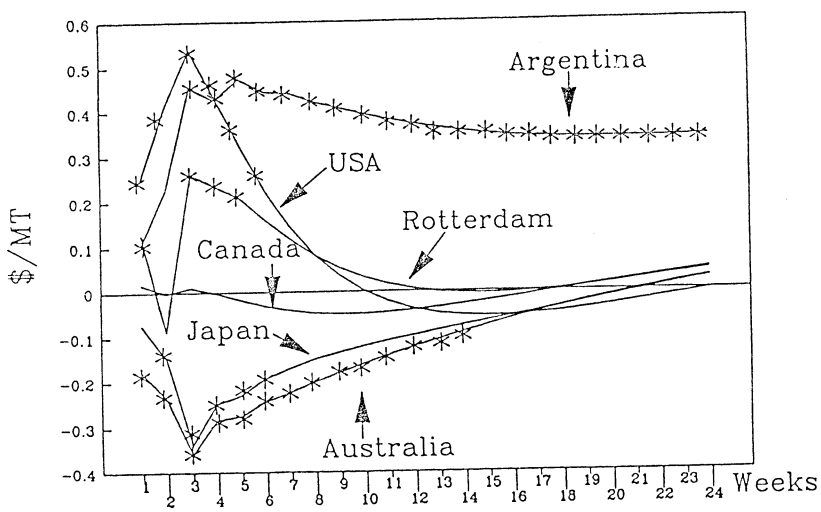


Figure 2 Impulse Responses to Standardized Shock in Ocean Freight Rate Index

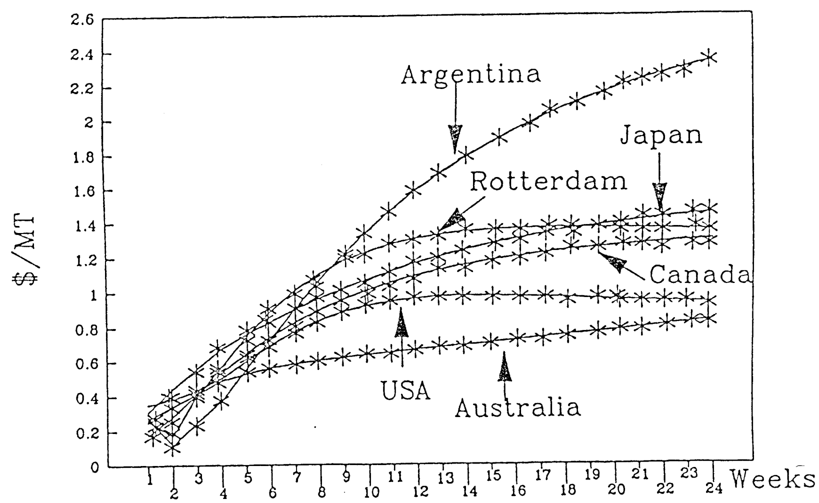


Figure 3 Impulse Responses to Standardized Shock in the U.S. Prices

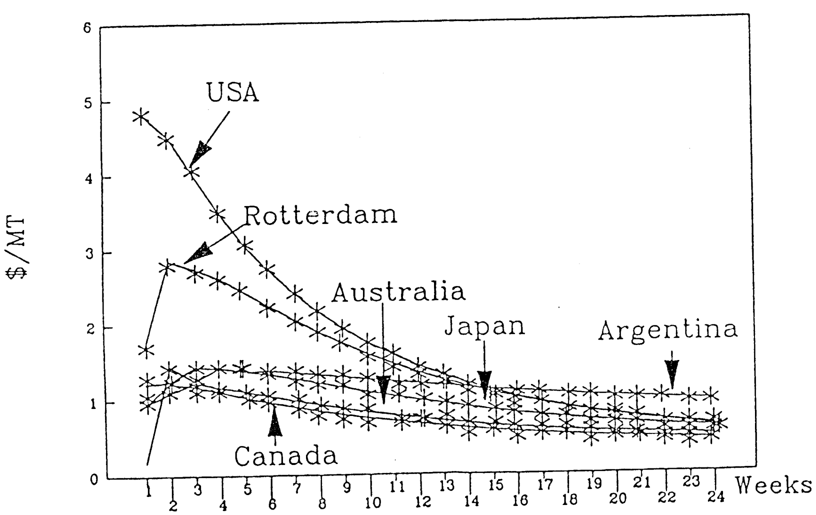
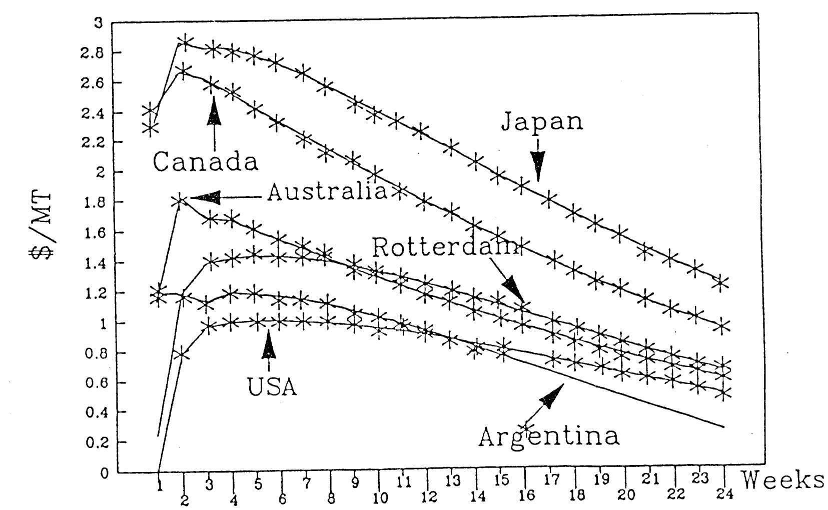


Figure 4 Impulse Responses to Standardized Shock in Canadian Export Prices



* indicates impulse responses significantly different from zero at 5% level.

Figure 5 Impulse Responses to Standardized Shock in Australian Export Prices

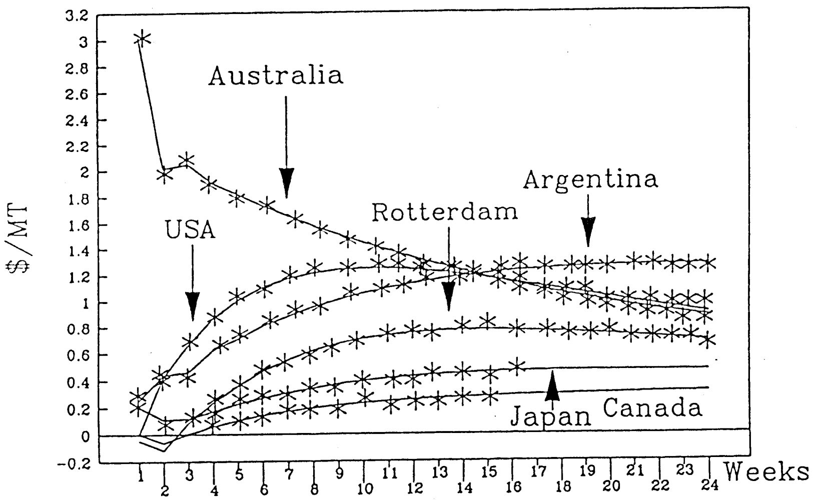


Figure 6 Impulse Responses to Standardized Shock in Argentine Export Prices

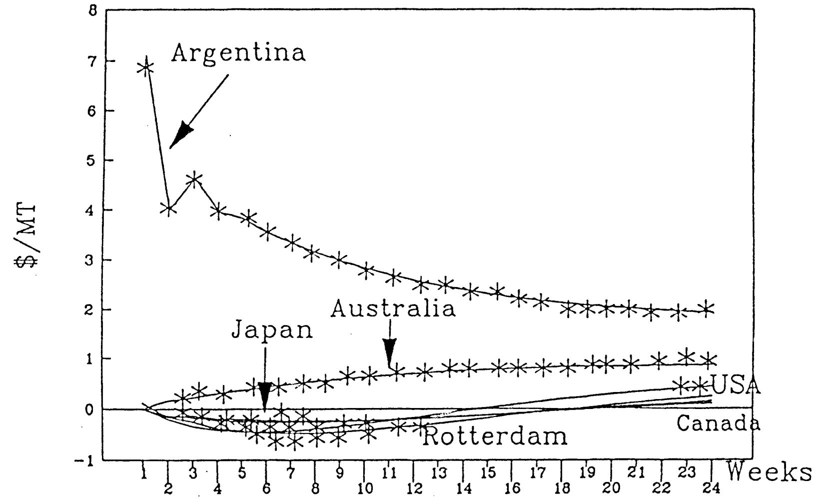


Figure 7 Impulse Responses to Standardized Shock in Japanese Import Prices

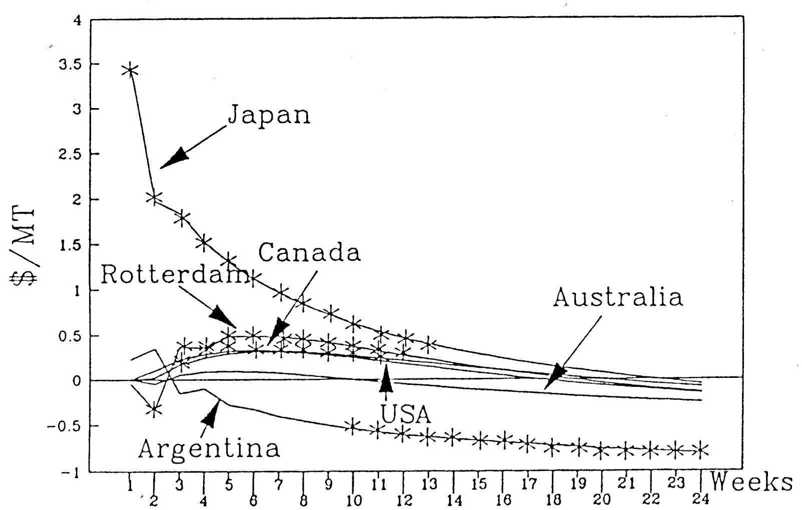
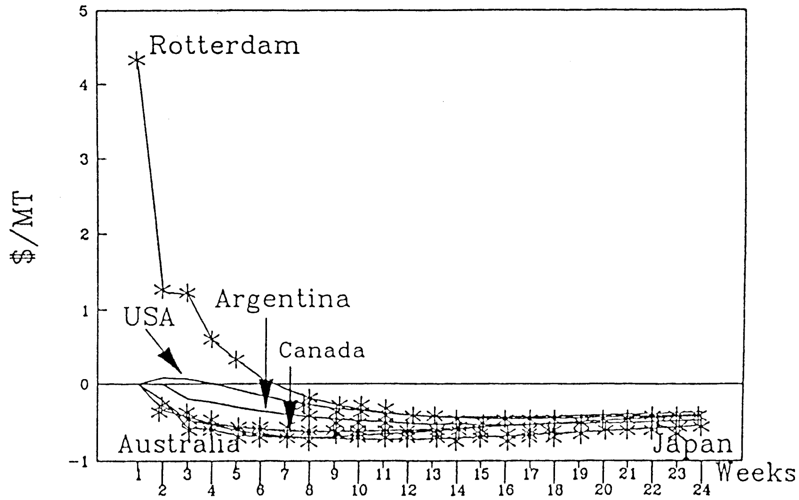


Figure 8 Impulse Responses to Standardized Shock in Rotterdam Import Prices



* indicates impulse responses significantly different from zero at 5% level.

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