Abstract

The Impact of US Monetary Policy and External Shocks to Small Open Economies

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The world has been highly connected and integrated that one country cannot think of surviving alone. What happened during the ’97 Asian Financial Crisis and how the ’08 Global Financial Crisis developed truly showed us that one country’s problem was that of every other country. Lately, the shockwaves coming from the other side of the world are getting much more often and much faster. If it were relatively small and open, the impact generated by external shocks like the two major global crises should be big. Then, do the external shocks really matter to these small open economies? Is the impact still effective in the long term? This paper is mainly designed to find out to what extent the monetary policy of the US and fluctuations of other external factors, in this paper, the oil price can affect small

open economies. So, I select 5 countries out of the OECD member list that share a similar economic scale and similar economic level and these countries are classified as small open economies. The vector regressive model has been developed through the research on the monetary policy and its effect over the domestic economy. However, until today, little have the development been made on research of the small open economies and the impact of external shocks. Some scholars such as Cushman and Zha have made some achievement to develop the most proper tool to estimate the external shocks over the small open economies and this methodology is called “a structural vector autoregressive model (SVAR model). Due to its effectiveness to find out the effect of the external shocks on the small open economies, I will use the structural VAR model. For the significance of factors whose fluctuations are caused by the external shocks on key economic indicators, I take the variance decomposition as well. Using the structural VAR model, it finds that by the negative external shocks, 5 countries experienced negative innovations of exchange rate, positive innovation, but quick decrease of exports, positive innovation but drastic fall of output, the rise of producer price index, positive innovation of interest rate, and lastly, positive monetary aggregates. Results of the variance decomposition show that exchange rates and export do affect on the changes of key economic factors which are producer price index, industrial productivity, and aggregate money which represent inflation, GDP and liquidity.

Key words*:* *small open economies, US economy, monetary policy shock, external shocks*

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Table of Contents

I. Introduction

The issue of how much impact big countries could give to small open economies and how effective external shocks are is to be very critical and of great an interest to the authorities and scholars in the small open economies. This is of course necessary since they are, more often than not, said to be completely exposed to the external shocks: a complex condition where they should concern about domestic circumstances and monitor what is happening outside at the same time.

For this issue, Mackowiak (2007) finds that external shocks explain almost one-half of variation of price level and exchange rate, one fifth of output. Mumtaz and Zanetti (2013) show that an increase in the volatility of the monetary policy shock generates a fall in the nominal interest rate, inflation, and output growth. ADB working paper series states that the international spillover effect of US quantitative easing on Asian economies is so strong that according to the paper, Asian economies experienced their GDP dropping down to 1.7% during the global financial crisis then bouncing back up to average 7.8% after the US began the expansionary monetary policy.

Korea Institute for Industrial Economics & Trade(KIET) suggests that in their study, effects of macroeconomic shock by 5% decrease of Won-dollar exchange rate could cause GDP to drop down to -0.35%, consumer price index to increase 0.5%, export volume to drop by 1.6%, and loss of 29 billion dollars of balance of payment.

This phenomenon is well explicated by the Mundell-flemming two-country model.

The Mundell-flemming two-country model suggests how the transmission mechanisms work between a big economy and a small economy, tracking the foreign exchange and output changes in the small open economies driven by the monetary policy shocks from the big country.

In case of relatively big and closed economies, like the U.S., as monetarists state, monetary policy is one of the causes of business cycles, leading to changes in output (Richard, 1990). For small open economies, however, the fluctuations in fundamentals are not only caused by domestic economic schemes but external changes take crucial part of the economic shifts.

Compared to significant development made in monetary policy shocks of a domestic economy for big economies by Bernanke and Blinder(1992), Eichenbaum(1993) and Kim(1999), there has been limited development in the study of the transmission mechanisms of the external shocks generated from the big economy which leads to fluctuations of small open economies.

Cushman and Zha(1997) developed the structural VAR model to better analyze impact of the external shocks to the small open economy, Canada, overcoming puzzles that can be found when examined with the conventional VAR model. Mackowiak(2007), on the other hand, also developed the structural VAR and found that US monetary policy shocks are an important source of changes of interest rates and exchange rates in emerging markets and the effect is quick and strong.

For the external impact relatively prolongs over the small open economies, and in real world, it intertwines many different economic factors, we need a methodology that is well suited to this trend. The structural vector autoregressive model

(SVAR model) well reflects this issue, which considers the external impact with many endogenous variables and within long time. Cushman and Zha(1997) explains that the vector autoregressive model *per se* creates empirical puzzles when applied to a case of small open economies as the traditional recursive approach does not consider the response to the exchange rate changes generated by external shocks, which is the most important factor to explain the small open economies. So for the small open economies, the structural VAR model is better fit.

Considering the matter of puzzles above, I estimate the SVAR model following the same methodology as Cushman and Zha (1992), following Gordon and Leeper (1994) and Sims and Zha (1995a)[1] , which is more suitable for the small and open economy.

My model includes two exogenous variables as indicators for external shocks, and six endogenous variables which represent economic fundamentals of small open economies. As small open economies are inclined to be under much influence of the fluctuations of the world commodity prices as well as the U.S. economic policy shifts, I use the federal funds rates and average crude oil prices to estimate the external shocks in the model. I assume that the two variables only affect the small open economies, but not affected, they are set as exogenous.

On the other hand, six other variables are the exchange rate, export index, producer price index, industrial productivity, interest rate, and monetary base of the small open economies. As these variables are merely subject to the external shocks and,

[1] Cushman and Zha (1997)

therefore, have no influence over external shocks; they are endogenous.

Since the small open economies here are assumed to be sensitive to the external shocks, they show quick, short-term responses. Furthermore, as the responses are to reflect only the external shocks and avoid other possible structural shocks, variables should be carefully chosen to satisfy this condition. For this matter, I select producer price index to estimate inflationary innovations as when either the exchange rate or commodity price changes, producers in the small open economies quickly adjust to the fluctuation. Then the producer price index should reflect the change quicker than any other indicator. This process will be more obvious in countries where import as well as export actively takes place.

For the same matter, I use industrial productivity to investigate how the nation's productivity responds to the external changes. M1 aggregate money liquidates most quickly, therefore, can be a good indicator which shows quick adjusting movements to the shocks. Also, call rates are the quickest indicator that reflects market changes.

In the SVAR model, I impose general identifying restrictions on the action and reaction between the exogenous variables and the endogenous variables.

Furthermore, I execute the variance decomposition on key economic factors that show one country's economic performance to see which variable is most effective in changes of the fundamentals after the external shocks. Here, the key economic factors are inflation, GDP, and liquidity; these three factors are represented by producer price index, industrial productivity, and M1 aggregate money for each.

I select five sample countries, which are Canada, Ireland, Korea, Mexico, and Turkey from the OECD member countries that share a similar level and scale of economy.

The results show that if US monetary policy and oil price have a negative innovation, these economies experience negative innovations of exchange rate, positive innovation, but quick decrease of exports, positive innovation but drastic fall of output, the rise of producer price index, the rise of interest rate, and positive monetary aggregates. All in all, fundamentals that experience the fluctuations generated by the external shocks either adjust to the new level or go back to their initial level. In other words, the effect tends to weaken in the long run.

Also, the results of the variance decomposition show that exchange rates and export have significant effect on changes of the aforementioned key economic factors and it is powerful in certain economies that are either integrated with U.S. economy or relatively more open.

The paper is organized as follows: section II introduces the structural VAR model for the small open economies, section III describes the identification and the choice of variables, section IV shows empirical results including results of variance decomposition, and section V will give the conclusion of this paper.

II. Methodology

Modeling VAR

By using the structural autoregressive model (SVAR), we can yield more fitted results for the small open economy. In this paper, I will mainly follow Cushman and Zha (1997).

I consider the following SVAR model:

$Z(L)y(t)=u(t)$

(1)

where y_t is a m x n vector of , Z(L) is a m x m matrix polynomial in the lag operator L and var(u_t), y(t) is a m x n vector which takes past data, and u_t is a m x n vector of shocks, or, structural disturbances. u(t) is serially uncorrelated. And

$$y(t) = \begin{bmatrix} y_1 \\ y_2 \end{bmatrix} \qquad A(L) = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ 0 & A_{21}(L) \end{bmatrix} \qquad u_t = \begin{bmatrix} u_1(t) \\ u_2(t) \end{bmatrix}$$

(2)

where $A_{11}(L)$ is m_1 x m_1, $A_{12}(L)$ m_1 x m_2, $A_{22}(L)$ m_2 x m_2, $y_1(t)$ m_1 x 1, $y_2(t)$ m_2 x n, $u_1(t)$ m_1 x n, and u_2 m_2 x n where $m_1 + m_2 = m$.

Also, the so-called 'block exogeneity restriction' which is defined here as $A_{21}(L)=0$ in this matrix implies that the second block $y_2(t)$ does not enter into the first block $y_1(t)$ either contemporaneously or for lagged variables in the structural form (1).

III. Identification and Variable Selection

The order of the impact generated by either the US Federal Funds Rate or changes of US monetary aggregates and commodity price is set up as follows: the exchange

rate has first impact from the shocks, and the impact is set to move on to the export, industrial productivity, thereby affecting the producer price index, call rate and lastly, monetary aggregates of the small open economies.

The logic behind the order of the endogenous variables is that if the US shifts its position from the current policy and the commodity price fluctuates, then the small open economies will get this external impact. As predicted, their exchange rates first respond to the external changes, and by the changes of their currency values, either appreciation or depreciation, their export quickly picks it up and will get the full effect. This will make their industrial productivity therefore producer's price index shift. As the whole economic performance changes, the financial market and money supply will move, too, which are identified as "call rate" and narrow money, "M1".

There are 12 lags overall, and the estimation periods for each country are as follows: Canada from January 1986 to July 2014, Ireland from January 1996 to April 2014, Korea from January 1992 to July 2014, Mexico spans from Jan. 1995 to Jul. 2014, and Turkey from May 1987 to June 2014. The data series used are monthly, and 36 months are examined for the impulse response.

IV. Empirical Results

The empirical tests were performed in the form of structural VAR model with short-run restriction: Ae=Bu where E(uu `) = I.

The data are impulse responses for 36 months of each country to one standard deviation of US interest rate (us_ffr) shocks and commodity price (oil_ave) shocks, which are described as 'the external shocks'. Six other variables are classified as 'endogenous' and ordered as follows: exchange rate(exr), export(exp01), industrial productivity (inp), producer price index(ppi), call rate(car), and aggregate money(m1).

The Appendix B is test results for individual countries after running impulse responses under Cholesky decomposition. All five countries showed similar patterns and they mostly satisfy the expected results, although some showed relatively divergent levels of innovations.

All countries had positive exchange rate innovations towards the negative external shocks. The export responded positively then quickly dropped. The industrial productivity responded positively and then drastically dropped afterwards and the producer price index also rose. The call rate responded positively and gradually decreased. Monetary aggregates also responded positively and then more or less maintained its level throughout the designated periods. The effect of the external shocks gradually faded away as time flowed.

In the next subsection, I report results of variance decomposition of inflationary fluctuations, level of productivity, and monetary base. The variance decomposition shows how important each factor is to affect another factor's variation. That is, it is to find which factor is the biggest cause of change.

Variance Decomposition

In this section, I report results of variance decomposition of each variable to analyze whether exchange rates and export have much effect on the fluctuations of inflation, productivity, and aggregate money which are important domestic indicators to measure economic conditions. The variance decomposition shows how each factor acts as cause of another factor's change. By this, we can find which factor is the biggest cause of variation.

Table 1 displays variance decomposition of producer price index(PPI) with the results of exchange rate(EXR), export(EXP01), and interest rate(CaR). As time flows, exchange rate takes up bigger part of PPI change in Canada, Ireland, and Korea. In particular, the exchange rate explains more than half of fluctuations of producer price index in Ireland, Korea and Mexico. In case of Ireland and Korea, both the openness and financial market and trade are large. In Ireland, exports and imports already exceeded almost 200 percent of Irish GDP by 2010 (Bermingham and Conefrey, 2011) and export in Korea accounts for more than 140 percent of its GDP. In case of Mexico, it can be explained with its economic closeness and integration with the US economy.

Notice that the variation of producer price index in Turkey is explained almost by 30 percent of call rate by the end of the period, surging from 0.8 percent in the 3rd month.

Table 1. Variance Decomposition of Producer Price Index

Country/month		3	6	12	24	36
Canada	EXR	16.83122	23.69909	24.37531	25.17869	30.56333
	(stdv.)	(4.52864)	(6.71942)	(8.50415)	(11.0977)	(14.2212)
	EXP	5.274233	8.547661	12.69404	9.743040	7.616174
	01	(3.02277)	(5.28217)	(7.52168)	(6.73757)	(6.10204)
	CaR	0.064791	0.244760	0.283757	9.780453	15.31198
		(0.49070)	(1.30902)	(1.96096)	(6.97889)	(9.17885)
Ireland	EXR	3.659779	9.809009	24.12407	53.32951	64.10673
		(3.14695)	(6.58772)	(9.83476)	(12.4180)	(13.7124)
	EXP01	1.087284	0.884202	1.653409	1.312577	0.996585
		(1.43400)	(2.07979)	(2.92363)	(3.13392)	(3.62716)
	CaR	7.684786	6.538458	7.018145	4.040077	3.328439
		(4.05607)	(3.80292)	(4.28280)	(3.39220)	(3.67915)
Korea	EXR	45.94912	61.52374	66.10849	75.24718	79.63671
		(6.34737)	(7.81619)	(9.95817)	(12.6676)	(14.1640)
	EXP01	3.855035	3.277161	10.48759	9.987001	8.463564
		(2.57400)	(4.11123)	(8.27044)	(9.13959)	(9.25207)
	CaR	1.143676	3.919960	3.452736	2.044569	1.841005
		(1.27374)	(3.29768)	(3.88404)	(4.26885)	(5.10942)
Mexico	EXR	64.21793	68.23951	60.44014	55.17780	53.35705
		(6.75502)	(8.74681)	(11.6596)	(13.5932)	(13.4177)
	EXP01	0.171812	1.589312	2.978169	1.710961	1.524145
		(0.78376)	(3.49255)	(7.75796)	(9.47494)	(10.8764)

	CaR	0.000622 (0.46161)	0.141141 (1.06361)	1.302732 (3.35225)	3.222611 (5.88559)	3.927216 (6.46563)
Turkey	EXR	51.97192 (5.49552)	63.75378 (7.16717)	59.02454 (9.64424)	50.91029 (13.0896)	46.43457 (14.4444)
	EXP01	0.756666 (1.07766)	0.485405 (1.21714)	1.804465 (2.41409)	8.834675 (6.94955)	11.14960 (8.43314)
	CaR	0.790633 (0.75421)	3.517115 (2.52850)	13.41316 (7.18480)	21.40700 (11.4678)	28.95979 (14.6759)

As expected, exchange rates and export are significant causes of the variance of industrial productivity change(table 2). Throughout all five countries, the significance of these two factors gets stronger, approximately 25 percent in case of Canada, and almost 20 percent in Korea. This is because not only the openness, but economic integration with the US is strong in Canada. This explanation is propped up by the role of exchange rates in the variance of aggregate money, which explains 10 percent of the variance. It is the highest amongst other countries (table 3).

Table 2. Variance Decomposition of Industrial Productivity –Exchange Rate, Export

Country/month		3	6	12	24	36
	EXR	1.945816	1.865785	3.868763	4.732641	4.817148

Canada		(1.88691)	(1.83132)	(2.21473)	(2.24276)	(2.45189)
	EXP01	19.67405	20.34720	19.97309	21.09102	21.02742
		(3.52074)	(3.41675)	(3.27654)	(3.14326)	(3.14858)
Ireland	EXR	1.503781	2.732223	4.695087	4.750700	4.779445
		(2.30590)	(3.29791)	(4.20300)	(4.27733)	(4.55604)
	EXP01	10.55133	11.72636	11.37291	11.29907	11.42772
		(4.52506)	(4.82741)	(4.25079)	(4.33825)	(4.59791)
Korea	EXR	7.866865	10.91120	13.09113	13.00774	13.21724
		(3.31142)	(3.52385)	(3.01251)	(3.03398)	(3.30458)
	EXP01	12.86632	15.51563	14.31793	14.92985	14.90686
		(2.99696)	(3.19165)	(2.90207)	(2.79259)	(2.98244)
Mexico	EXR	0.677001	1.385589	5.411651	6.346603	6.378278
		(1.44356)	(2.34023)	(2.79411)	(3.08218)	(3.18668)
	EXP01	2.878932	2.948834	6.830772	8.537643	8.623013
		(2.91980)	(2.93242)	(3.26221)	(3.46133)	(3.53807)
Turkey	EXR	0.228535	0.627231	2.254215	2.439157	2.458894
		(0.76478)	(1.27330)	(2.21577)	(2.63157)	(2.68855)
	EXP01	16.59559	15.99610	16.23252	16.95111	17.34251
		(4.06021)	(3.69825)	(3.38063)	(3.35696)	(3.56711)

Interestingly, export explains more than 10 percent of the variance of aggregate money in Mexico. This is due to Mexico's dependence on the US import, which became more than 14 times bigger in 2014 compared to 1985.

Also, I found that once the exchange rate is less significant in first several months, but it becomes very strong factor especially between 24th and 36th month to explain the variance of aggregate money in Korea, which implies it has a long term effect. This can be explained by the financial market condition in Korea which has been completely liberalized since the'97 Asian Financial Crisis.

Table 3. Variance Decomposition of Aggregate Money(M1)-Exchange Rate, Export

Country/month		3	6	12	24	36
Canada	EXR	10.34729 (4.07673)	8.033666 (4.78039)	6.399048 (6.32066)	6.082453 (10.2739)	6.046528 (13.0713)
	EXP01	0.094379 (0.93429)	0.585172 (1.70987)	2.343175 (3.37527)	2.618043 (3.95587)	1.995053 (3.59470)
Ireland	EXR	2.171987 (2.77331)	1.629388 (3.61784)	1.085939 (4.43935)	2.586434 (8.20901)	3.085497 (10.5240)
	EXP01	0.100184 (1.28952)	0.109207 (2.15096)	1.087172 (3.91398)	0.773332 (3.98905)	0.619763 (3.98558)
Korea	EXR	0.741294 (1.42928)	5.473599 (4.45779)	6.839138 (6.44792)	6.872087 (6.09682)	24.59243 (12.9893)
	EXP01	0.093965 (0.99981)	1.859289 (2.84648)	5.682632 (6.48385)	6.452647 (8.25160)	4.229581 (7.51749)
Mexico	EXR	4.222653 (4.39076)	3.246420 (5.69541)	4.399622 (6.89517)	3.900717 (7.07644)	3.592923 (7.46237)

	EXP01	0.076229 (1.43523)	0.284290 (2.00184)	1.349490 (5.16279)	9.277413 (13.7852)	10.84254 (16.0607)
Turkey	EXR	9.150393 (4.28936)	5.200531 (3.48957)	2.120070 (2.80911)	1.429583 (4.27450)	1.435232 (5.81749)
	EXP01	0.050268 (0.71938)	0.467904 (1.56115)	1.011534 (2.86156)	1.042532 (4.39816)	1.128894 (4.91774)

V. Conclusion

Mostly, five countries showed similar patterns in all respects with some degree of difference in the level of changes.

On the negative external shocks, exchange rates of all five countries responded positively; the export indicator showed positive innovations then quickly dropped; the industrial productivity responded positively and then soon dropped afterwards; the producer price index rose; the call rate responded positively and gradually decreased; monetary aggregates also responded positively and then more or less maintained its level throughout the whole period of 36 months. As predicted, the effect of the external shocks gradually faded away as time flowed.

Although some countries show different responses to the shocks, it is only a matter of level, not a total divergence. To find the detail of causes of divergence between economies, potential government intervention and economic integration with US should be scrutinized further. Overall, US monetary shocks and commodity price shocks do matter and are important to the fluctuations of the small open economies'

fundamentals.

By the variance decomposition I found that exchange rates and export could explain fluctuations of inflation and industrial productivity in a significant level, especially for economies where economic openness and integration with the US is strong. Also, I found that aggregate money could get significant impact from exchange rates and export, and this phenomenon is fairly strong in Korea and Mexico, where the two factors explain from 10 up to 30 percent.

Further studies should be made on conditions before and after the financial liberalization in each country to see how much the coupling between U.S. and the small open economies has been deepened, and the level of government intervention to offset the external shocks and its effectiveness.

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Appendix A

All the variables were obtained from OECD Stats (http://stats.oecd.org) except for the oil price. The oil price was extracted from the World Bank pink sheet (www.worldbank.org/en/research).

US_ffr: US Federal Funds Rate

Ave_Oil: Crude Oil, Average (World Bank Pink Sheet)

EXR: Exchange Rate

EXP01: Export

INP: Industrial Production

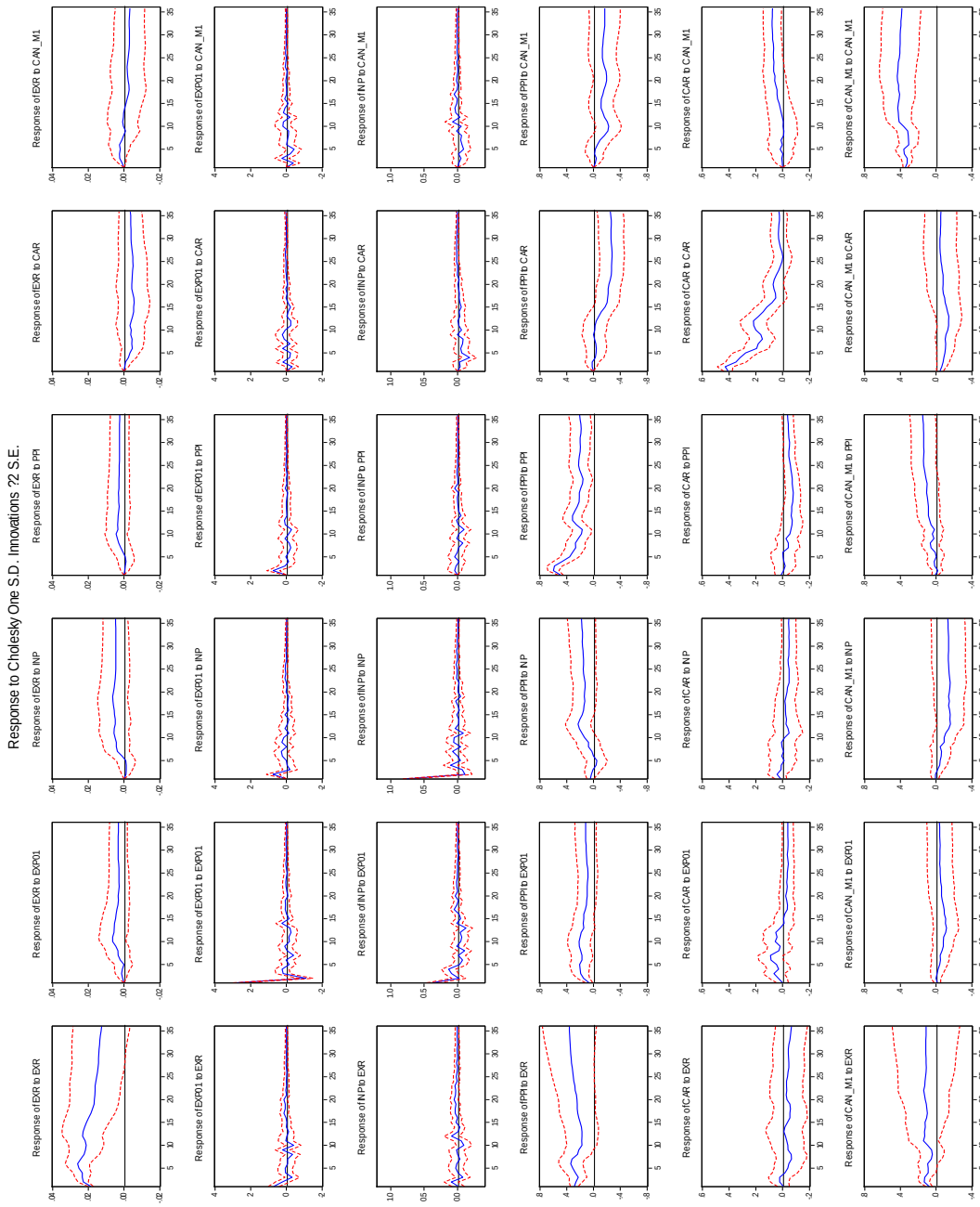
PPI: Producer Price Index

CAR: Call Rate

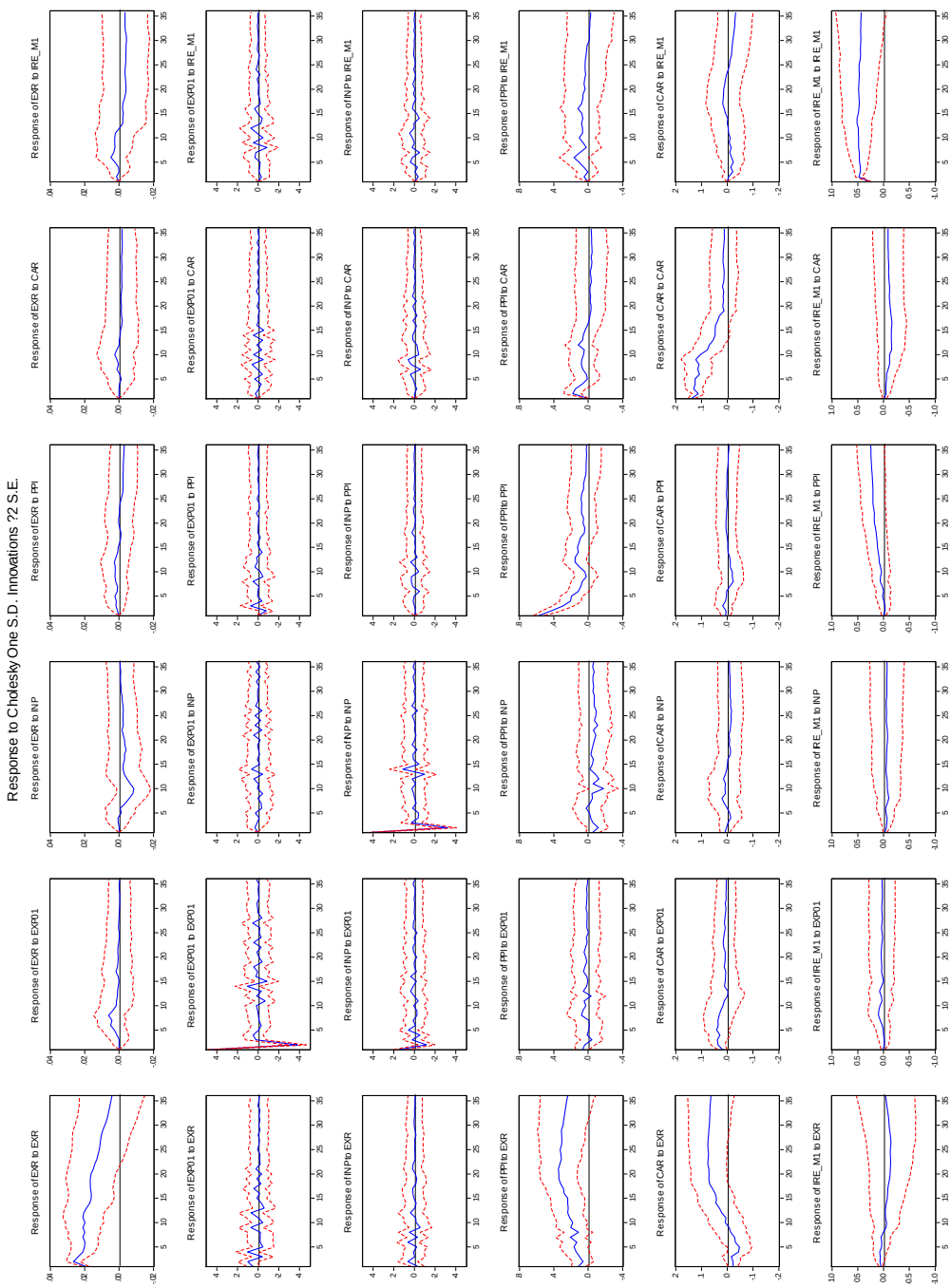
CAN_M1, KOR_M1, IRE_M, MEX_M1, TUR_M1: Each country's monetary aggregates (narrow money)

Appendix B

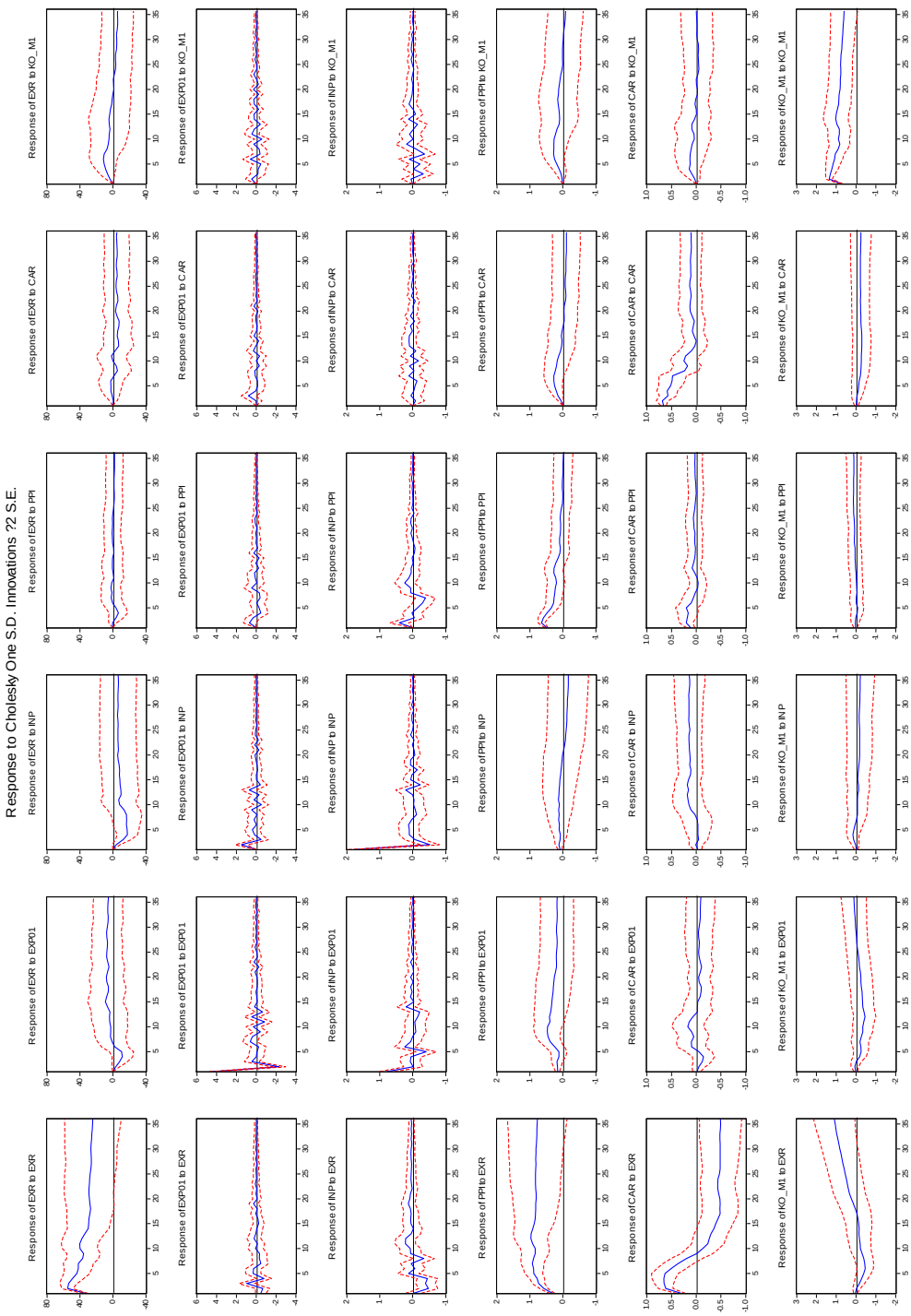
(1) Canada's Impulse Responses to External Shocks



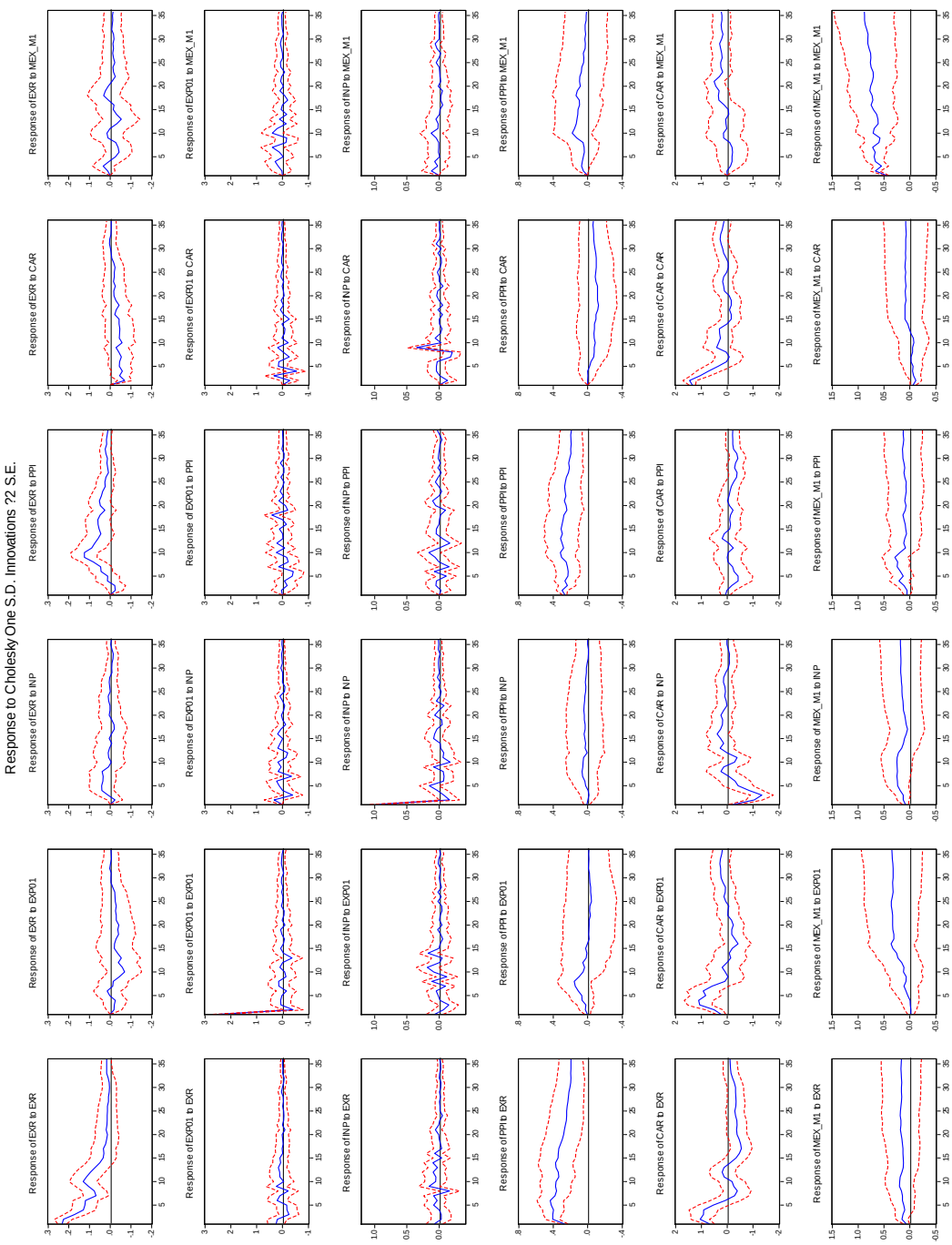
(2) Ireland's Impulse Responses to External Shocks



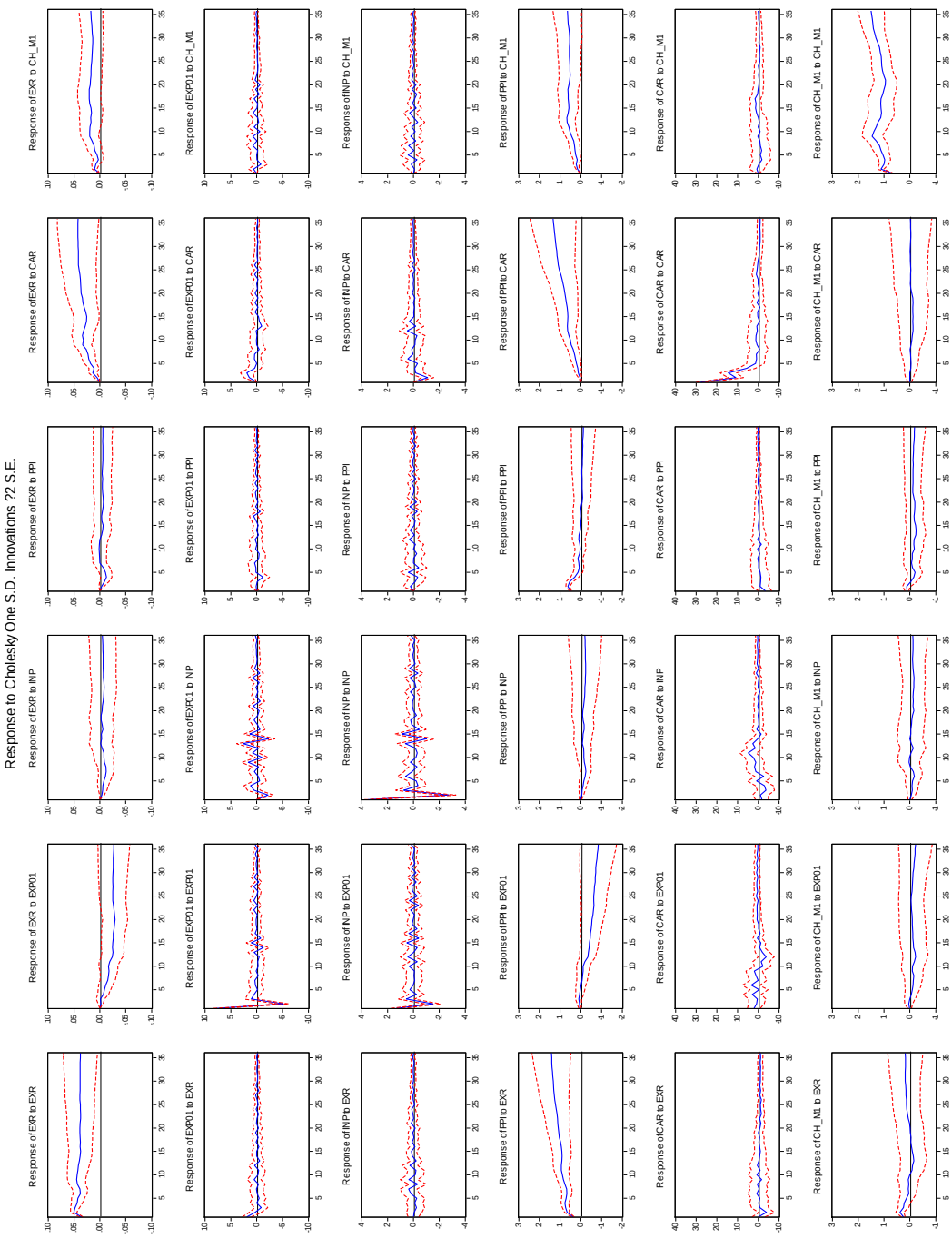
(3) Korea's Impulse Responses to External Shocks



(4) Mexico's Impulse Responses to External Shocks



(5) Turkey's Impulse Responses to External Shocks



요 약

현재 전세계는 고도적으로 연결되어, 위기시 한 국가가 혼자 살아남을 수 있다는 것을 생각할 수 없게 되었다. 실제로 1997년도 아시아 금융위기와 2008년 세계경제위기는 한 국가의 문제는 전세계의 문제라는 것을 여실히 보여주었다. 최근 지구 반대편에서 일어나는 충격은 훨씬 그 빈도가 잦아지고 속도 또한 빨라졌다. 만약 충격을 받는 국가가 소규모 개방경제라면, 두 대규모 경제 위기처럼 외부경제상황에 의한 충격은 클 것이다.

그렇다면, 이 외부충격은 실제로 소규모 경제에 영향을 미칠까? 충격은 장기적 효과 또한 지니고 있는가? 본 논문은 미국의 통화정책과 유가 변동과 같은 외부충격이 소규모개방경제에 얼마나 큰 영향을 주는지를 알아볼 것이다. 이에 OECD 가입국 중 다섯 개의 소규모개방경제국가들을 뽑았다.

벡터자기회귀모형은 내수경제에 대한 통화정책효과 연구를 통해 발달되어 왔으나, 현재까지 소규모개방경제와 외부충격효과에 대한 연구는 많지 않다. Cushman과 Zha같은 몇몇 학자들은 소규모개방경제에 대한 외부충격효과를 연구하기에 가장 알맞은 “구조적벡터자기회귀모형(SVAR model)”을 발전시켰다. 구조적벡터자귀회귀모형은 소규모개방경제에 대한 외부충격효과를 알아보는 데에 효율적인 면이 있어, 본 논문에서도 이 방법론을 따를 것이다.

또한, 외부충격에 의한 주요 경제 지표 변동에 유효성을 지닌 변수를

알아보기 위해 분산분해(variance decomposition) 또한 시행할 것이다. 결과적으로, 외부충격효과에 의해 5 개의 국가들 모두 환율하락을 경험했고, 수출과 생산성은 초기 상승과 함께 급격히 제자리로 돌아가는 형태를 보였다. 또한, 생산자물가지수, 이자율, 또한 통화량은 상승하였다. 분산분해의 결과, 환율과 수출은 생산자물가지수와 생산성, 통화량과 같은 주요 경제 지표에 영향을 미침을 보였다.

주요어: 소규모 개방경제, 미국경제, 통화정책충격, 외부충격

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