The unbalanced spillover effects of the Federal Reserve's quantitative easing policy on countries or regions with different economic development qualities --Based on GVAR model

Content Summary

This article uses GVAR (Global Vector Autoregressive Model) to analyze the impact of the Federal Reserve's quantitative easing policy on the real economy and financial markets of other countries and regions with different quality of economic development in the world. It is believed that there are spillover effects in US monetary policy, while there is heterogeneity in the response of countries or regions with different characteristics of economic development to external shocks. It is proposed that in the future, countries around the world can improve the driving force of domestic economic development by optimizing their economic structure, etc., while enhancing their ability to withstand external shocks. While improving innovation capabilities, accelerating opening up, optimizing the allocation of market resources, and strengthening the construction of ecological civilization, it is necessary to pay attention to the enhancement of the spillover degree of external environmental shocks. At the same time, the degree of debt leverage in different sectors will also change the impact of external shocks.

Key words: GVAR model; Quantitative easing policy; Quality of economic development

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Since the beginning of the 21st century, the degree of economic exchange among countries around the world has significantly improved, and the idea of economic globalization has taken root in the hearts of the people. The policy actions of major economic countries not only have an impact on domestic macro and micro economies, but also cause fluctuations in various economic variables in other countries in the world. Monetary policy, as an important regulatory policy for a country, has always received academic attention. As one of the major economies in the world, changes in the monetary policy of the United States will inevitably affect other countries and regions in the world. Due to their different levels of economic development, the response to the impact of US monetary policy spillovers will also be different. Therefore, exploring the factors that affect changes and their mechanisms is crucial for countries around the world to make future foreign relations and policy choices. This paper uses the Generalized Vector Autoregressive Model (GVAR) to analyze the spillover effects of the Federal Reserve's monetary policy by constructing a multinational dynamic model.

1.literature review

From the perspective of research direction, there are many studies on monetary policy spillover effects in developed countries represented by the United States. Zhuang Jia (1999) used a mixed sample approach to study the medium and long-term effects of US monetary policy on China's output, and found that the spillover effect continues to increase as economic exchanges deepen; Zhang Jingjing (2013) theoretically explores the impact and transmission channels of US monetary policy on China's economy; Li Zilei and Zhang Yun (2013) believed through the SVAR model that the quantitative easing policy of the United States affects China's inflation level through commodity prices and exchange rates; Xu Yijia (2015) constructed an SVAR model to show that the effects of quantitative easing policies in the United States on exchange rates, output, and price levels in the "Greater China Economic Circle"

are different; Jiang Meihua (2014) explored the impact of economic growth and money supply on inflation levels in various countries through GVAR models based on economic data from the United States, China, Japan, and South Korea; Liang Bing and Xu Wenli (2022), from the perspective of quantitative easing policy of the European Central Bank, use GVAR analysis to believe that the monetary policy of the European Central Bank has a significant impact on domestic price levels and financial markets.

From the perspective of research objects, there are many studies on the impact of monetary policy spillovers in developed countries on China and the world. Ehrmann&Fratzscher (2009) believed that the different monetary policies of the Federal Reserve have a significant impact on financial markets and resource allocation throughout the world; Neri&Nobili (2010) analyzed the impact of US monetary policy on the exchange rate of G7 countries through the SVAR model; Hausman&Wangswan (2011) found that US monetary policy has an impact on the exchange rates and interest rates of 49 countries; Tang Yueli and Zhu Huiming (2021) believe that the spillover effects of the Federal Reserve's monetary policy on China's financial markets differ at different quantiles based on the quantile regression theory.

From the perspective of research methods, due to exploring the links between different countries, most of the empirical aspects of the academic community focus on vector autoregressive models and their expanded forms. Cui Baisheng (2021) explored the impact of China's and the United States' monetary policies on themselves and each other based on the FAVAR model; Lu Yan and Liu Yaqun (2014) believed through VAR model that quantitative easing monetary policies in developed countries have a significant impact on China's monetary policy; Yang Zirong and Bai Delong (2016) explored whether China's monetary policy has spillover effects on the US economy through the SVAR model; Lu Jiaying and Guo Jianwei (2021) selected the PVAR model to explore the spillover effect of China's monetary policy on the "the Belt and Road" countries; Zhang Wenyan (2019) used the GVAR model to explore the national impact of the Federal Reserve's quantitative easing policy on different monetary policies, exchange rate systems, and capital control levels.

In summary, the world academic community has made certain achievements in the study of monetary policy spillovers, especially in exploring the monetary policies of developed countries, especially the United States, from the discussion of a single country to the overall discussion of the entire world; Regression from panel to VAR, SVAR, PVAR, GVAR, and other models; From the impact

effect to the transmission mechanism. Most of the current literature focuses on the impact with specific countries, ignoring the dynamic links with other countries in the world; Even if countries with different economic sizes are considered, the research approach is relatively limited, and there is a lack of mechanism discussion, which does not fully analyze the causes of spillover effects. This article will start from the perspective of the Federal Reserve's quantitative easing policy, analyze the different responses of countries and regions with different economic development qualities to the Federal Reserve's quantitative easing policy, and explore the spillover impact from the macro dynamic perspective of the entire world using the GVAR model.

The contribution of this article lies in the following three points: First, taking into account various factors of economic development quality from a different perspective, systematically presenting the impact of US monetary policy on the world economy. The second is to adopt the GVAR model, which compensates for the shortcomings caused by the limitations of the previous academic research on the Federal Reserve's monetary policy spillovers. It also includes most of the world's major economies or countries, and constructs a worldwide dynamic model. The third is to provide a new perspective for future foreign economic cooperation among countries around the world and when facing the uncertain impact of the post crisis era.

2.model building

The general form of the GVAR model is the same as that of traditional vector autoregressive models, with the form:

$$y(t) = \alpha(i) + \sum_{s=1}^{n} \beta(s) y(t-s) + v(t)$$

$y(t)$ is a matrix of endogenous economic variables for each country or region during the t period，$y(t-s)$ is a matrix of endogenous economic variables that lag for a certain period in the country or region, $\beta(s)$ is the coefficient matrix corresponding to the hysteresis term，$v(t)$ is a random impact matrix. Then, foreign economic variables are introduced to construct a country country VAR model in the form of:

$$X(i,t) = Ai + \sum_{s=1}^{n} B(i,s)X(i,t-s) + \sum_{r=0}^{m} C(i,r)X^{*}(i,t-r) + \varepsilon(i,t)$$

$X(i,t)$ represents the endogenous economic variable matrix of the ith country or region in the t period,$X(i,t-s)$ represents the endogenous economic variables of the country or region in the t-s period, $B(i,s)$ is the corresponding coefficient, $X^{*}(i,t-r)$ represents the endogenous economic variables of the country or region in the t-r period,$C(i,r)$ is the corresponding coefficient, $X^{*}(i,t) = W(i)X(i,t)$， The weight matrix shows the proportion of the import and export trade volume between different countries or regions and the economy to all their import and export trade volumes. If the sum of each column is 1, it can be expressed as:

$$W(i,j) = \begin{cases} 0, i = j \\ wij, i \neq j \end{cases}$$

Then stack the country country country VAR models of different countries or regions through the weight matrix to obtain the formula:

$$X(i,t) = Ai + \sum_{s=1}^{n} B(i,s)X(i,t-s) + \sum_{r=0}^{m} C(i,r)W(i)X(i,t) + \varepsilon(i,t)$$

Then simplify:

$$X(t) = E + \sum_{o=1}^{o=\max(m,n)} F(o)X(t-o) + \propto (t)$$

$E = A/(I - C(0)W)$， $\propto (t) = \varepsilon(t)/(I - C(0)W)$, $F(o) = (B(o) - C(o)W)/(I - C(0)W)$.

3. model settings

This model uses 24 countries or regions, which are distributed in different regions and have differences in economic systems. It selects variables from these countries or regions to construct a GVAR model to analyze the spillover effects of US monetary policy on economic variables in other countries.

Table 1 description of measurement indicators

general standard	subcriteria	standard corresponding	indicator statistical	unit	data sources

		indicators	method		
high quality economic development level	economic structure	capital pulling degree	gross capital formation/GDP	%	World Bank
		consumption pulling degree	final consumption expenditure/GDP	%	World Bank
		export degree	service and trade imports/GDP	%	World Bank
		import degree	exports of services and trade/GDP	%	World Bank
	innovation-driven development	scientific research level	number of scientific research personnel per million people	people	World Bank
		technical level	number of technical personnel per million people	people	World Bank
		innovation output	number of patents granted/total population	pieces/1000 persons	World Intellectual Property Organization
		R&D investment	R&D expenditure/GDP	%	World Bank
	resource allocation	factor productivity	total factor productivity	United States=1	University of Groningen
		non performing	non performing	%	World Bank

	loan ratio	loan ratio of commercial banks		
market mechanism	financial market development	financial market development index	spot	International Monetary Fund
	development of financial institutions	financial institution development index	spot	International Monetary Fund
	proportion of government investment	government non-financial investment/gdp	%	International Monetary Fund
economic growth	consumer price index	consumer price index	point (2010=100)	International Monetary Fund
	unemployment rate	registered unemployment rate	%	World Bank
	economic growth	year-on-year growth rate of gdp	%	World Bank
infrastructure	logistics distribution capacity	logistics performance index	spot	World Bank
	railway transportation capacity	railway passenger flow/total population	times	World Bank
	air	air passenger	million person	World Bank

	transportation capacity	volume/total population	kilometers/1000 people	
	perfection of network facilities	network broadband users per 100 people	people	World Bank
ecological environment	forest coverage	forest coverage	%	World Bank
	coverage rate of natural reserves	proportion of natural reserve area	%	World Bank
	exhaust emissions	nitric oxide emissions/gdp	%	World Bank
	greenhouse gas emissions	greenhouse gas emissions/gdp	%	World Bank
	pollution mortality	number of deaths due to air pollution per 100000 people	people	World Bank
economic benefits to the people	per capita output	gdp per capita	dollar	World Bank
	health benefits	population mortality	‰	World Bank
	educational welfare	percentage of people aged 25 and above completing junior high school education	%	World Bank
	leisure enjoyment	proportion of international	%	World Bank

		tourism in total imports		
debt structure	resident leverage ratio	resident debt leverage ratio	%	Bank for International Settlements
	government leverage	government debt leverage	%	Bank for International Settlements
	leverage ratio of non-financial corporate sector	leverage ratio of non-financial corporate sector	%	Bank for International Settlements
	bank leverage ratio	bank capital/assets	times	Bank for International Settlements

Table 2 names and English abbreviations of countries or regions

Country or region name	Abbreviation of economy	Country or region name	Abbreviation of economy
Austria	aust	Australia	ausl
Canada	can	Brazil	bra
Denmark	den	Chinese Mainland	chn
Germany	ger	France	fra
India	ina	Hong Kong, China	hon
Ireland	ire	Indonesia	ind
the republic of korea	kor	Japan	jap
Mexico	mex	Malaysia	mal
Singapore	sin	South Africa	sou
Spain	spa	Sweden	swe
Switzerland	swi	Thailand	tha
britain	uk	U.S.A	us

The specific construction steps are as follows:

First, set the transmission path for different economies. Domestic variables depend on the current and lagging values of foreign variables, while national variables are influenced by global variables.

Secondly, select the countries or regions to be studied and construct VARX models respectively. The model includes 24 countries or regions, and the variables include eight variables: stock index eq=ln (E/CPI) (E is the actual stock index), long-term interest rate rl=0.25ln (1+RL/100) (long-term treasury bond yield), inflation rate dp=ln (CPI) (including seasonally adjusted CPI index, 2010=100) Short-term interest rate rs=0.25 ln (1+RS/100) (interbank offered rate, short-term money market interest rate, etc., in which the U.S. short-term interest rate variable refers to the effective federal fund shadow interest rate of Wu&Xia (2015)), exchange rate ep=ln (E) (E=nominal exchange rate, direct pricing method), output y=ln (GDP) (quarterly adjusted real GDP), international crude oil price oil (Brent crude oil futures settlement price), gold closing price pgold (COMEX gold futures closing price), And perform a first order difference for all variables. Due to the availability of data, the time span is selected from the second quarter of 2004 to the fourth quarter of 2019 (quarterly data). The original data comes from databases or websites such as China Economic Network, CEIC, IMF, WTO, WIND, BIS, and the World Bank.

In these VARX models, not only domestic variables need to be included, but also corresponding foreign variables should be added, including stock market index eq, long-term interest rate rl, inflation rate dp, short-term interest rate rs, exchange rate ep, and output y. Foreign variables include stock market index eqs, long-term interest rate rls, short-term interest rate rss, and exchange rate eps, The global variables are crude oil price, oil price, and gold closing price, pgold (in which the U.S. exchange rate variable is not included in the domestic variable, while considering the spillover effect of the United States on other countries or regions, its foreign variables do not include short-term interest rates and stock indexes, while the global variables are endogenous variables in the United States (domestic variables: y, dp, rs, rl, eq, oil, pgold; foreign variables: eps); Foreign variables in other countries or regions do not include exchange rates, while global variables are exogenous variables in other economies (domestic variables: y, dp, rs, rl, eq, ep; foreign variables: rss, rls, eqs). Then construct a VARX model.

Third, construct a trade weight matrix. Based on the weight coefficient calculated from the import

and export trade volume from 2016 to 2018, the weight is calculated again among the 24 economies, so that the sum is 1. The VARX models of different economies are connected through the trade weight matrix.

Table 3 trade weight matrix (I)

	ausl	aust	bra	can	chn	den	fra	ger	hon	ina	ind	ire
ausl	0.000	0.001	0.100	0.002	0.005	0.004	0.002	0.003	0.001	0.008	0.006	0.002
aust	0.002	0.000	0.004	0.002	0.003	0.013	0.018	0.091	0.001	0.003	0.002	0.004
bra	0.310	0.005	0.000	0.007	0.035	0.008	0.013	0.012	0.004	0.019	0.013	0.003
can	0.021	0.007	0.019	0.000	0.021	0.009	0.010	0.012	0.005	0.016	0.010	0.011
chn	0.193	0.048	0.306	0.096	0.000	0.092	0.083	0.135	0.591	0.211	0.246	0.046
den	0.006	0.008	0.004	0.002	0.004	0.000	0.011	0.028	0.001	0.003	0.002	0.007
fra	0.020	0.055	0.025	0.010	0.022	0.055	0.000	0.148	0.012	0.025	0.010	0.103
ger	0.053	0.583	0.059	0.023	0.066	0.304	0.308	0.000	0.017	0.054	0.026	0.113
hon	0.003	0.003	0.012	0.003	0.120	0.006	0.012	0.007	0.000	0.065	0.018	0.005
ina	0.033	0.007	0.026	0.008	0.033	0.010	0.017	0.015	0.033	0.000	0.069	0.005
ind	0.018	0.002	0.012	0.003	0.026	0.003	0.006	0.005	0.006	0.049	0.000	0.001
ire	0.006	0.005	0.003	0.003	0.004	0.015	0.017	0.017	0.001	0.003	0.001	0.000
jap	0.020	0.013	0.034	0.029	0.119	0.022	0.021	0.031	0.054	0.040	0.137	0.023
kor	0.016	0.009	0.035	0.015	0.111	0.014	0.013	0.022	0.042	0.050	0.065	0.007
mal	0.015	0.004	0.014	0.004	0.039	0.003	0.006	0.010	0.022	0.038	0.056	0.003
mex	0.032	0.007	0.034	0.044	0.020	0.006	0.009	0.016	0.005	0.019	0.004	0.011
sin	0.002	0.003	0.014	0.002	0.031	0.008	0.016	0.009	0.052	0.050	0.124	0.008
sou	0.010	0.003	0.007	0.001	0.015	0.004	0.004	0.013	0.005	0.026	0.005	0.002

spa	0.034	0.025	0.026	0.005	0.012	0.032	0.134	0.063	0.003	0.014	0.010	0.025
swe	0.005	0.017	0.006	0.003	0.006	0.191	0.021	0.035	0.001	0.005	0.003	0.008
swi	0.022	0.085	0.013	0.006	0.015	0.013	0.058	0.082	0.025	0.049	0.009	0.046
tha	0.022	0.004	0.013	0.004	0.032	0.006	0.007	0.008	0.024	0.026	0.065	0.003
uk	0.016	0.037	0.021	0.025	0.031	0.091	0.099	0.106	0.017	0.037	0.010	0.243
us	0.142	0.070	0.211	0.703	0.230	0.089	0.116	0.134	0.079	0.188	0.107	0.321
总计	1	1	1	1	1	1	1	1	1	1	1	1

Table 4 trade weight matrix (II)

	jap	kor	mal	mex	sin	sou	spa	swe	swi	tha	uk	us
ausl	0.001	0.002	0.004	0.003	0.000	0.008	0.009	0.002	0.005	0.005	0.002	0.005
aust	0.003	0.004	0.002	0.002	0.002	0.006	0.015	0.021	0.038	0.002	0.010	0.005
bra	0.011	0.013	0.009	0.012	0.005	0.020	0.020	0.009	0.009	0.011	0.008	0.021
can	0.021	0.015	0.005	0.029	0.004	0.007	0.010	0.011	0.013	0.007	0.030	0.191
chn	0.309	0.357	0.218	0.111	0.189	0.243	0.088	0.096	0.098	0.234	0.121	0.205
den	0.003	0.003	0.001	0.001	0.001	0.005	0.012	0.138	0.004	0.002	0.015	0.003
fra	0.018	0.013	0.015	0.008	0.027	0.031	0.254	0.080	0.086	0.016	0.094	0.028
ger	0.045	0.042	0.040	0.029	0.031	0.161	0.243	0.286	0.240	0.036	0.197	0.057
hon	0.038	0.061	0.052	0.001	0.099	0.019	0.004	0.005	0.058	0.046	0.022	0.015
ina	0.015	0.028	0.045	0.011	0.036	0.078	0.016	0.013	0.046	0.033	0.021	0.025
ind	0.035	0.026	0.052	0.002	0.081	0.013	0.008	0.004	0.005	0.052	0.004	0.009

ire	0.007	0.003	0.003	0.003	0.002	0.006	0.016	0.014	0.022	0.003	0.064	0.020
jap	0.000	0.118	0.101	0.029	0.077	0.070	0.018	0.024	0.029	0.176	0.029	0.068
kor	0.083	0.000	0.051	0.025	0.063	0.028	0.015	0.016	0.010	0.040	0.018	0.040
mal	0.033	0.026	0.000	0.012	0.157	0.016	0.004	0.005	0.008	0.072	0.011	0.017
mex	0.018	0.022	0.008	0.000	0.007	0.008	0.027	0.005	0.006	0.011	0.007	0.186
sin	0.032	0.030	0.169	0.003	0.000	0.010	0.003	0.006	0.023	0.051	0.013	0.017
sou	0.007	0.004	0.005	0.001	0.002	0.000	0.007	0.006	0.005	0.010	0.016	0.004
spa	0.007	0.007	0.004	0.012	0.003	0.027	0.000	0.033	0.027	0.006	0.050	0.009
swe	0.004	0.004	0.003	0.001	0.003	0.011	0.016	0.000	0.007	0.004	0.023	0.005
swi	0.012	0.005	0.010	0.003	0.021	0.017	0.026	0.018	0.000	0.032	0.056	0.020
tha	0.055	0.019	0.075	0.009	0.044	0.032	0.005	0.007	0.017	0.000	0.008	0.014
uk	0.022	0.019	0.012	0.006	0.020	0.066	0.107	0.108	0.100	0.021	0.000	0.038
us	0.221	0.180	0.116	0.685	0.125	0.119	0.076	0.093	0.144	0.129	0.181	0.000
总计	1	1	1	1	1	1	1	1	1	1	1	1

Note: Each column represents the proportion of imports and exports between other countries or regions. For example, the trade volume between Australia and Brazil in the first column accounts for 31% of the total imports and exports between these 24 countries or regions and Australia.

4.empirical testing

1. unit root test

This article uses the ADF unit root test to test the original series of domestic variables, foreign variables, and global variables in various countries or regions. Most of the variables pass the test.

Table 6 unit root test for domestic variables (I)

Domestic Variables	Statistic	Critical Value	AUSTRALIA	AUSTRIA	BRAZIL	CANADA	CHINA	DENMARK	FRANCE	GERMANY
y	ADF	-3.45	-5.30	-5.44	-4.85	-4.90	-5.88	-5.94	-3.51	-4.26
dp	ADF	-3.45	-6.73	-5.44	-3.60	-4.01	-6.05	-6.36	-5.96	-4.63
rs	ADF	-3.45	-5.09	-4.15	-4.77	-3.06	-4.39	-4.50	-4.41	-4.15
rl	ADF	-3.45	-5.90	-6.60	-3.14	-5.29	-5.39	-5.36	-6.58	-6.71
ep	ADF	-3.45	-6.21	-6.33	-5.36	-5.09	-3.85	-6.44	-6.33	-6.33
eq	ADF	-3.45	-5.09	-5.68		-6.50	-4.94		-5.12	-5.79

Note: Variables that fail the unit root test are marked in red

Table 7 unit root test for domestic variables (II)

Domestic Variables	Statistic	Critical Value	HONG KONG	INDIA	INDONESIA	IRELAND	JAPAN	KOREA	MALAYSIA	MEXICO
y	ADF	-3.45	-3.79	-6.77	-2.99	-5.49	-4.87	-5.26	-5.60	-5.11
dp	ADF	-3.45	-5.66	-3.42	-6.67	-3.27	-5.59	-5.35	-6.67	-5.09
rs	ADF	-3.45	-2.77	-5.86	-4.97	-4.18	-4.09	-4.96	-4.06	-4.58
rl	ADF	-3.45	-7.20	-5.24	-6.00	-4.17	-6.91	-4.44	-5.72	-6.33
ep	ADF	-3.45	-6.10	-4.72	-6.08	-6.33	-3.21	-4.78	-5.57	-5.90
eq	ADF	-3.45	-5.94	-4.95			-5.23	-5.95	-4.94	

Note: Variables that fail the unit root test are marked in red

Table 8 unit root test for domestic variables (III)

Domestic Variables	Statistic	Critical Value	SINGAPORE	SOUTH AFRICA	SPAIN	SWEDEN	SWITZERLAND	THAILAND	UK	US
y	ADF	-3.45	-4.77	-4.34	-2.49	-4.20	-3.81	-6.61	-3.52	-3.69
dp	ADF	-3.45	-4.13	-4.39	-3.82	-3.55	-6.11	-7.12	-3.37	-4.07
rs	ADF	-3.45	-2.55	-4.01	-5.61	-4.11	-4.75	-3.01	-3.17	-3.09
rl	ADF	-3.45	-5.66	-5.90	-3.42	-6.49	-5.50	-6.21	-5.97	-6.71
ep	ADF	-3.45	-6.24	-6.03	-6.33	-6.30	-5.56	-5.93	-6.61	
eq	ADF	-3.45	-5.68	-5.36	-5.23	-5.08	-4.46	-6.03	-5.01	-5.24

Note: Variables that fail the unit root test are marked in red

Table 9 unit root test for foreign variables (I)

Domestic Variables	Statistic	Critical Value	AUSTRALIA	AUSTRIA	BRAZIL	CANADA	CHINA	DENMARK	FRANCE	GERMANY
rss	ADF	-3.45	-4.38	-4.13	-3.83	-2.38	-3.71	-2.94	-4.11	-4.06
rls	ADF	-3.45	-6.72	-6.74	-6.47	-6.93	-6.98	-6.73	-6.80	-6.70
eqs	ADF	-3.45	-4.61	-5.37	-4.57	-4.98	-5.39	-5.16	-5.13	-4.93

Note: Variables that fail the unit root test are marked in red

Table 10 unit root test for foreign variables (II)

Domestic Variables	Statistic	Critical Value	HONG KONG	INDIA	INDONESIA	IRELAND	JAPAN	KOREA	MALAYSIA	MEXICO
rss	ADF	-3.45	-4.11	-3.58	-3.89	-2.50	-2.74	-2.82	-3.59	-2.33
rls	ADF	-3.45	-5.93	-6.81	-6.75	-6.94	-6.62	-6.61	-6.80	-6.85
eqs	ADF	-3.45	-4.96	-4.74	-4.79	-5.12	-4.64	-4.47	-4.89	-4.98

Note: Variables that fail the unit root test are marked in red

Table 11 unit root test for foreign variables (III)

Domestic Variables	Statistic	Critical Value	SINGAPORE	SOUTH AFRICA	SPAIN	SWEDEN	SWITZERLAND	THAILAND	UK	US
rss	ADF	-3.45	-3.83	-4.01	-4.19	-4.23	-4.06	-3.80	-2.75	
rls	ADF	-3.45	-6.56	-6.43	-6.75	-6.67	-6.83	-6.69	-6.68	
eps	ADF									-5.90
eqs	ADF	-3.45	-4.79	-4.75	-5.12	-5.13	-5.14	-4.63	-5.00	

Note: Variables that fail the unit root test are marked in red

Table 12 unit root test for global variables

Domestic Variables	Statistic	Critical Value	Statistic
poil	ADF	-3.45	-6.01
pgold	ADF	-3.45	-5.22

Note: Variables that fail the unit root test are marked in red

2. cointegration inspection

In this paper, the cointegration test was calculated based on the AIC information criterion. The following table shows the results, indicating that there is a long-term equilibrium relationship between the variables in the GVAR model in this paper.

Table 13 coefficients of cointegration test

country or region	p	q	cointegration quantity
AUSTRALIA	1	1	5
AUSTRIA	2	2	3

BRAZIL	2	1	1
CANADA	2	1	5
CHINA	2	1	5
DENMARK	2	2	4
FRANCE	2	1	3
GERMANY	2	2	3
HONG KONG	1	1	4
INDIA	2	2	4
INDONESIA	2	2	5
IRELAND	2	2	3
JAPAN	1	1	3
KOREA	1	1	5
MALAYSIA	1	1	3
MEXICO	1	2	4
SINGAPORE	2	1	4
SOUTH AFRICA	2	2	4
SPAIN	2	2	4
SWEDEN	2	2	3
SWITZERLAND	1	1	3
THAILAND	2	2	5
UK	1	2	3
US	1	2	6

3. weak exogenicity test

The GVAR model requires that foreign variables and global variables in models with cointegration relationships should meet the weak exogenous test hypothesis. From the table below, it can be seen that most variables are not significant at a significance level of 5%.

Table 14 weak exogenicity test coefficient table

country or region	Fcrit_0.05	rss	rls	eps	eqs	poil	pgold
AUSTRALIA	2.57	0.29	0.25		0.86	1.50	0.42
AUSTRIA	2.82	7.58	3.90		3.63	1.20	1.41
BRAZIL	4.05	0.24	0.03		8.73	2.11	0.35
CANADA	2.44	1.23	2.35		1.56	1.08	0.22
CHINA	2.57	0.44	0.93		1.19	0.45	0.42
DENMARK	2.59	0.43	1.64		2.44	1.35	4.53
FRANCE	2.87	0.12	0.63		0.51	1.12	0.71
GERMANY	2.82	1.19	2.04		2.14	3.96	3.81
HONG KONG	2.71	0.20	0.70		0.23	0.20	0.45
INDIA	2.71	1.04	0.96		0.85	0.31	2.13
INDONESIA	2.44	1.58	0.93		2.49	1.74	1.62
IRELAND	2.82	0.88	2.57		0.32	1.70	4.58
JAPAN	2.93	0.21	0.94		0.32	0.38	0.35
KOREA	2.57	0.66	0.32		1.38	1.47	1.17
MALAYSIA	2.82	0.12	0.02		0.16	0.47	1.21
MEXICO	2.59	1.23	0.46		1.07	0.31	0.64
SINGAPORE	2.71	1.55	1.06		2.89	1.26	0.30
SOUTH AFRICA	2.59	1.35	1.23		1.35	3.31	1.13
SPAIN	2.59	0.84	1.50		1.97	1.24	2.52
SWEDEN	2.87	0.48	0.13		0.80	0.44	1.58
SWITZERLAND	2.87	1.13	2.66		1.42	0.34	0.17
THAILAND	2.57	0.42	0.60		1.07	1.17	0.78
UK	2.93	0.43	0.11		2.59	0.88	0.30
US	2.32			1.01			

Note: The variables marked in red are those that fail the test.

4. Structural stability test

Due to the large time span and the occurrence of significant events, it is necessary to conduct a

structural stability test to determine whether the parameter stability assumption is tenable. It can be seen that the total number of indicators after robust adjustment is relatively small at the significant level of 5%, indicating that the structure is relatively stable.

Table 15 structural stability test

index	y	dp	rs	rl	ep	eq	poil	pgold	Proportion
PK sup	3	1	1	0	0	0	0	0	3.57%
PK msq	5	1	0	0	0	0	0	1	5.00%
Nyblom	0	3	2	0	2	2	0	0	6.43%
Robust Nyblom	0	2	3	0	3	1	0	0	6.43%
QLR	1	2	5	4	5	4	0	0	15.00%
Robust QLR	0	1	2	0	0	1	0	0	2.86%
MW	4	5	7	2	7	5	0	0	21.43%
Robust MW	0	1	2	0	1	1	0	0	3.57%
APW	2	2	5	4	5	3	0	0	15.00%
Robust APW	0	1	2	0	0	1	0	0	2.86%

Note: The "Proportion" list shows the proportion of variables that have not passed the structural stability test to the total variables.

5. Impulse response analysis (US short-term interest rate change of one negative unit)

According to different indicators of high-quality economic development, 24 countries and regions are divided into the following groups.

Table 16 group classification

system	group name	group abbreviation	including countries or

			regions
economic structure	reasonable economic structure	eth	Switzerland, Sweden, South Korea, Austria, Denmark, Canada, Germany
	poor economic structure	etl	Brazil, Hong Kong, Japan, the United States, the United Kingdom, South Africa, Singapore
innovation-driven development	high degree of innovation and development	tah	Sweden, South Korea, Japan, Switzerland, Denmark
	low level of innovation and development	tal	Indonesia, Mexico, Thailand, South Africa, India
resource allocation	efficient resource allocation	rdlh	Canada, Sweden, Switzerland, United States, United Kingdom
	inefficient resource allocation	rdhl	Indonesia, India, Thailand, Malaysia, South Africa
market mechanism	high financial development index	mfh	Australia, Canada, United States, United Kingdom, Switzerland, Spain
	low financial development index	mfl	Brazil, India, Indonesia, Mexico
economic growth	better quality of economic growth	egh	Singapore, Malaysia, Thailand, South Korea, Switzerland

	poor quality of economic growth	egl	Brazil, South Africa, Spain, France
infrastructure	developed logistics and communication	bch	Japan, France, Sweden, Switzerland, the United Kingdom, Hong Kong, Singapore, South Korea, Austria
	logistics and communication are underdeveloped	bcl	India, Mexico, Indonesia, Brazil, Thailand, South Africa, Malaysia
ecological environment	low pollution	eph	Sweden, Austria, France, UK, Japan
	high pollution	epl	India, Indonesia, South Africa
economic benefits to the people	benefiting the people is high	prh	UK, Germany, Sweden, Switzerland, Canada, Australia
	benefiting the people is low	prl	Mexico, India, Indonesia, Thailand
debt structure	low leverage for residents	lril	Mexico, Indonesia, Brazil, China, India, South Africa
	high leverage for residents	lrih	Denmark, Switzerland, Australia, United Kingdom, Canada, United States
	low government leverage	lrgl	Australia, South Korea, Mexico, Thailand, Indonesia, Switzerland

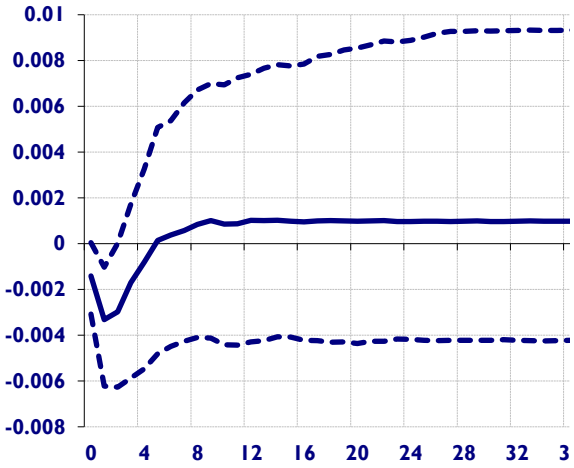
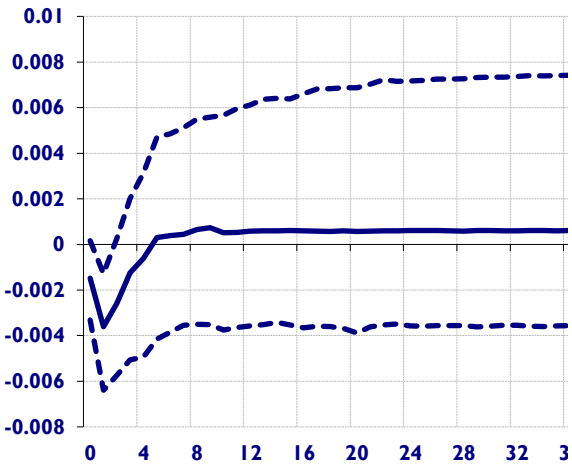
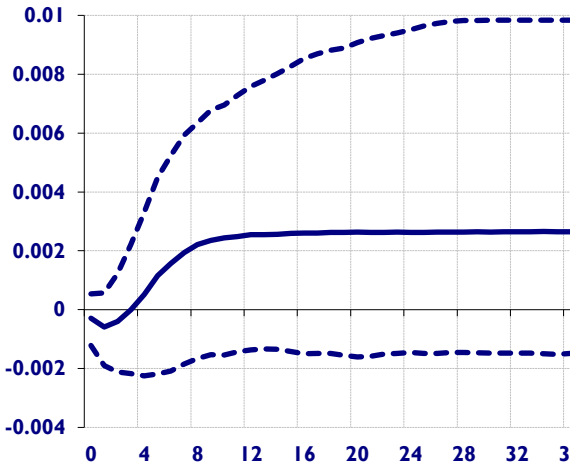
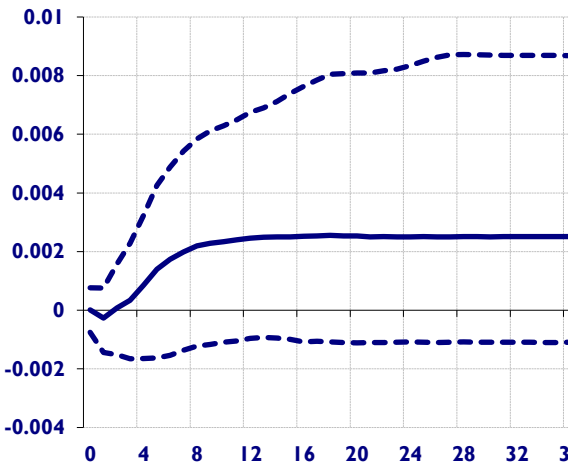
high government leverage	lrgh	Japan, Singapore, France, Austria, United States
low leverage in the non-financial corporate sector	lrcl	Mexico, Indonesia, South Africa, Brazil
high leverage in the non-financial corporate sector	lrch	Hong Kong, Ireland, Sweden, China, France
low leverage of banks	lrbl	Hong Kong, Brazil, Indonesia, Mexico, the United States, Thailand
high leverage of banks	lrbh	Canada, France, Japan, Germany, Sweden, Austria, Australia, United Kingdom

From the perspective of economic structure, short-term interest rates in countries or regions with good economic structure decreased by about 0.0004 units in the first period, while short-term interest rates in economies with poor economic structure decreased by 0.0005 units in the first period, indicating that economies with poor economic structure are more vulnerable to external shocks due to their unbalanced economic structure. In terms of exchange rates, economies with better economic structures experienced a relatively low impact after implementing quantitative easing in the United States, resulting in a rapid recovery in production and exports. At the same time, international capital flowed into more stable economies to avoid risks, resulting in a long-term appreciation of their exchange rates of 0.001 units; Economies with poorer economic structures are more vulnerable to external shocks, with slower economic recovery and international capital outflows, resulting in a devaluation of their exchange rate of about 0.0007 units in the 0 th period.

In summary, after the implementation of quantitative easing by the Federal Reserve, countries or regions with better economic structures have a strong ability to withstand external shocks. Although in the short term, the global economic downturn will affect output decline, the future recovery momentum will be strong, which will help export, while capital inflows will lead to an increase in

exchange rates.

economic structure:

variable	eth	etl
y		
dp		

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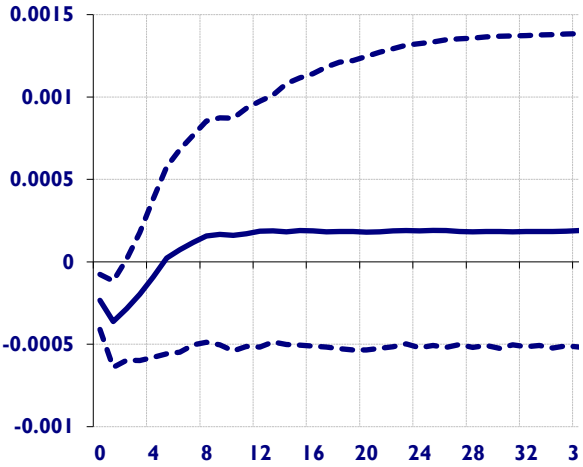
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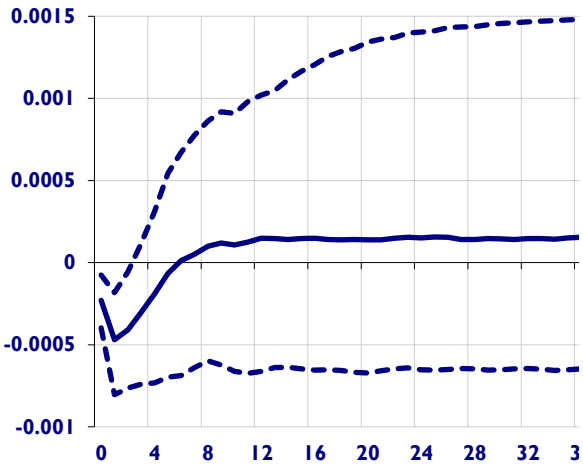
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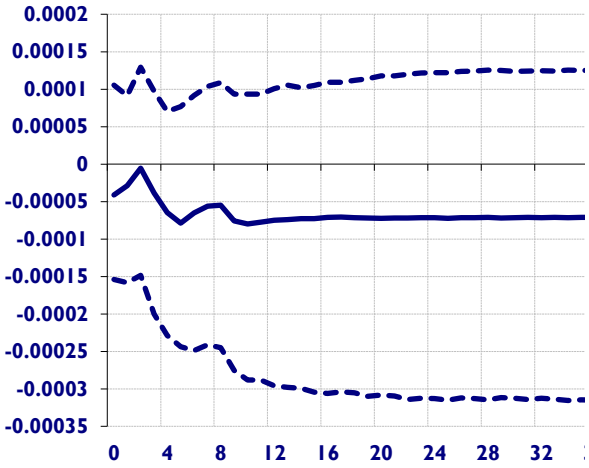
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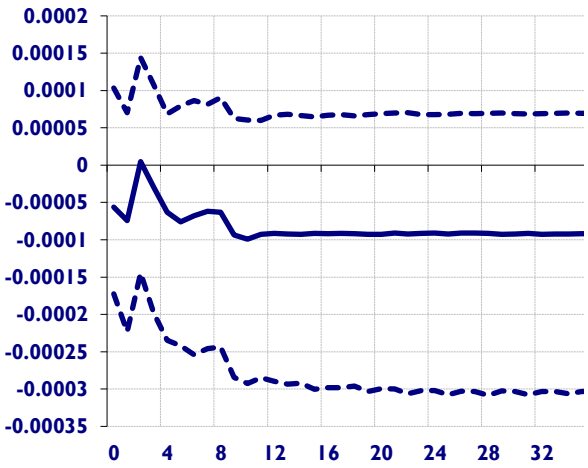
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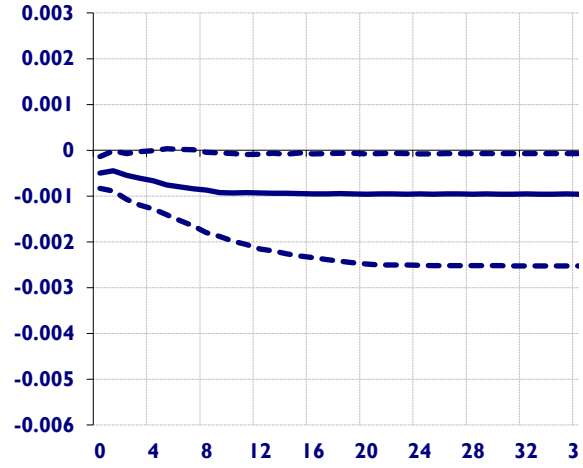
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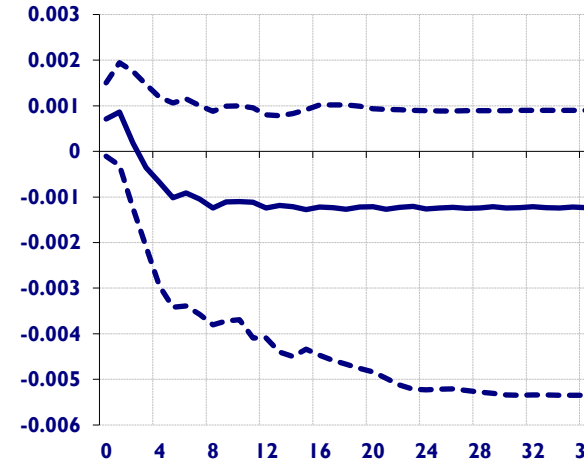
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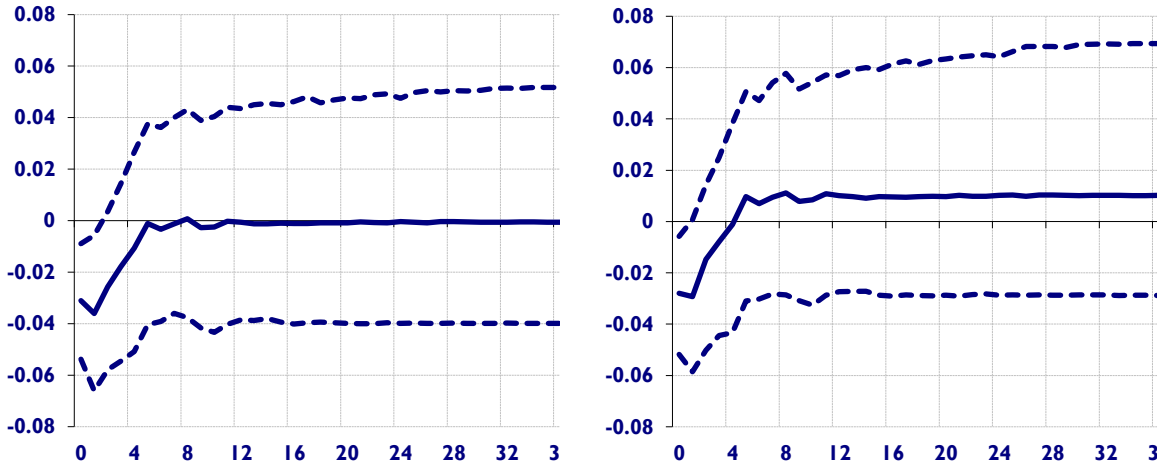
eq

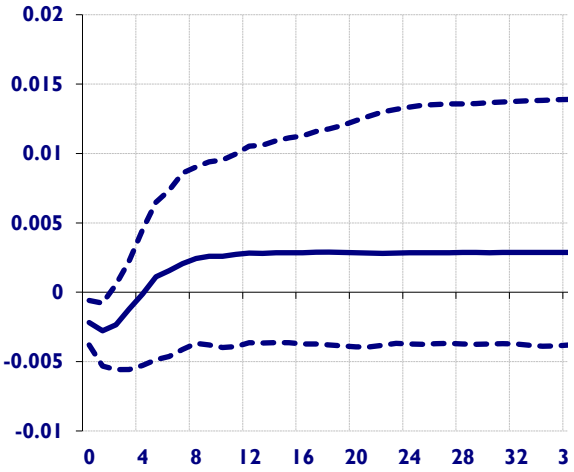


From the perspective of innovation and development, short-term interest rates in countries or regions with strong innovation and development capabilities decreased by about 0.0005 units in the first period, an increase of about 0.0003 units compared to the other group. This may be due to the fact that domestic science and technology enterprises are one of the main drivers of economic development, while science and technology enterprises are more vulnerable to external shocks and global economic downturn, so the government has significantly lowered interest rates to ensure the survival and development of enterprises, Reduce the pressure of enterprise financing and daily operations. In terms of output and stock indexes, due to a significant reduction in interest rates, the output and stock indexes of economies with strong innovation capabilities have decreased significantly compared to the other group, indicating that low interest rate policies are conducive to economic recovery and improving market expectations, thereby promoting international trade, capital inflows, and currency appreciation, with a long-term decline in their exchange rate of about 0.0018 units.

innovation-driven development:

variable	tah	tal

y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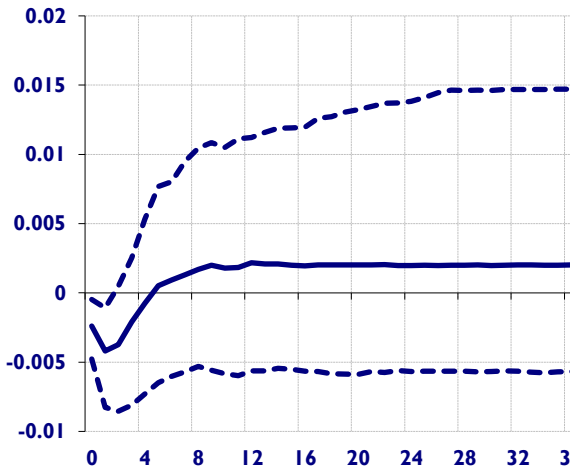
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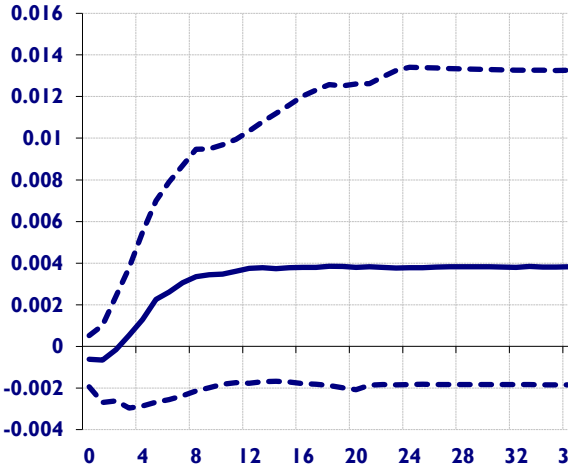
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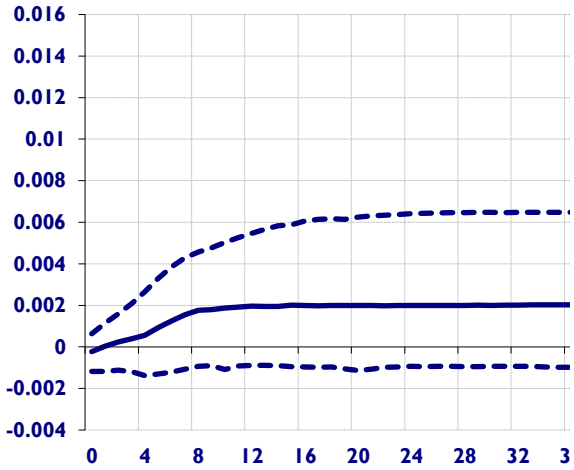
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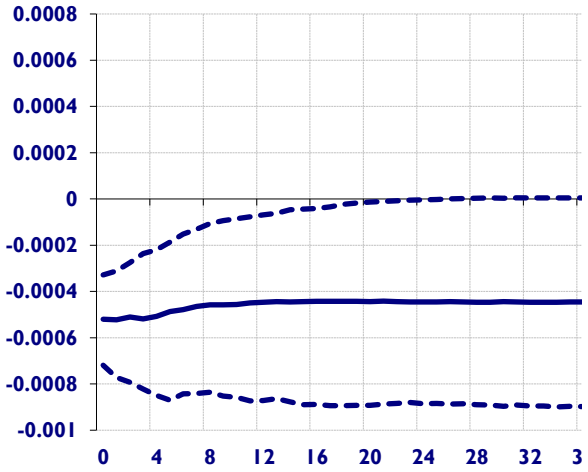
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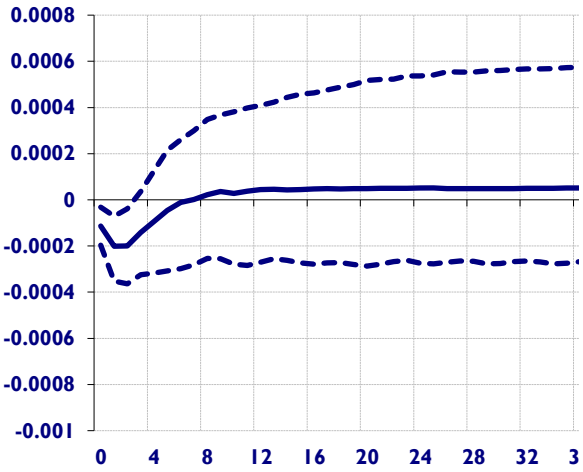
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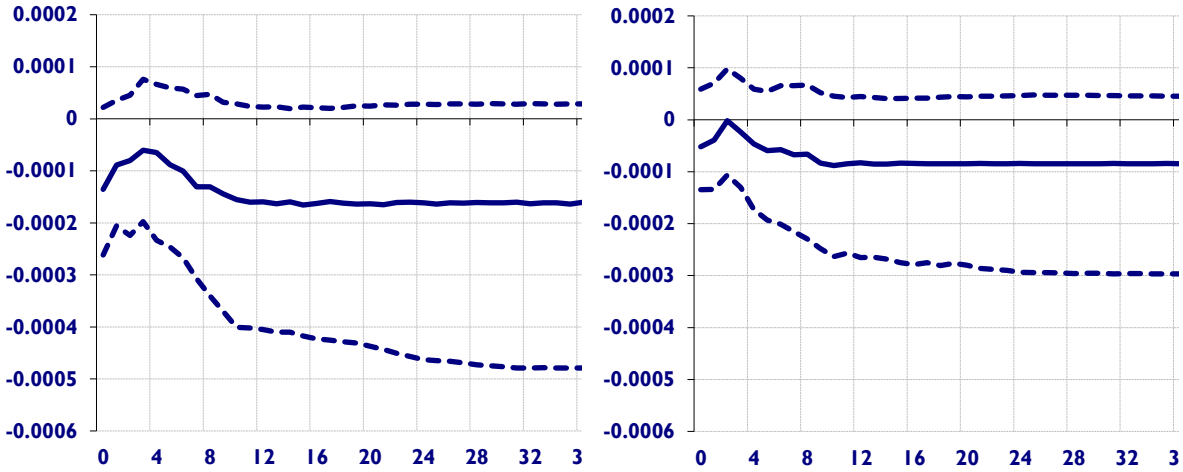
rl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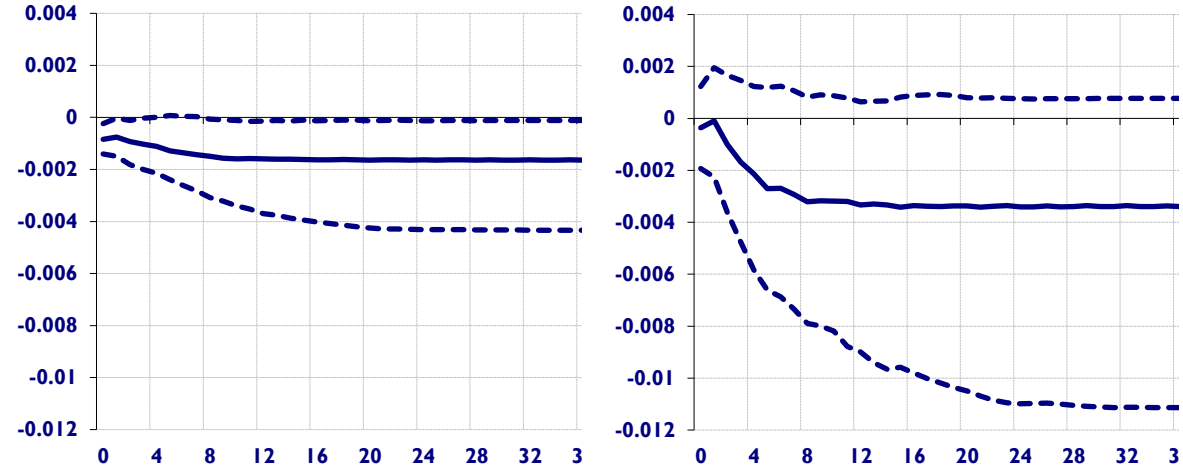
ep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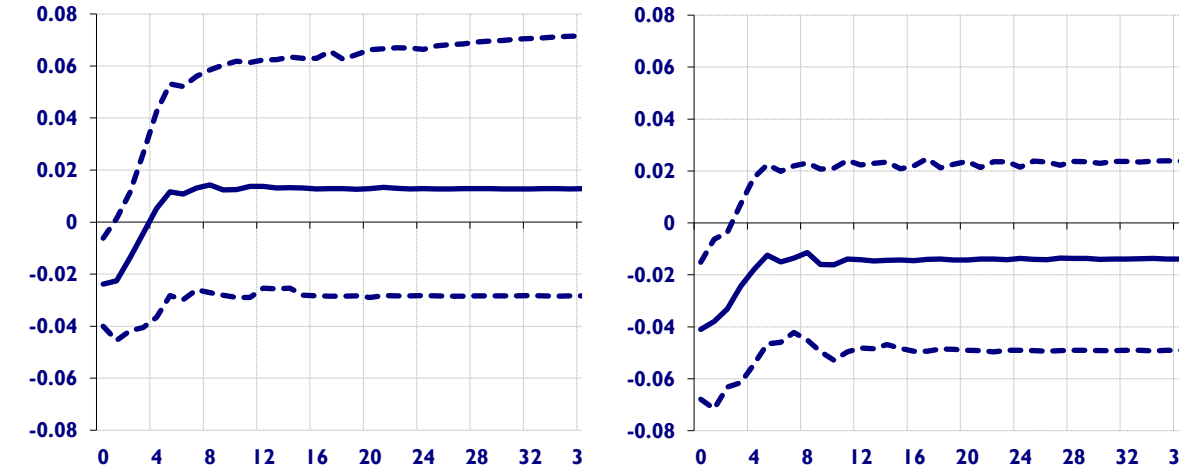
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-0.06
-0.08
0 4 8 12 16 20 24 28 32 3

From the perspective of resource allocation, the output of countries or regions with good resource allocation decreased by 0.003 units in the first period, while the output of another group decreased by 0.002 units in the first period. At the same time, the decline in the price index and stock index is also higher than that of economies with low resource allocation. This may be due to the fact that economies with high resource allocation generally have close external connections and high resource utilization rates. When the external environment and economy are sluggish, raw material supply is in short supply The obstruction of trade has a significant impact on output, which is reflected in prices and the stock market. In terms of interest rates, the short-term and long-term interest rates of countries or regions with efficient resource allocation decreased by 0.0006 and 0.0005 units respectively in the first period, while the short-term interest rates of countries or regions with inefficient resource allocation decreased by 0.0005 units in the long-term, indicating that in the short-term, countries or regions with efficient resource allocation were greatly impacted, and their interest rates fell more widely. In terms of exchange rate, due to the high degree of economic setbacks in economies with efficient resource allocation, their weak trade and investment, and capital outflows, the exchange rate increased by about 0.001 units in the 0 th period.

resource allocation:

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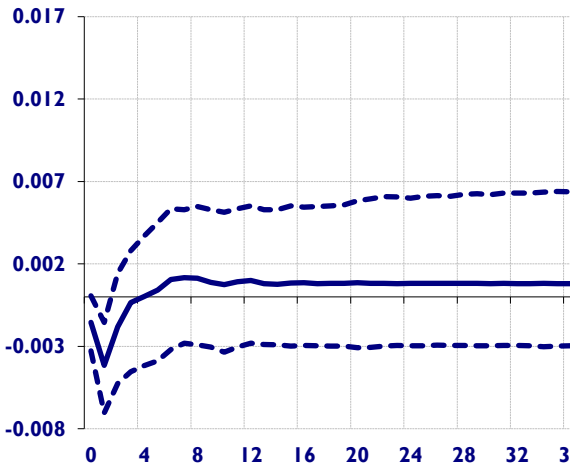
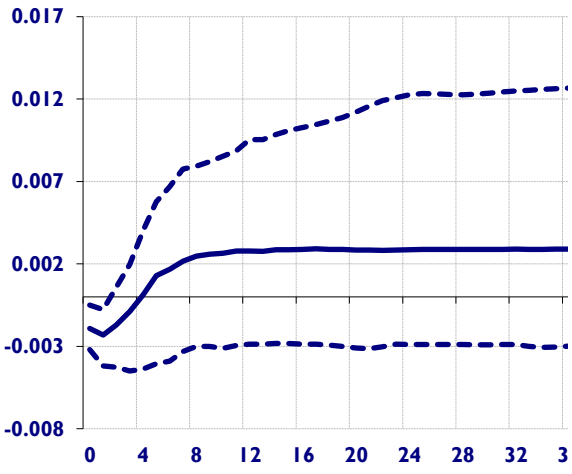
y		

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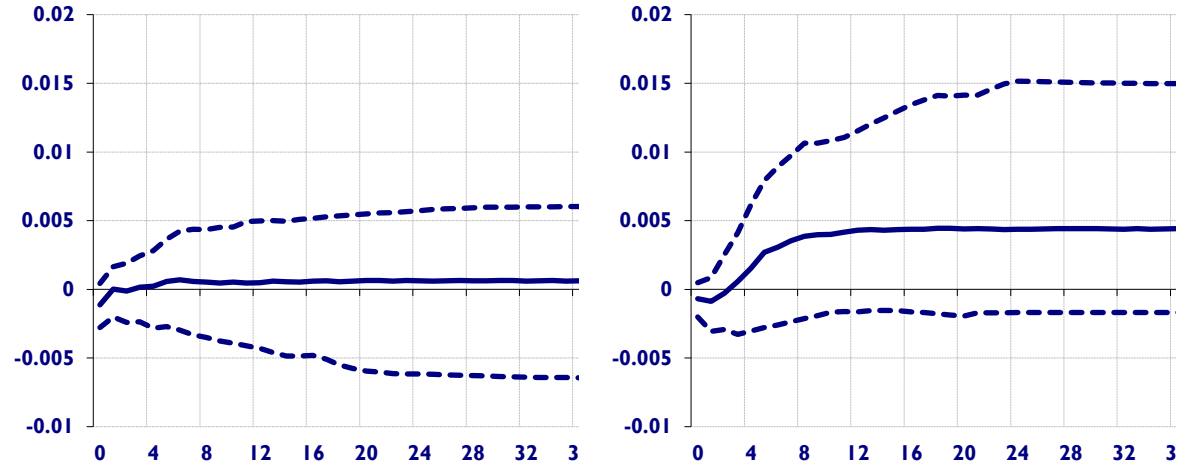
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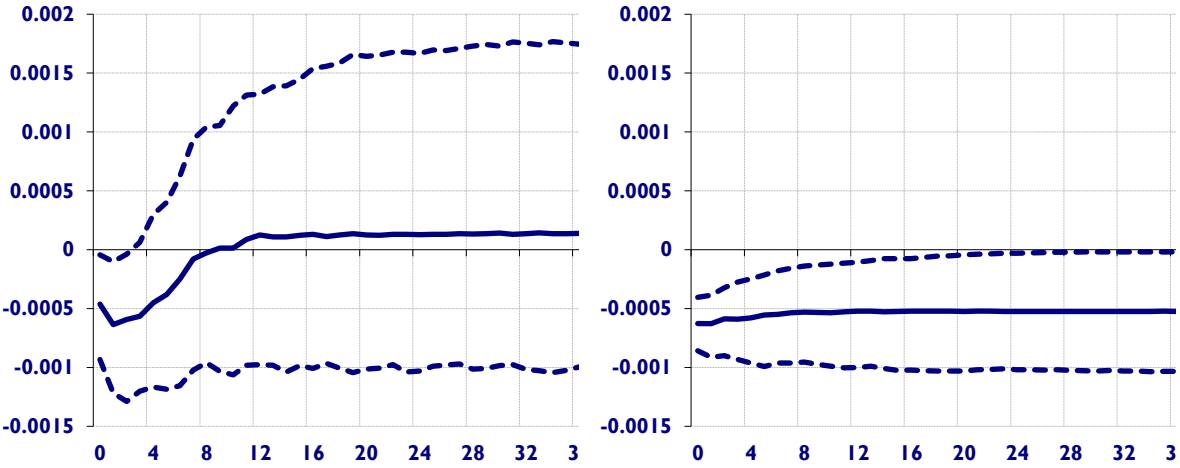
rs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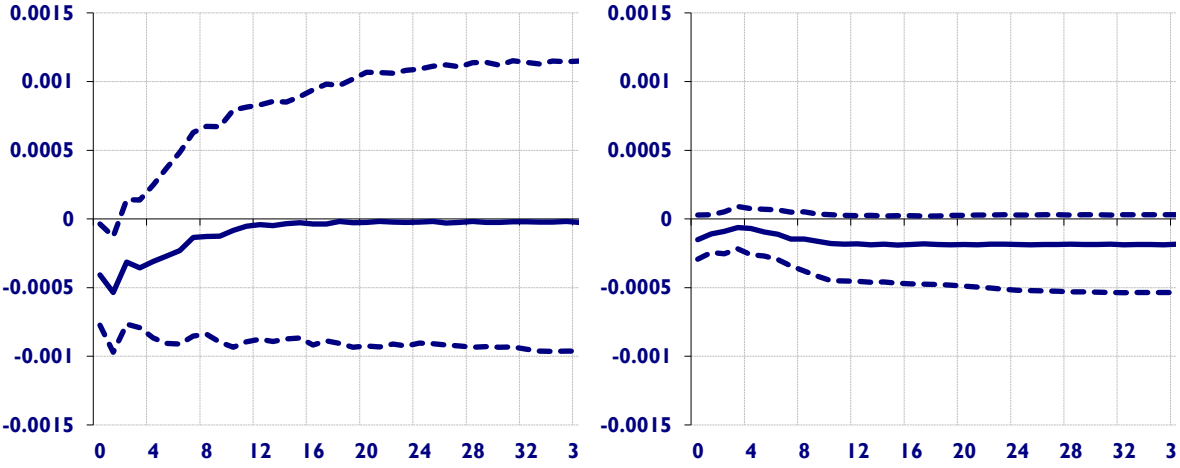
rl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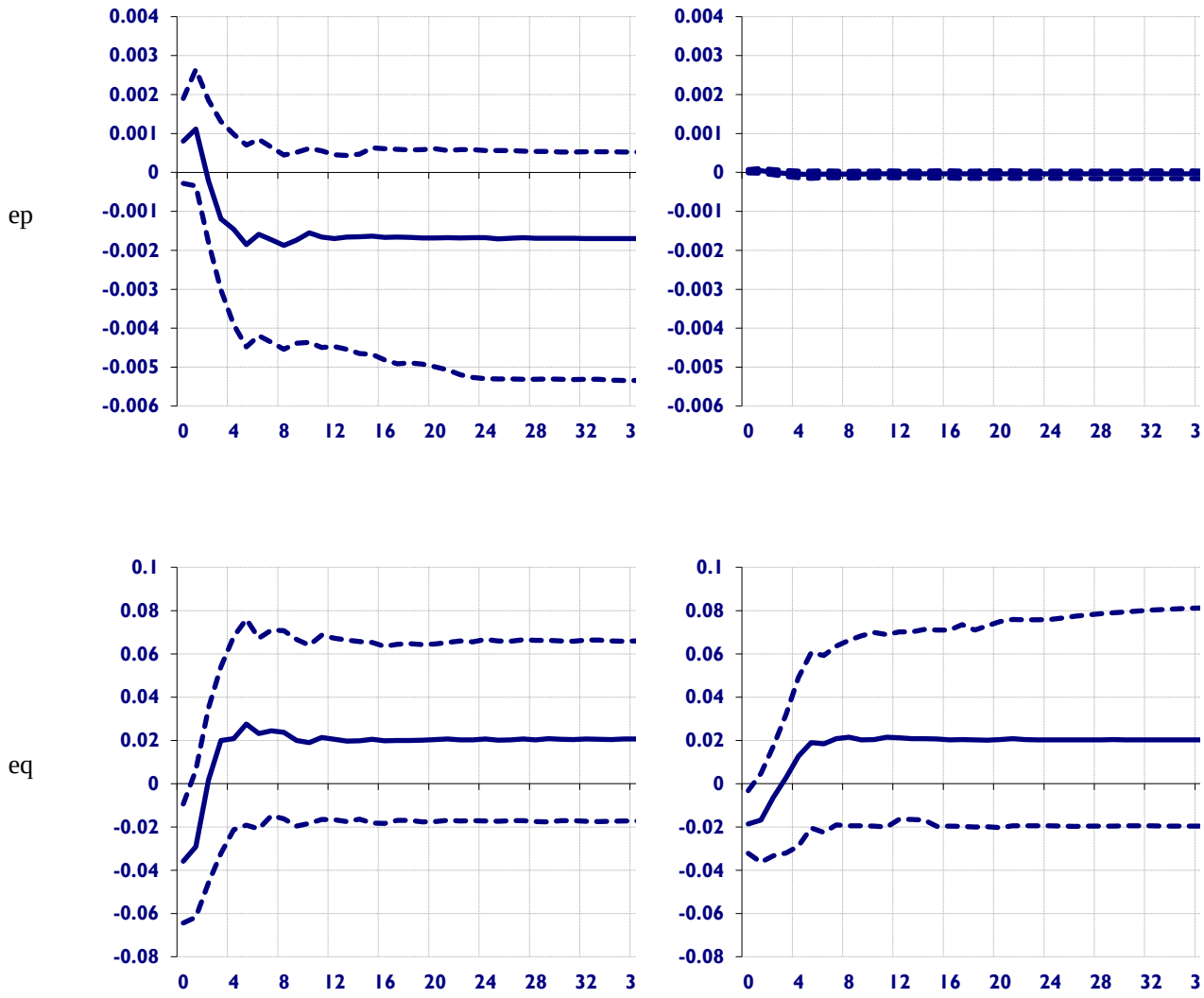
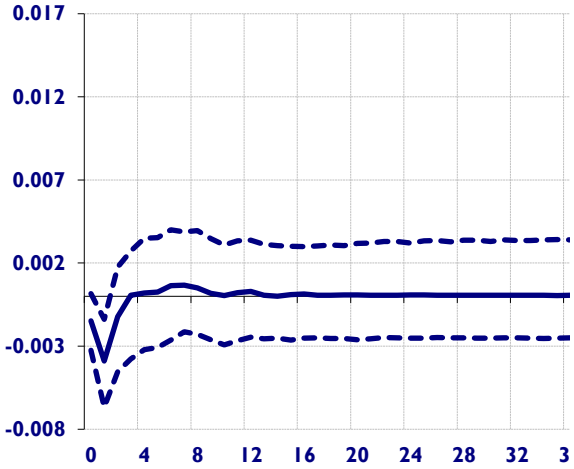
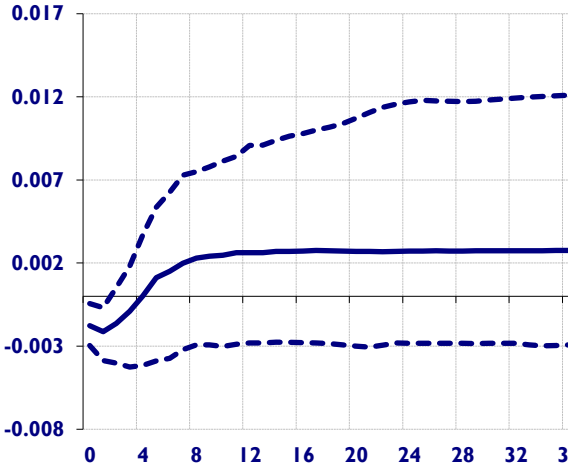
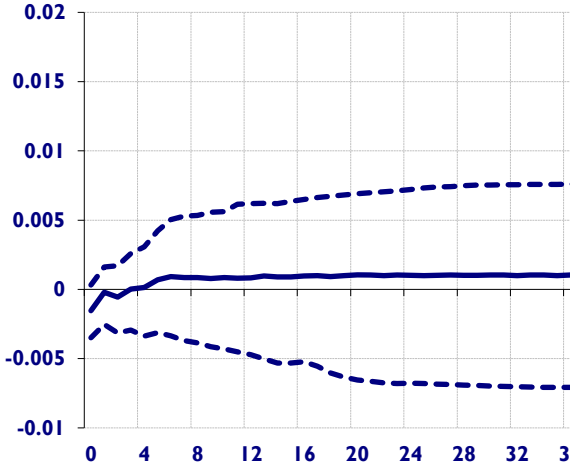
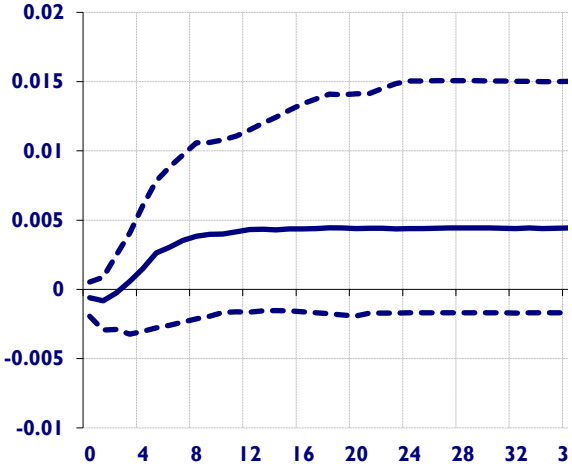


Similar to resource allocation, economies with well-developed market mechanisms are more vulnerable to external shocks, with short-term and long-term interest rates falling by 0.0007 and 0.0006 units respectively in the first period; In the short term, the sluggish economic recovery has led to an increase in output by 0.0028 units compared to the other group in the first period, an increase in the price index by 0.0007 units in the second period, and an increase in the stock index by 0.013 units in the second period. Multiple factors have driven the exchange rate to depreciate by 0.001 units in the second period.

market mechanism:

variable	mfh	mfl
y		
dp		

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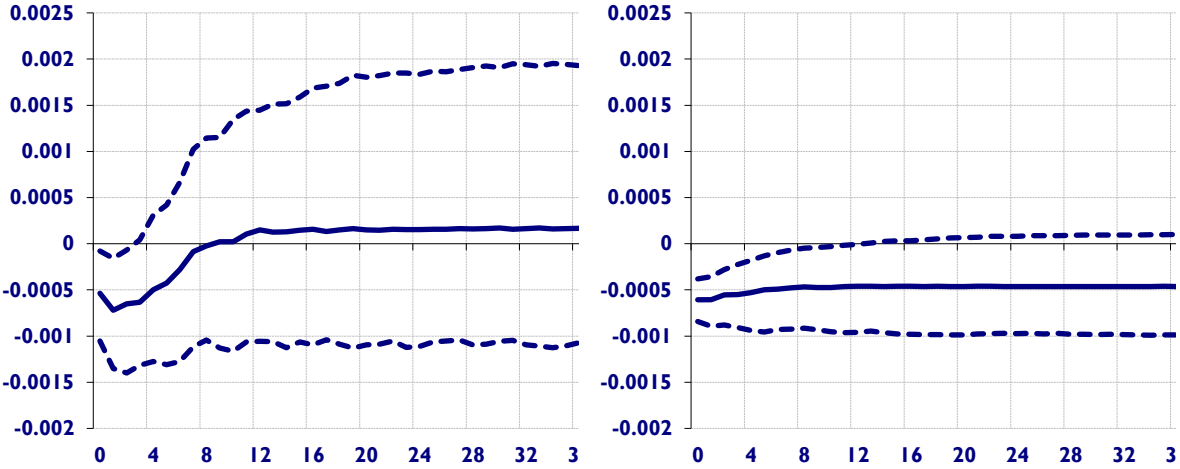
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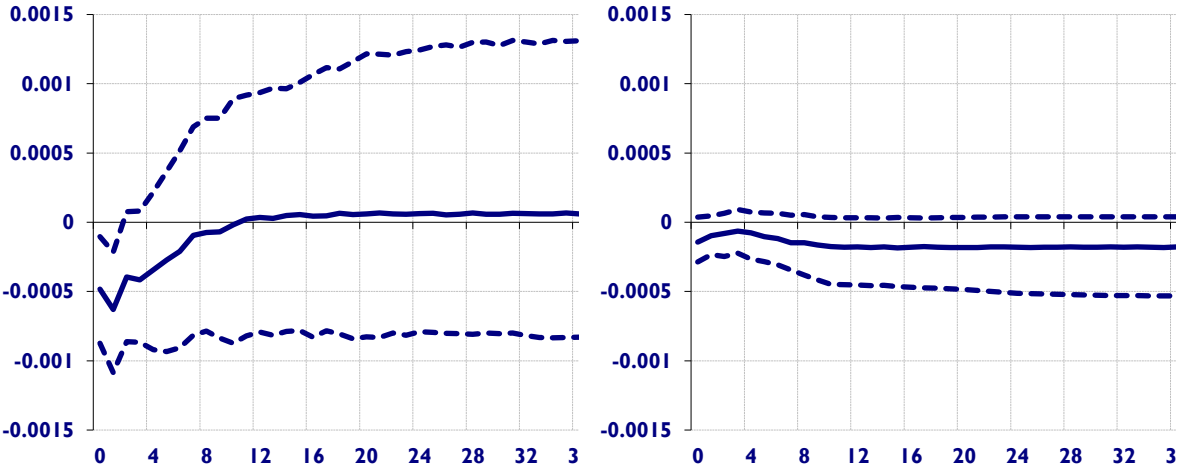
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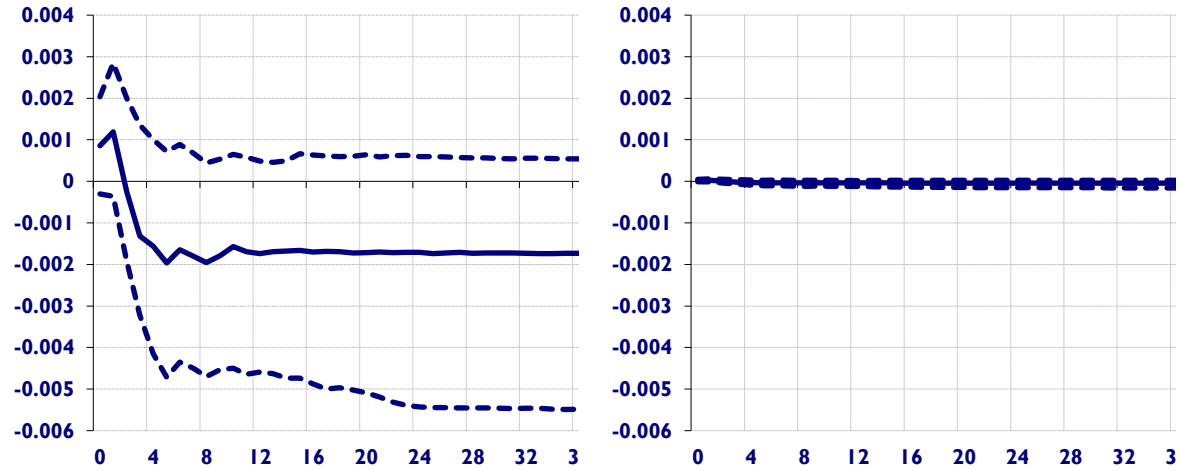
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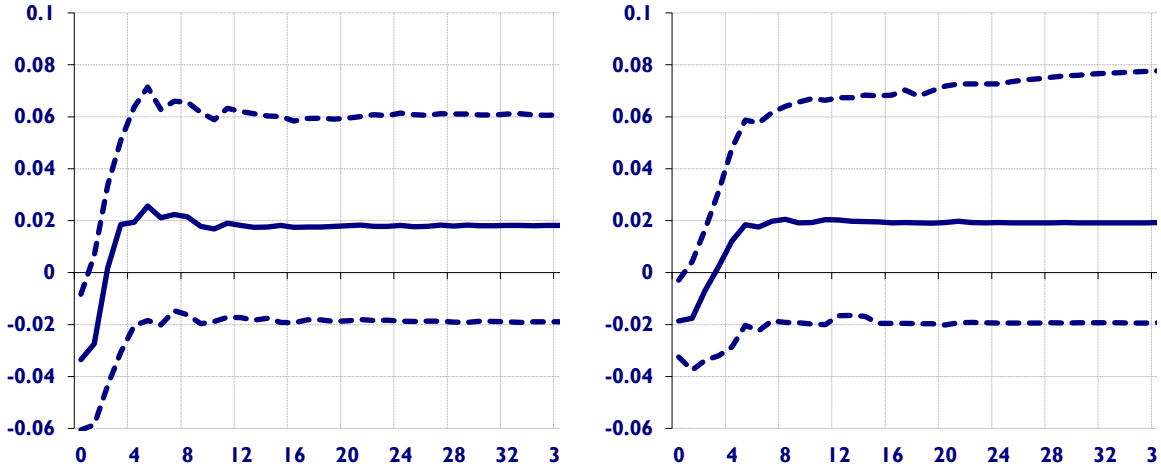
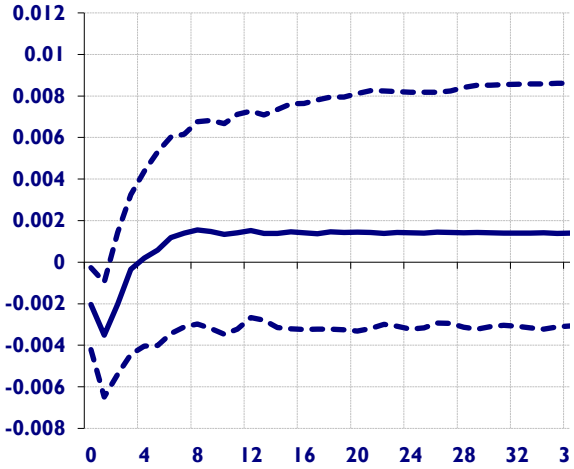


From the perspective of economic growth, the stock index of economies with high economic growth decreased by 0.04 units in the first period, an increase of 0.014 units compared to the other group. At the same time, short-term and long-term interest rates decreased by 0.0006 and 0.0005 units respectively in the first period, both of which decreased by a greater extent than the other group, indicating that economies with high economic growth are closely related to the external environment in terms of trade and investment, When exposed to external shocks, economic variables and market expectations react more acutely. For example, when the overall external economy of a country that relies on exports for economic growth is depressed, its trade volume will decline. However, due to the good fundamentals of its economic development, despite short-term pressure, the economic recovery is strong, reducing the scope of currency depreciation.

economic growth:

variable	egh	egl

y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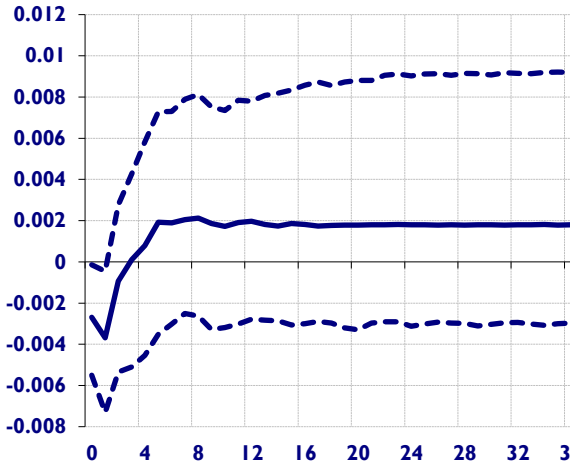
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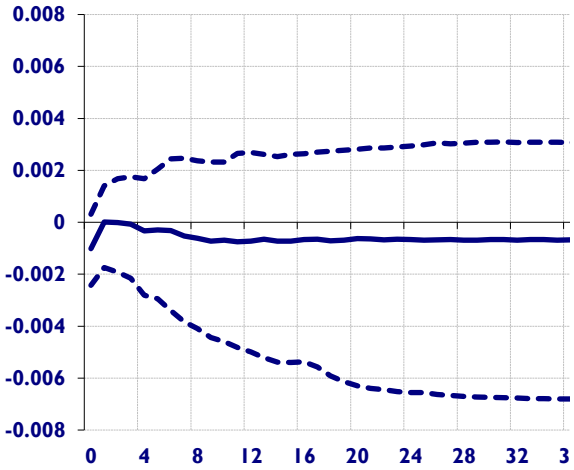
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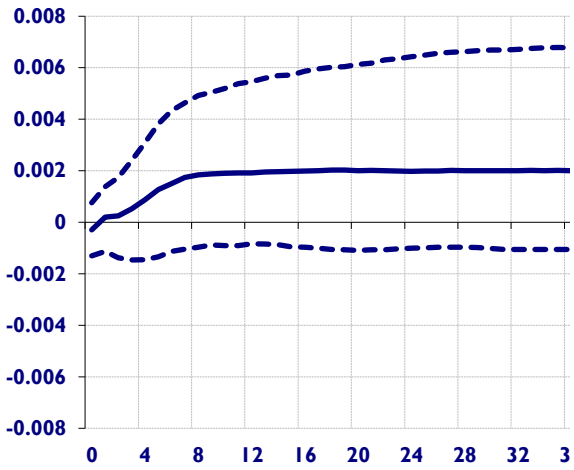
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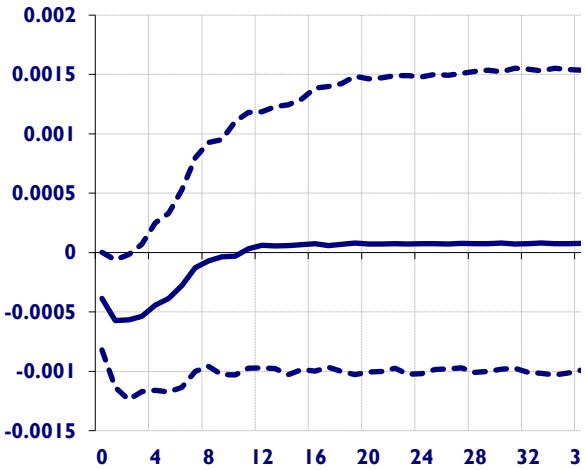
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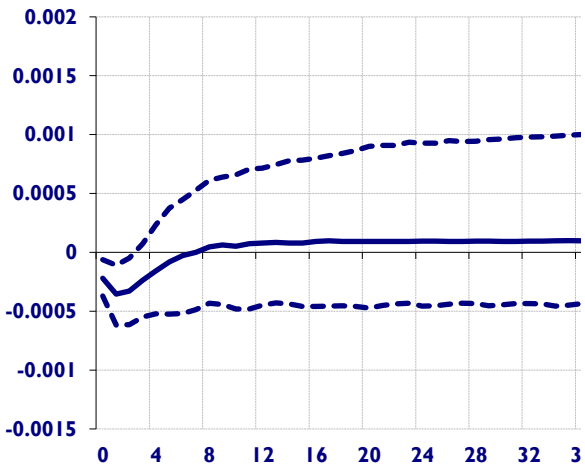
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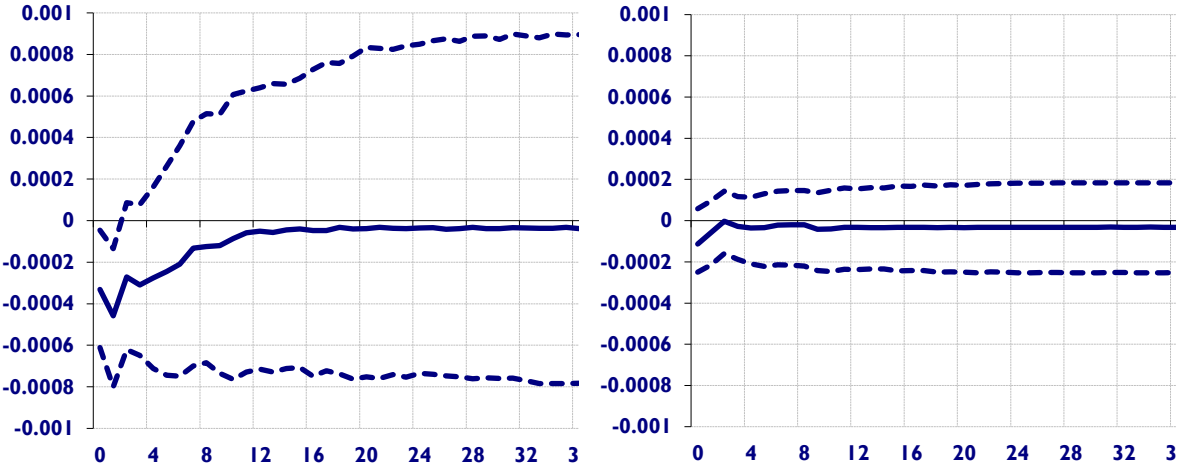
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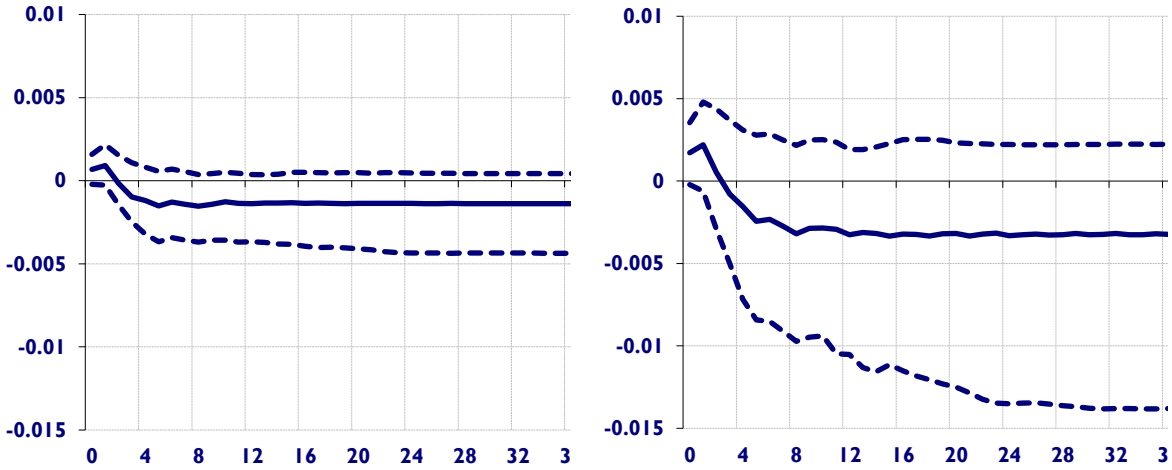
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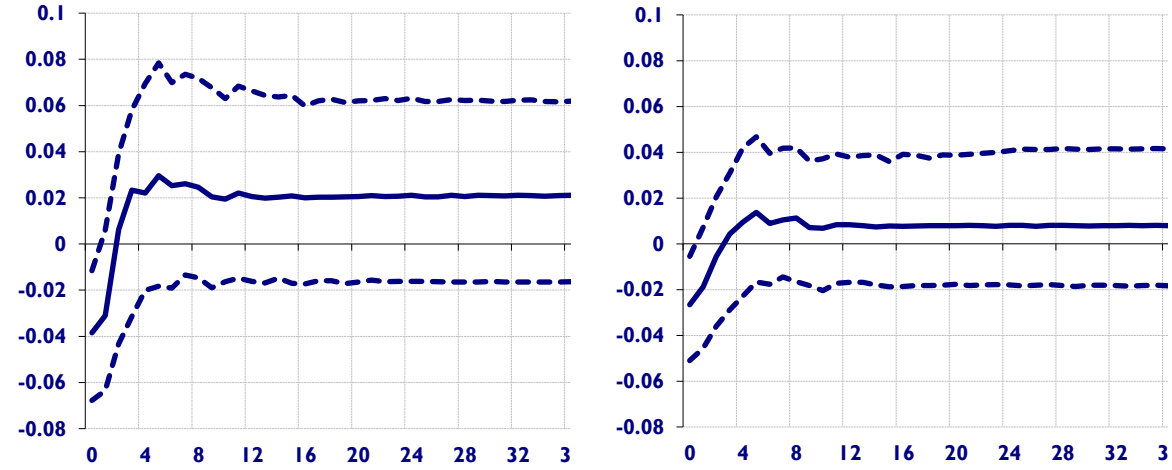
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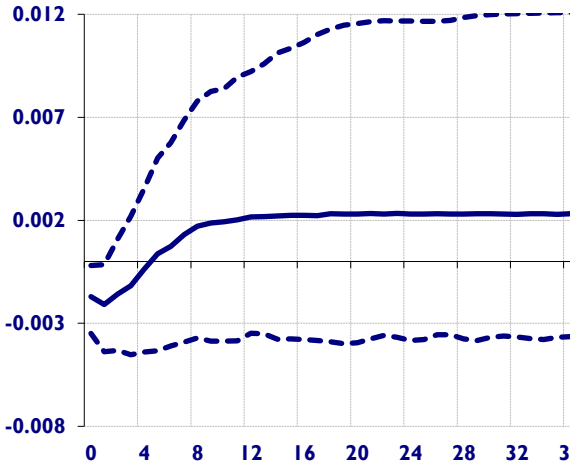
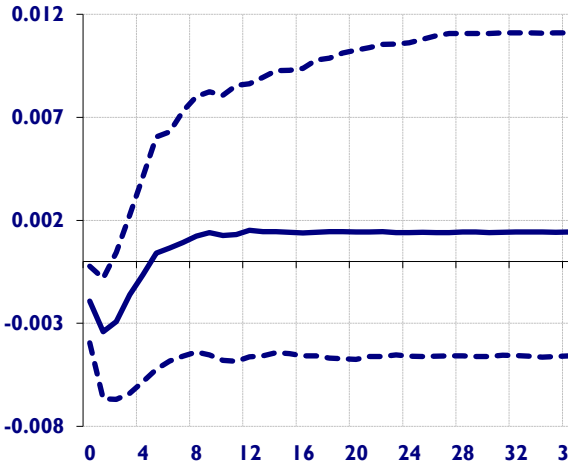
From the perspective of infrastructure, the output of countries or regions with good infrastructure construction decreased by about 0.002 units in the first period, which is 0.0014 units less than that of the other group. This indicates that strengthening infrastructure construction can help reduce the negative impact on output when affected by the external environment. From the perspective of the stock index, countries or regions with well-developed infrastructure fell by about 0.02 units in the 0 th period, while economies with poor infrastructure fell by about 0.036 units in the 0 th period, which can also indicate that strengthening infrastructure construction is conducive to reducing economic volatility.

infrastructure:

variable	bch	bcl
y		

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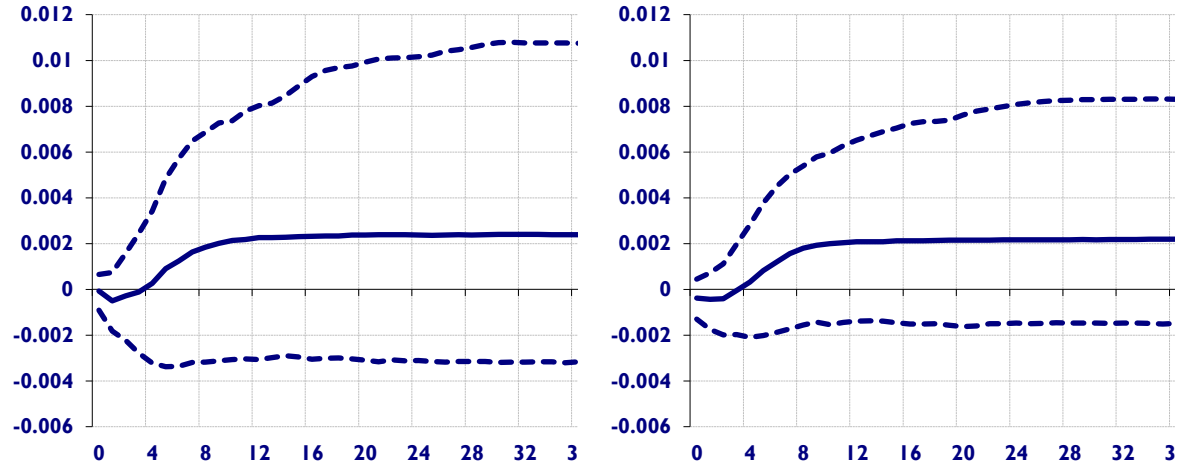
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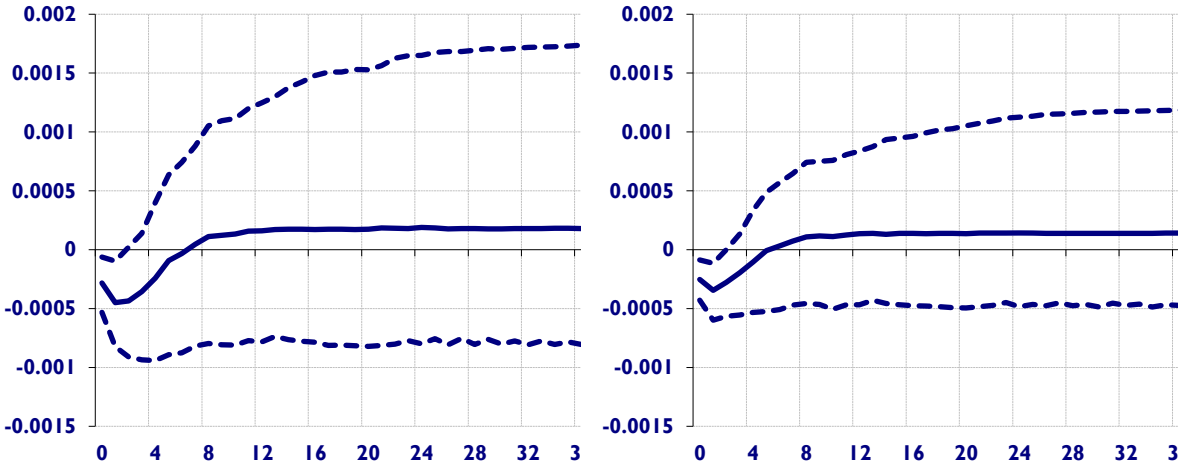
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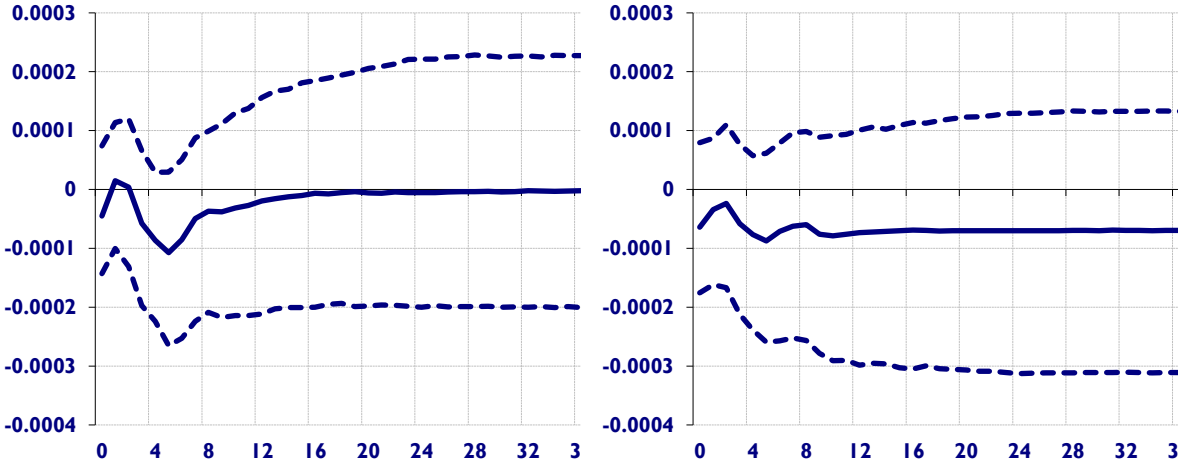
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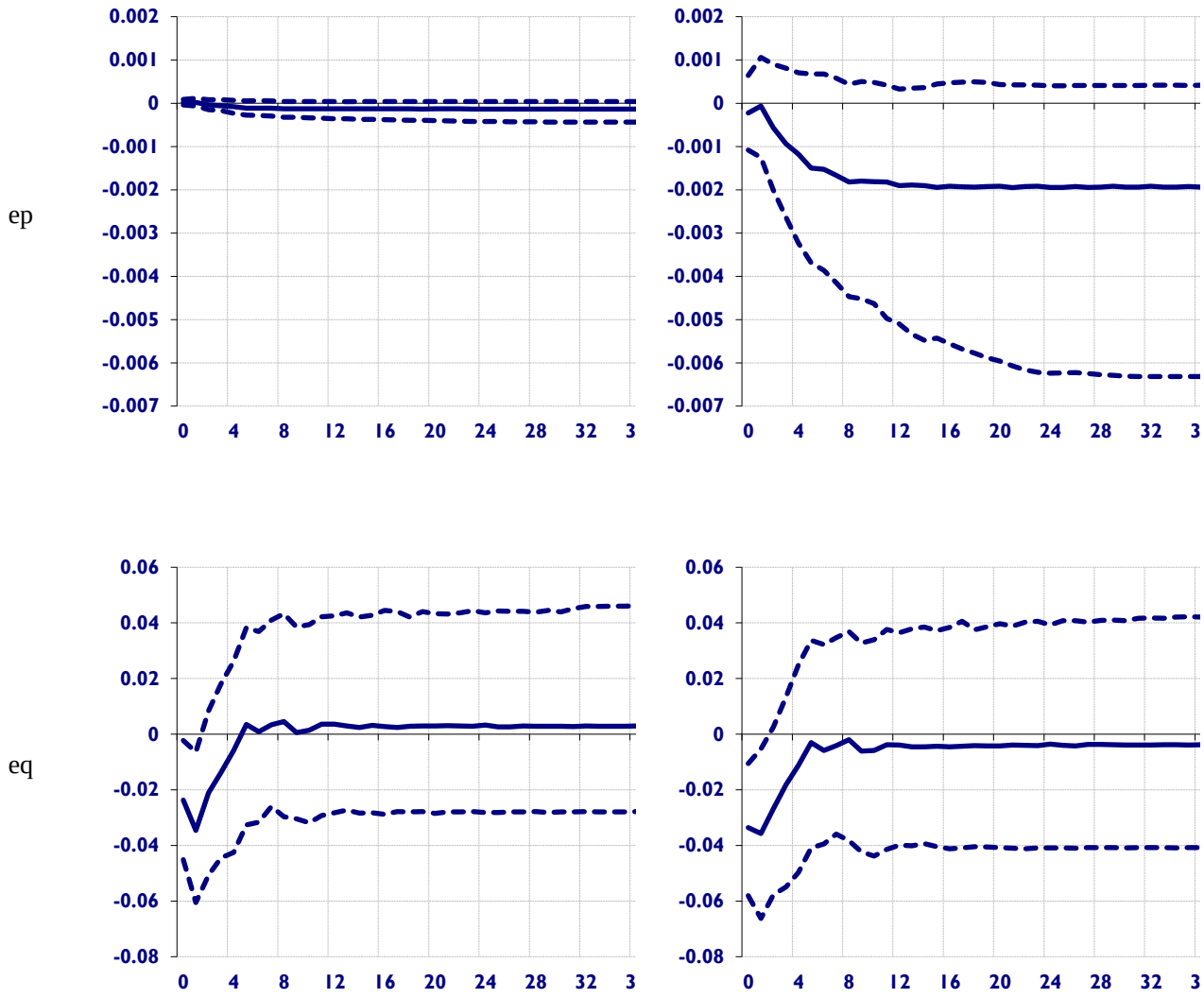
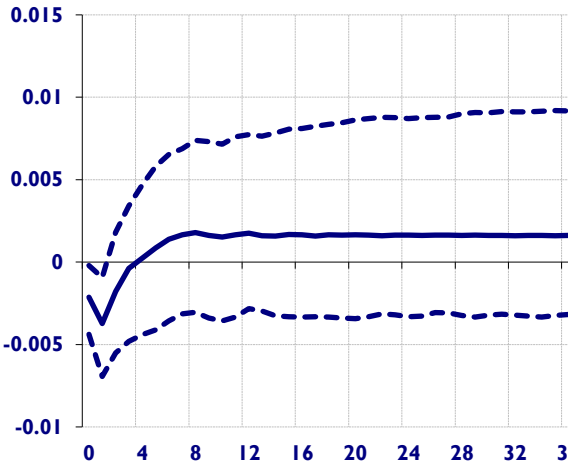
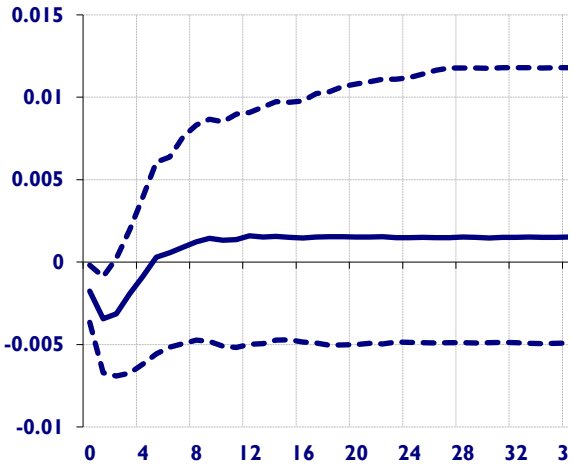
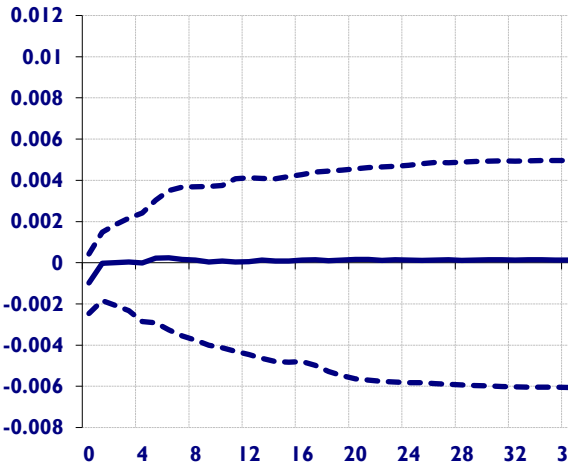
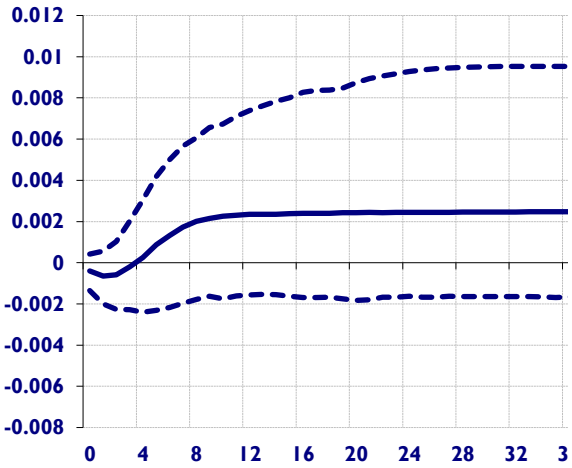


From the perspective of ecological environment, short-term and long-term interest rates in countries or regions with good ecological environment protection decreased by 0.0005 and 0.0004 units respectively in the first period, while short-term interest rates in countries or regions with poor ecological environment protection decreased by about 0.0004 units in the first period, and long-term interest rates were not significant. The reason may be that industries with severe pollution in countries or regions with good ecological environment protection accounted for less economic development, The service industry and other tertiary industries are the leading industries, and when subjected to external economic shocks, their own impact is greater, so both short-term and long-term interest rates will decline in the short term; Countries or regions with poor ecological environment protection have more industries with high pollution and damage to the ecological environment, typically

manufacturing and agriculture. However, when the external environment changes, the degree of change is not significant, so the corresponding economic variables are not significantly changed. In terms of exchange rates, countries or regions with poor ecological environments have appreciated by about 0.0015 units in the long term. It is precisely due to their industrial structure that the economy has been less affected and has recovered quickly from external pressure in the short term, driving exchange rate appreciation.

ecological environment:

variable	eph	epl
y		
dp		

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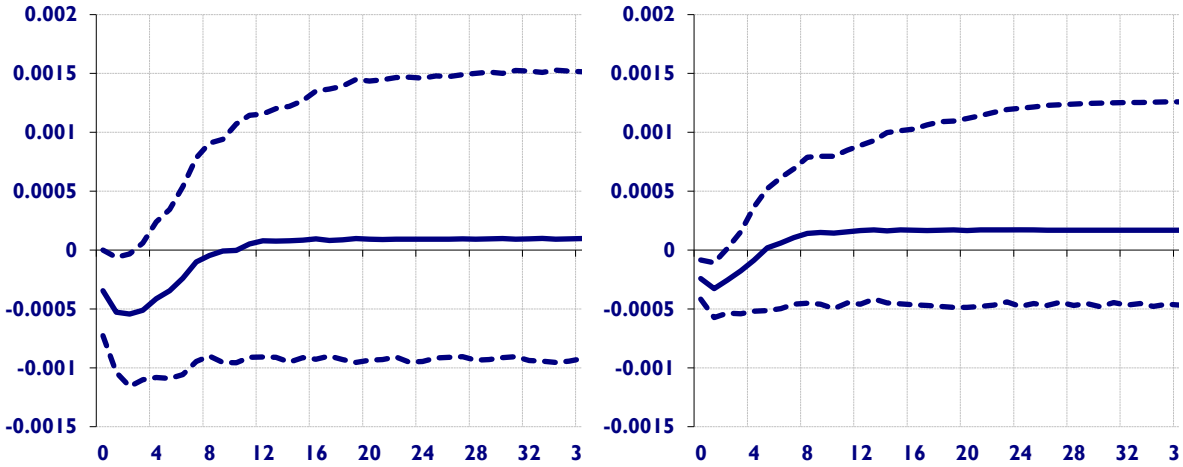
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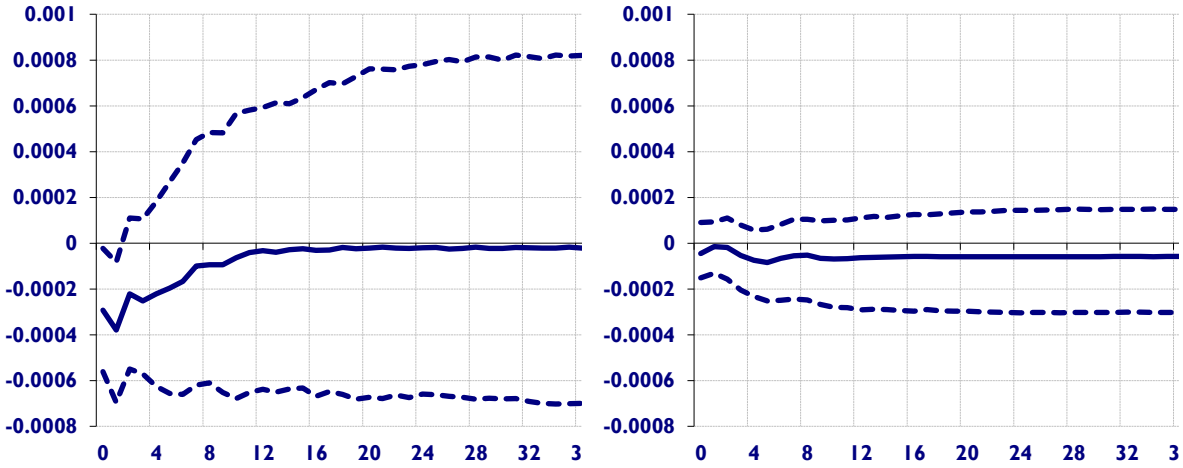
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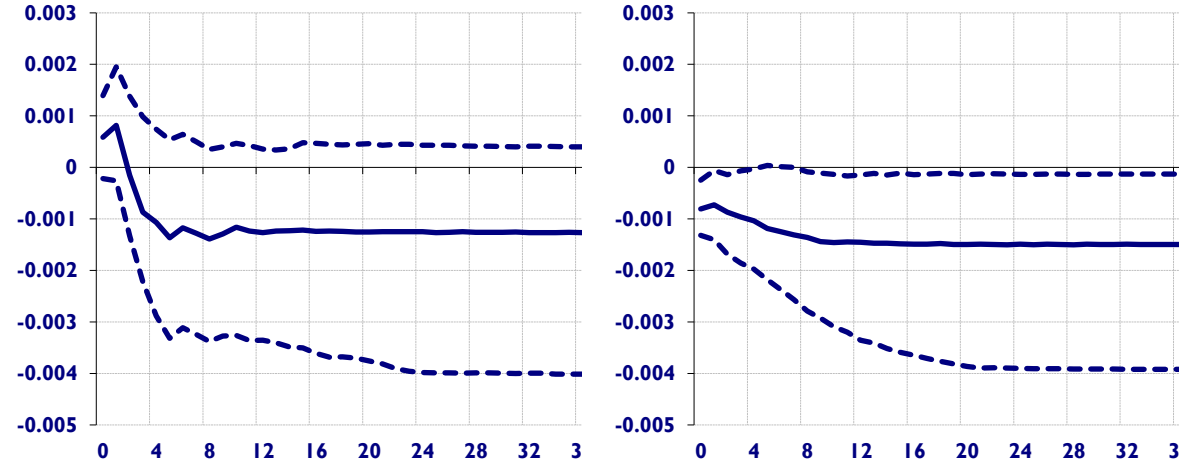
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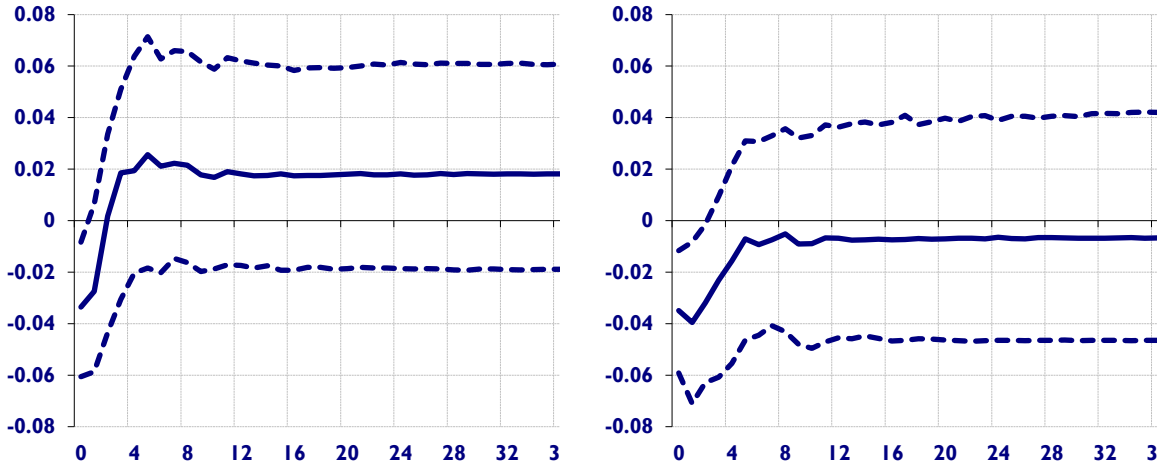
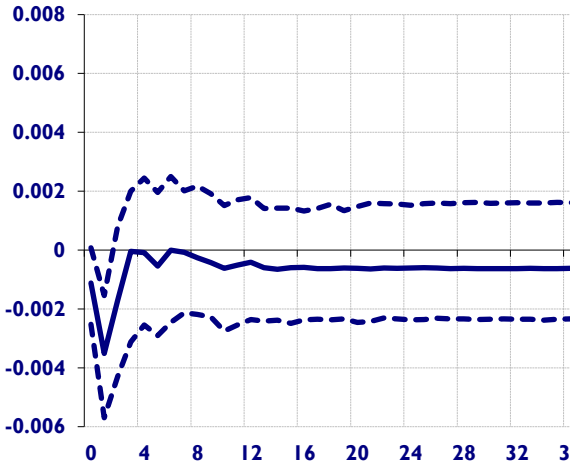


From the perspective of economic benefits to the people, countries with a high degree of economic benefits to the people generally have strong environmental protection, resource allocation, market mechanisms, and technological innovation, and are closely linked to the external environment. Therefore, when the United States implements quantitative easing policies, they will be greatly affected. In terms of output, economies with a high degree of economic benefit to the people decreased by 0.0036 units in the first period, an increase of about 0.0008 units compared to the other group. The price index decreased by about 0.0015 units in the first period, and the stock index decreased by about 0.04 units in the second period; In terms of interest rates, the short-term and long-term interest rates of economies with high economic benefits for the people decreased by 0.0008 and 0.00078 units respectively in the first period, while the short-term interest rates of economies with low economic benefits for the people decreased by 0.0005 units in the first period, with no significant change in long-term interest rates. Due to the significant external impact on economies with high economic benefits to the people, foreign trade is hindered, and capital outflows lead to a devaluation of the exchange rate, with a devaluation of 0.001 units in period 0.

economic benefits to the people:

variable	prh	prl

y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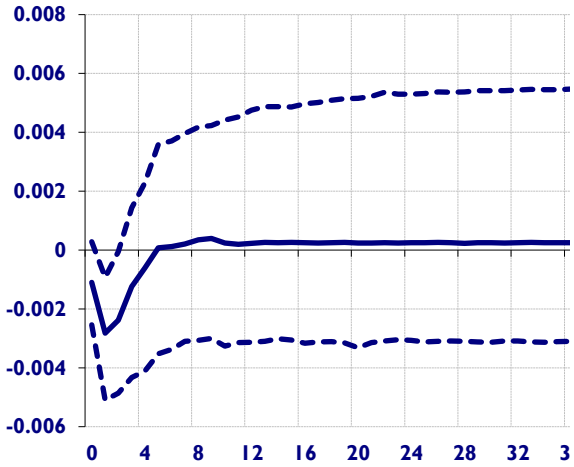
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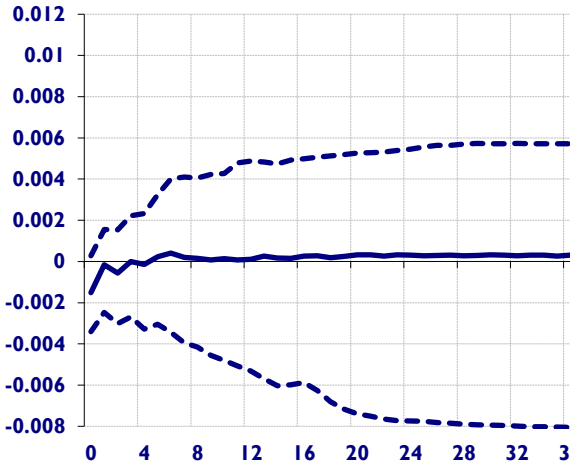
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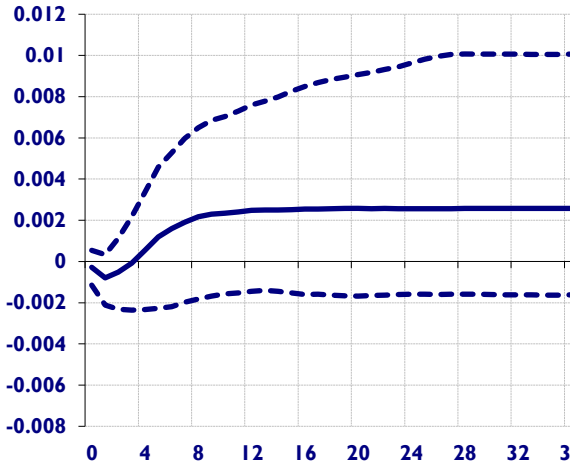
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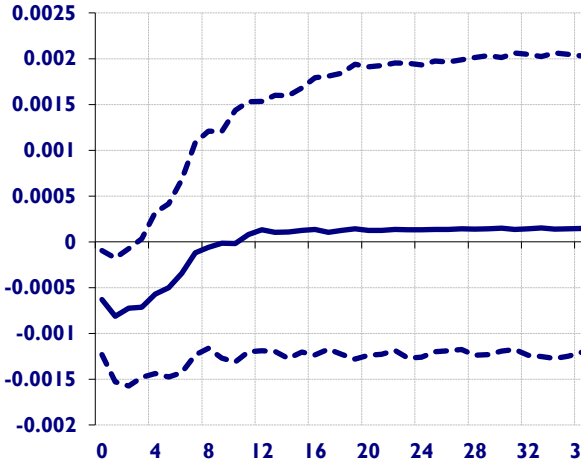
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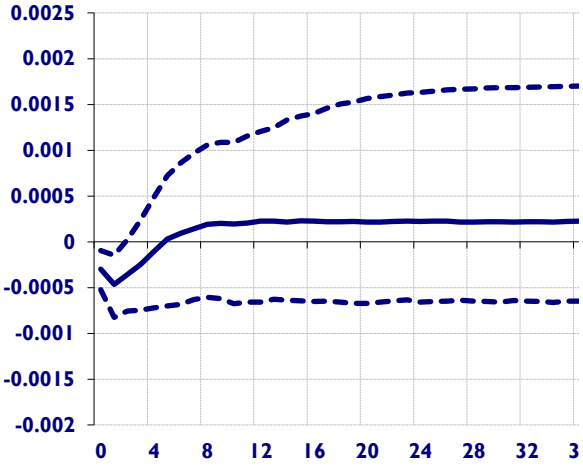
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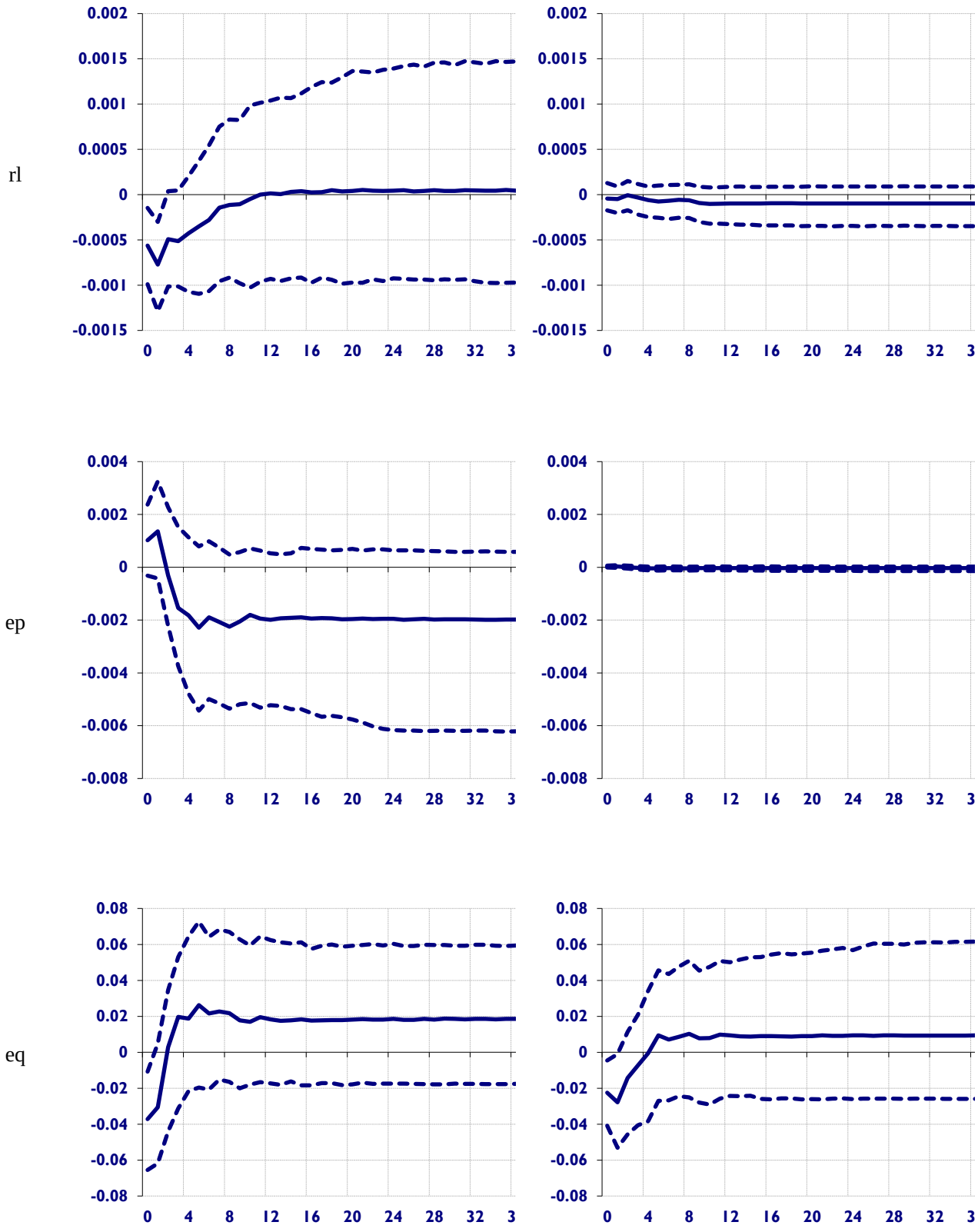
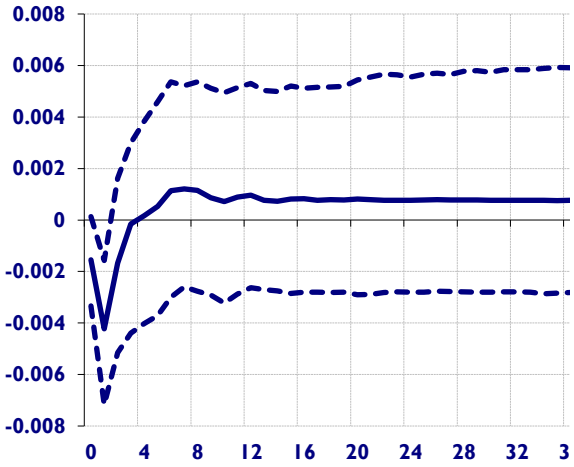
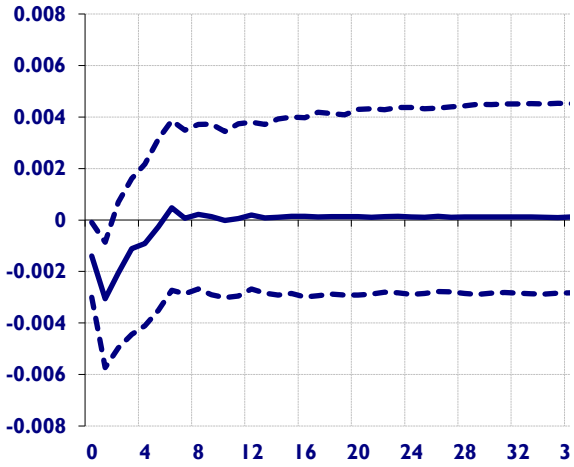


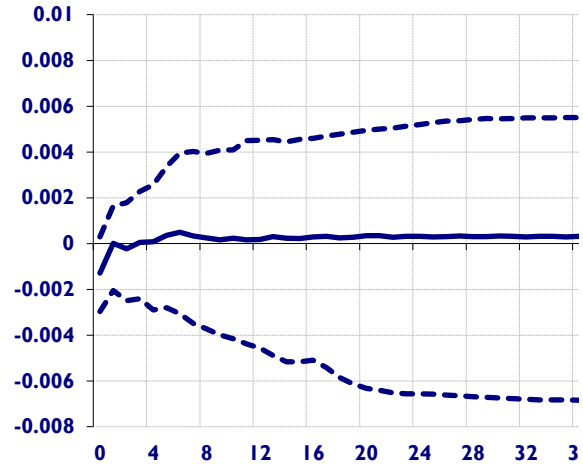
From the perspective of the debt structure of the residential sector, the output of countries or

regions with low leverage decreased by 0.004 units in the first period, while that of economies with high leverage decreased by 0.003 units in the first period. At the same time, the price index of countries or regions with low leverage also decreased more. It is said that due to low leverage and poor consumption ability of residents, such as low willingness to borrow and repay loans, the real estate industry developed slowly, which affected economic development, Therefore, when subjected to external shocks, its output decreases significantly; In order to stimulate consumption and investment, countries or regions with low leverage have significantly lowered interest rates, with short-term and long-term interest rates falling by 0.0007 and 0.0006 units respectively in the first period, while economies with high leverage have short-term interest rates falling by 0.0003 units in the second period, with no significant change in long-term interest rates. The weak economic recovery in low leverage economies pushed the exchange rate down, rising by about 0.001 units in the 0 th period.

debt structure - resident sector:

variable	lril	lrih
y		

dp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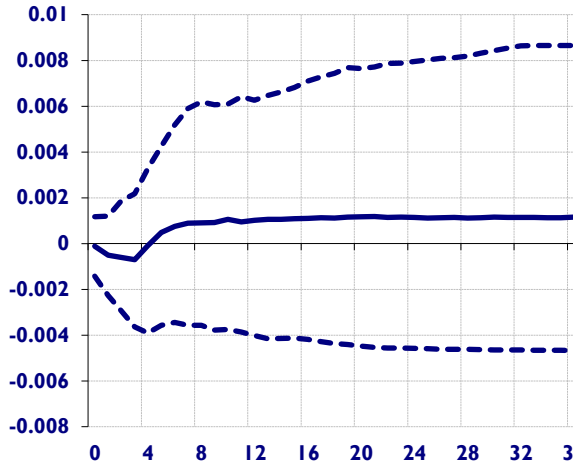
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
0 4 8 12 16 20 24 28 32 3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0.008
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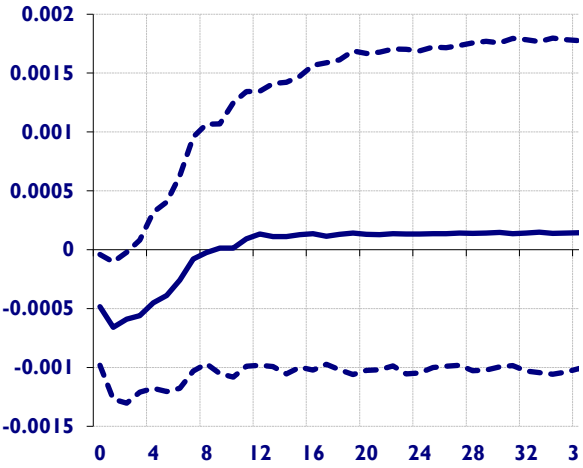
0.004
0.002
0
-0.002
-0.004
-0.006
-0.008
0 4 8 12 16 20 24 28 32 3

rs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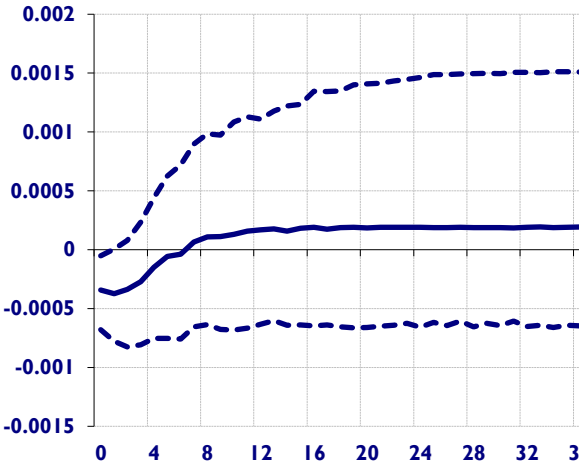
0.001
0.0005
0
-0.0005
-0.001
-0.0015
0 4 8 12 16 20 24 28 32 3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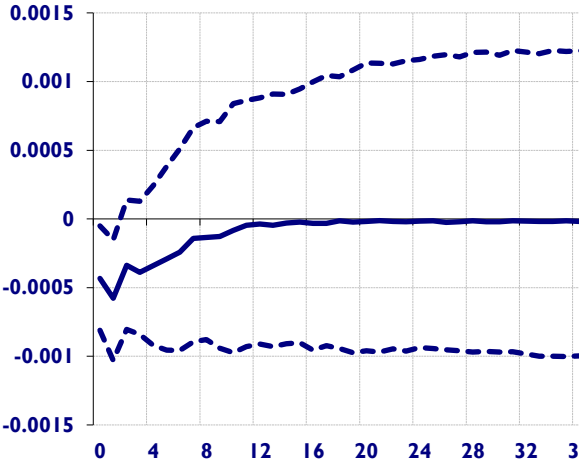
0.0015
0.001
0.0005
0
-0.0005
-0.001
-0.0015
0 4 8 12 16 20 24 28 32 3

rl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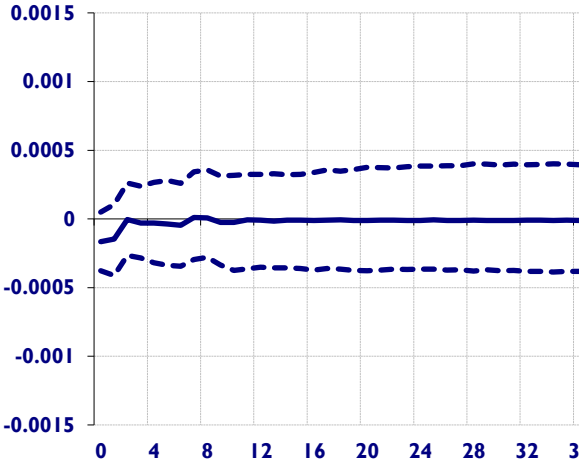
-0.0015
0 4 8 12 16 20 24 28 32 3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0
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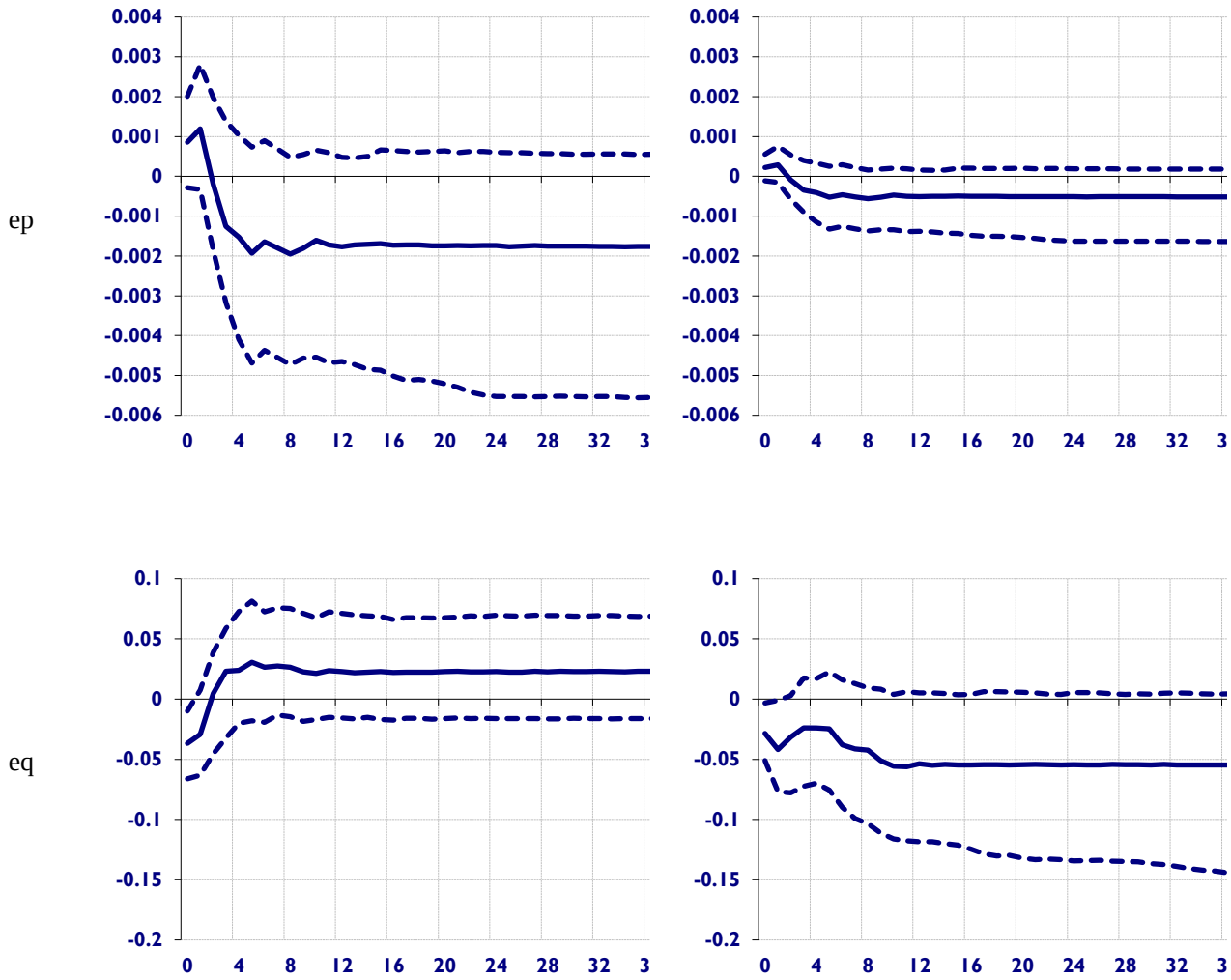
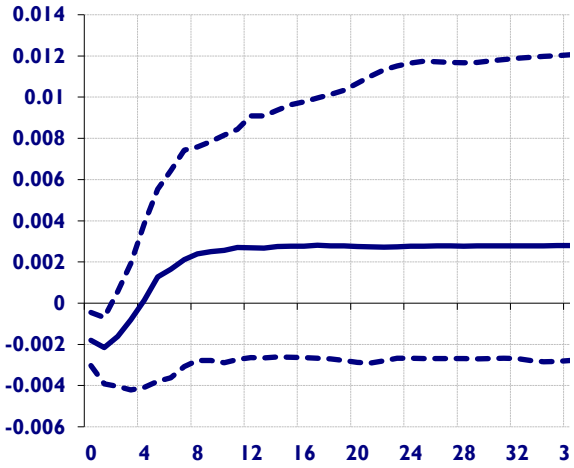
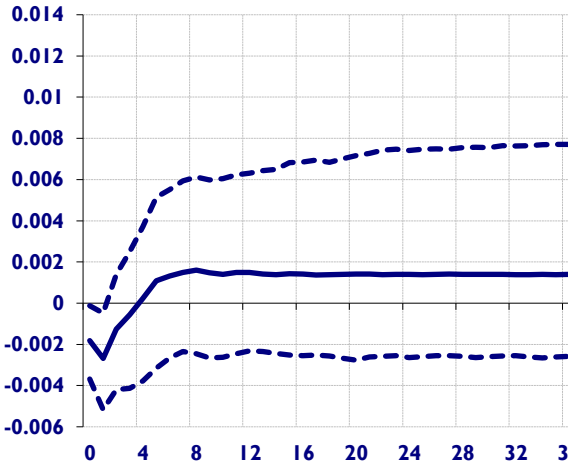
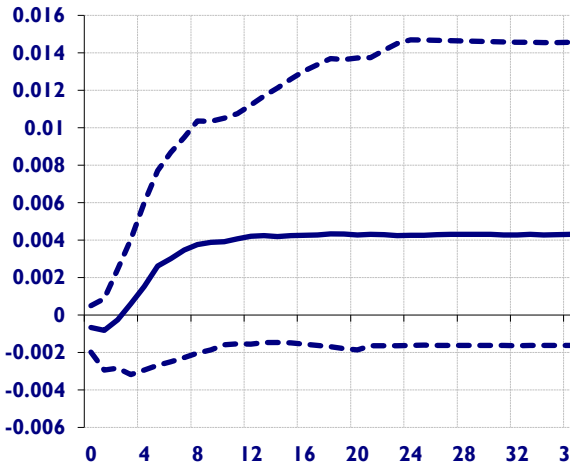
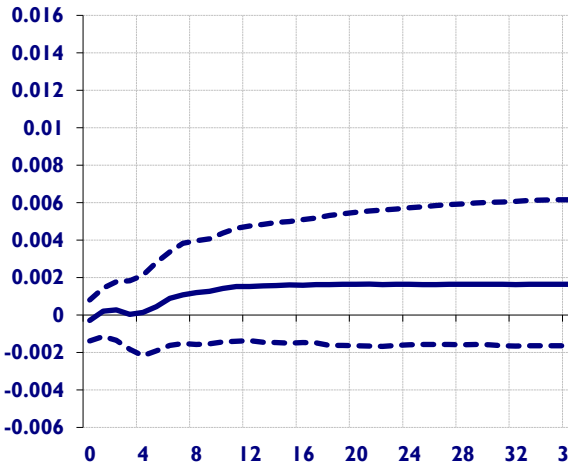
0 4 8 12 16 20 24 28 32 3



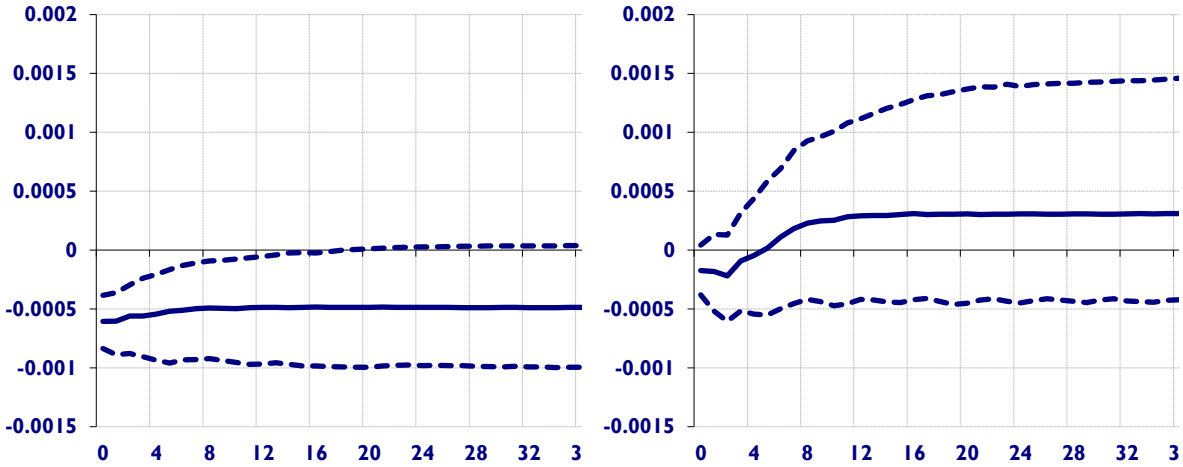
From the perspective of the debt structure of government departments, countries or regions with high leverage usually mean that the government has a higher degree of participation in economic development, which is consistent with Keynesian government interventionism, leading to a lower degree of marketization. When subjected to external shocks, it has a greater impact on the economy and the government, which in turn affects economic output and other aspects. The output of highly leveraged economies decreased by about 0.0027 units in the first period, while the stock index decreased by 0.03 units in the second period. At the same time, the uncertainty caused by large economic fluctuations led to a devaluation of the exchange rate by 0.0015 units in the second period. Economies with low leverage from government departments have relatively complete market mechanisms, and their interest rates are closely linked to the external environment. Their short-term

interest rates have fallen by 0.0005 units over the long term.

debt structure - government sector:

variable	lrgl	lrgh
y		
dp		

rs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0.0015
0.001
0.0005
0
-0.0005
-0.001
-0.0015
0 4 8 12 16 20 24 28 32 3
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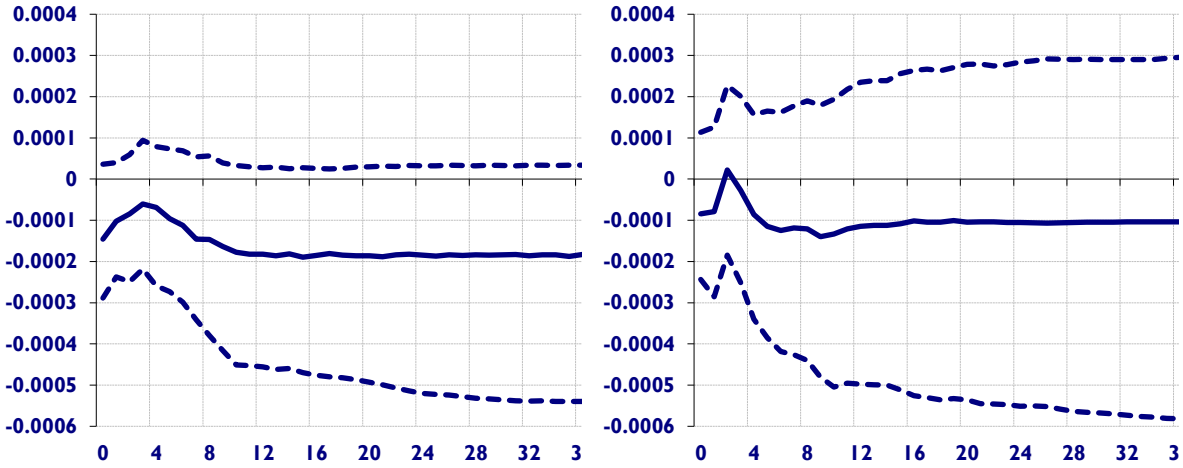
0.001
0.0005
0
-0.0005
-0.001
-0.0015
0 4 8 12 16 20 24 28 32 3

rl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-0.0004
-0.0005
-0.0006
0 4 8 12 16 20 24 28 32 3
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0.0003
0.0002
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-0.0002
-0.0003
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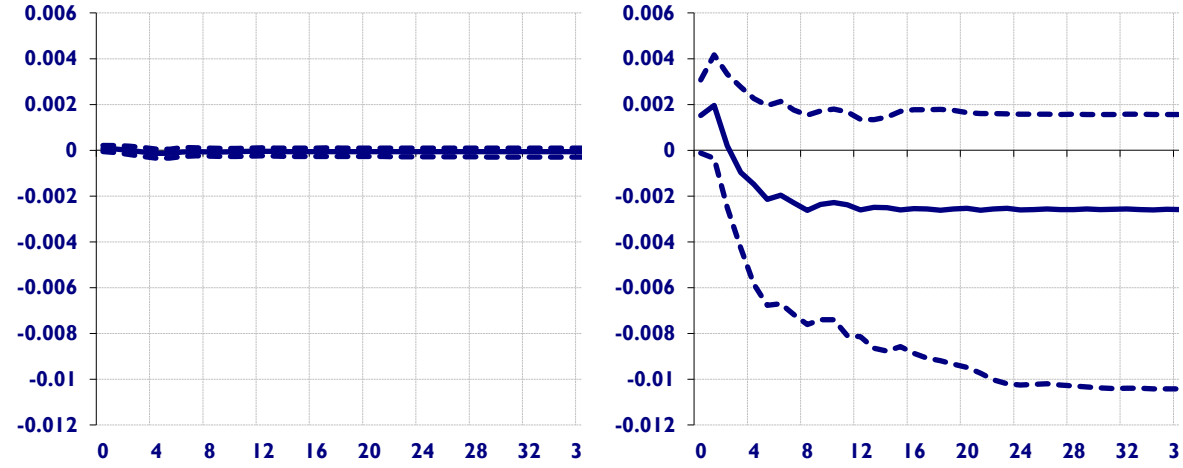
-0.0005
-0.0006
0 4 8 12 16 20 24 28 32 3

ep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0.002
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-0.008
-0.01
-0.012
0 4 8 12 16 20 24 28 32 3
0.006
0.004
0.002
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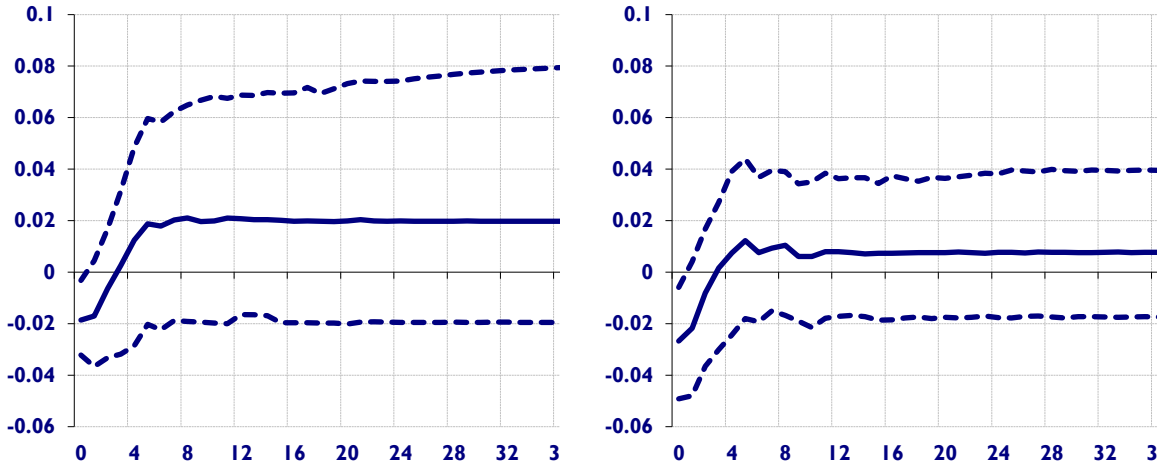
0 4 8 12 16 20 24 28 32 3

eq

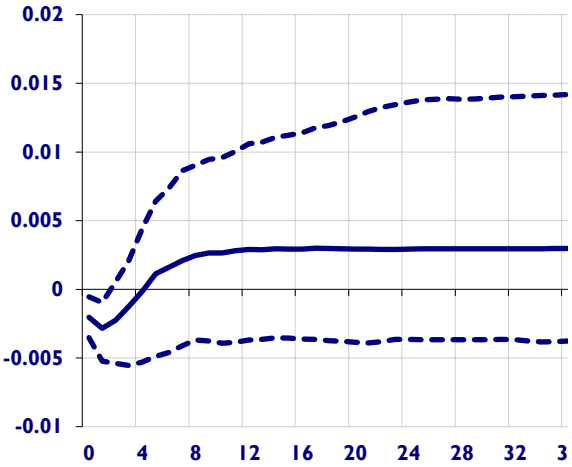


From the perspective of the debt structure of the non-financial corporate sector, a high leverage ratio of a company usually means that its operational risk is high, and the impact is high when there are changes in interest rates and external economic environment shocks. Therefore, the short-term and long-term interest rate changes in highly leveraged economies are not significant, while in low leveraged economies, the flexibility is high, and their short-term interest rate decreases by 0.0005 units over the long term; In terms of exchange rates, economies with low leverage have been less affected by external shocks. The rapid economic recovery and relatively stable investment environment have prompted their exchange rates to appreciate, resulting in a long-term decline of 0.002 units. However, economies with high leverage have experienced a short-term depreciation of 0.001 units due to their greater risks and weak economic recovery.

debt structure - non financial corporate sector:

variable	lrcl	lrch

y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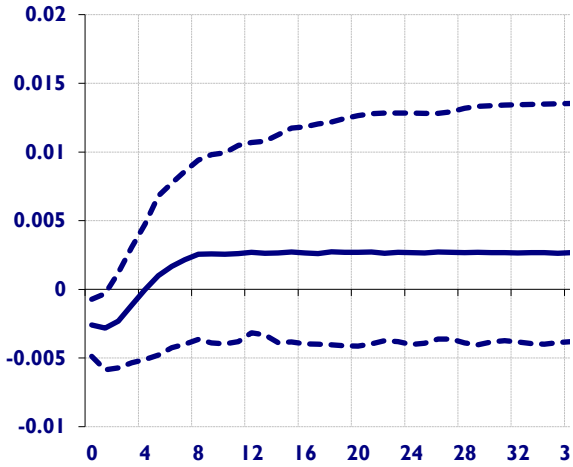
0.015
0.01
0.005
0
-0.005
-0.01
0 4 8 12 16 20 24 28 32 3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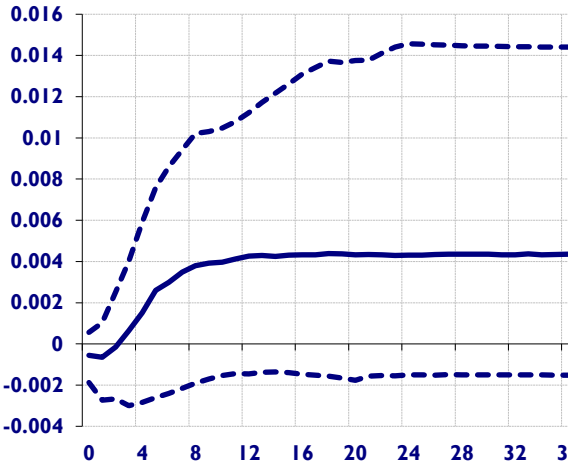
0.015
0.01
0.005
0
-0.005
-0.01
0 4 8 12 16 20 24 28 32 3

dp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0.014
0.012
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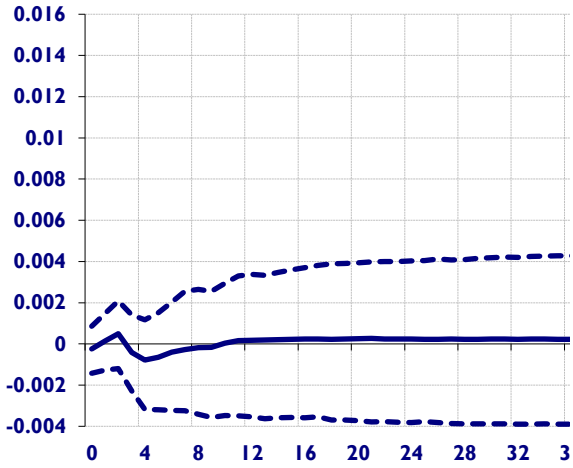
0.008
0.006
0.004
0.002
0
-0.002
-0.004
0 4 8 12 16 20 24 28 32 3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0.006
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0
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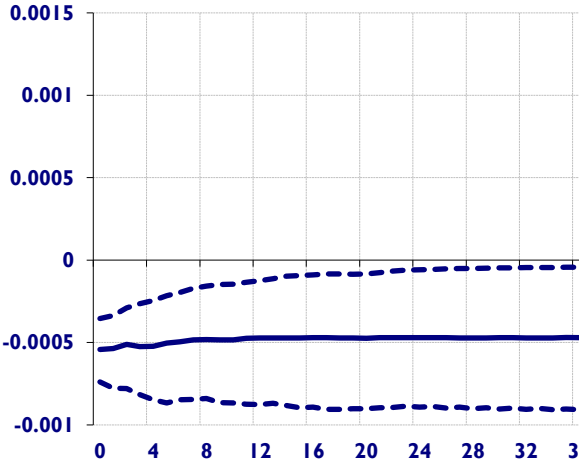
0 4 8 12 16 20 24 28 32 3

rs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0.0005
0
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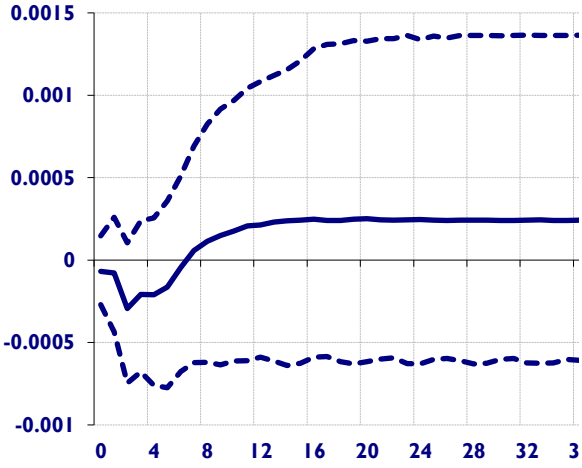
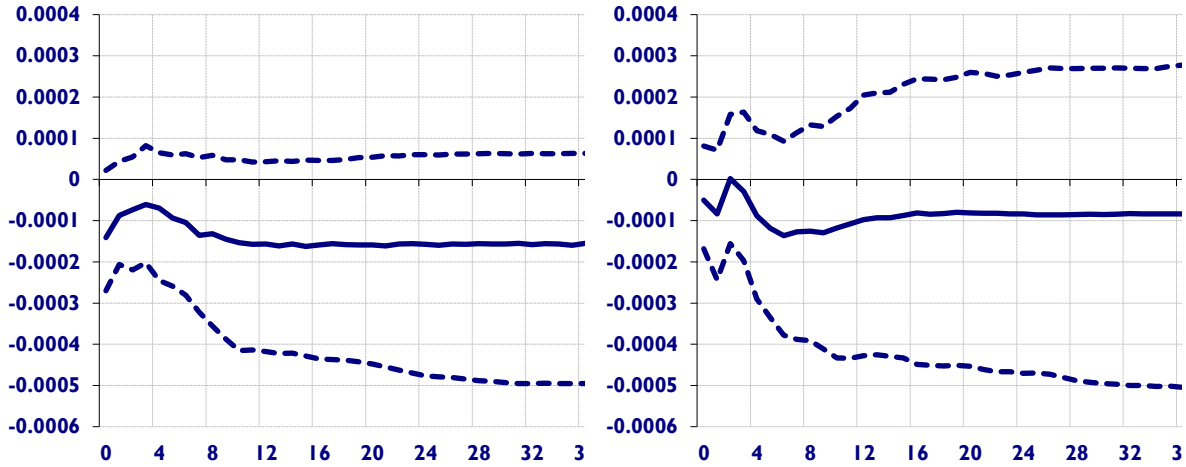
-0.001
0 4 8 12 16 20 24 28 32 3


0.0015
0.001
0.0005
0
-0.0005
-0.001
0 4 8 12 16 20 24 28 32 3

rl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-0.0005
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0 4 8 12 16 20 24 28 32 3
0.0004
0.0003
0.0002
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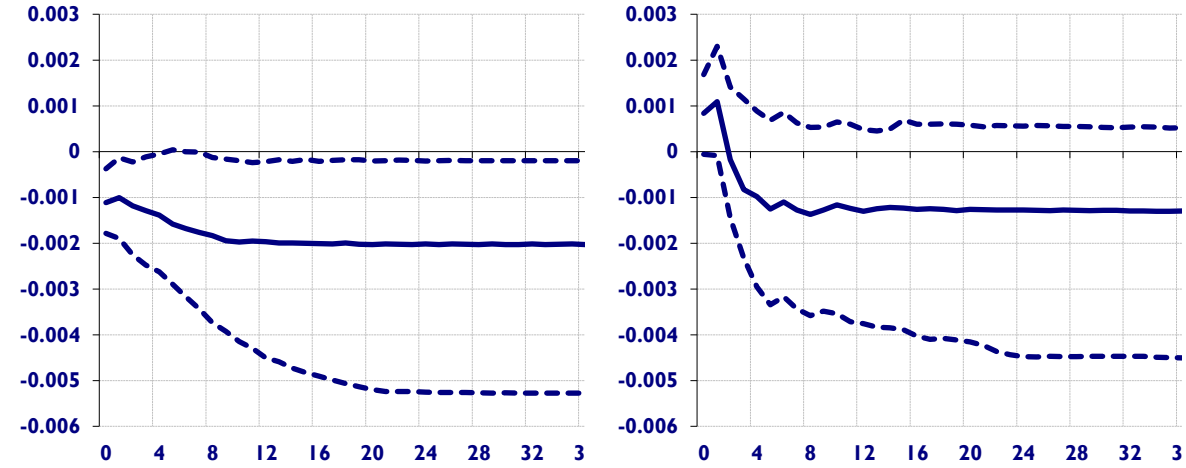
-0.0006
0 4 8 12 16 20 24 28 32 3

ep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0.002
0.001
0
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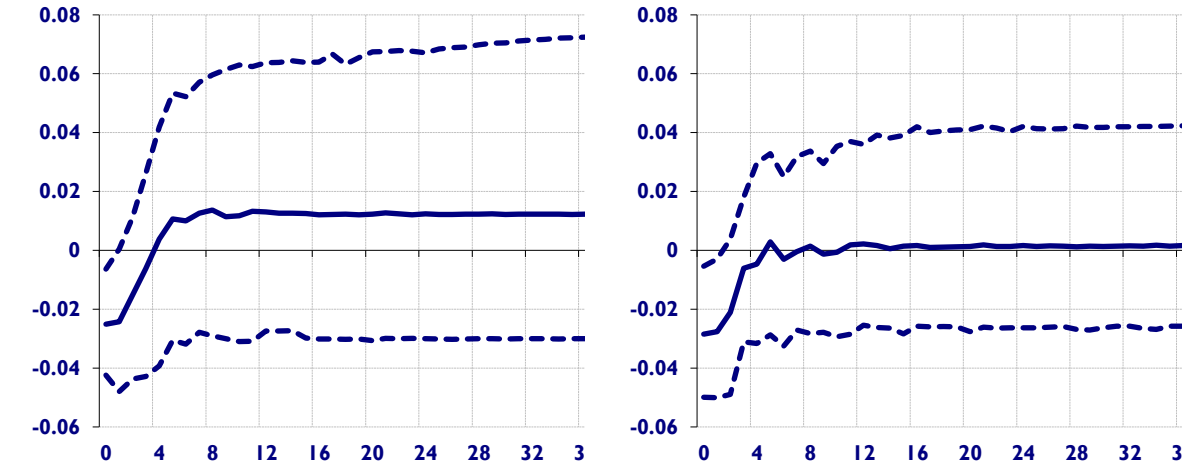
-0.002
-0.003
-0.004
-0.005
-0.006
0 4 8 12 16 20 24 28 32 3
0.003
0.002
0.001
0
-0.001
-0.002
-0.003
-0.004
-0.005
-0.006
0 4 8 12 16 20 24 28 32 3

eq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0.06
0.04
0.02
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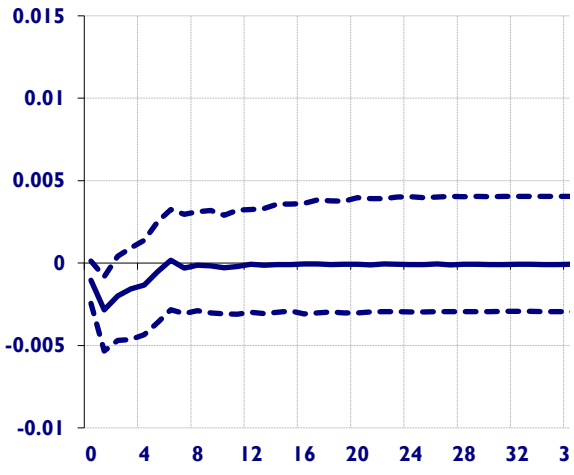
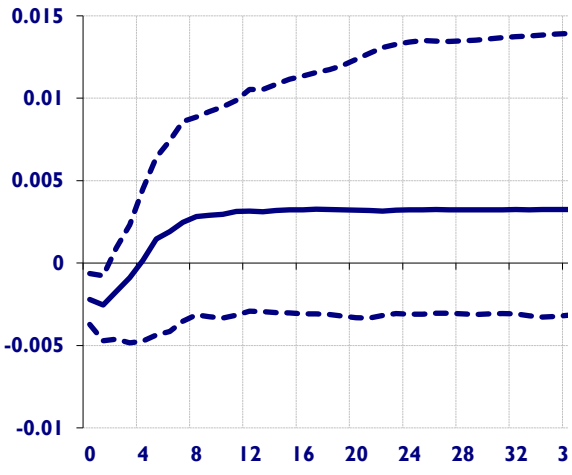
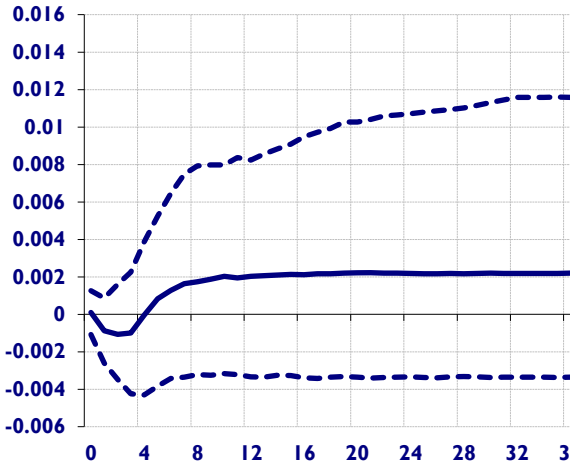
-0.04
-0.06
0 4 8 12 16 20 24 28 32 3
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
0 4 8 12 16 20 24 28 32 3

From the perspective of the debt structure of the banking sector, short-term interest rates in highly leveraged countries or regions have decreased by 0.0005 units in the long run, and long-term interest rates have decreased by 0.0002 units in the 0th period, while short-term interest rates in low leveraged economies have decreased by 0.0003 units in the 0th period. The impact of long-term interest rates is not significant. The capital adequacy ratio of the banking sector with high leverage is relatively low, and when the world economy is in a downturn and the United States implements quantitative easing, it will be greatly impacted, At the same time, in order to reduce the possibility of bank crises, their economies have made significant adjustments in interest rates; In terms of exchange rate, due to the high leverage of the banking sector, there is more uncertainty and risk, and the demand for its currency in the international market has decreased, resulting in a devaluation of 0.00076 units in the 0 th period; In terms of stock index, due to the significant interest rate reduction in economies with high leverage in the banking sector, the price of securities assets is supported to some extent, and the decline in stock index is smaller than in economies with low leverage.

debt structure - banking sector:

variable	lrbl	lrbh
y		

dp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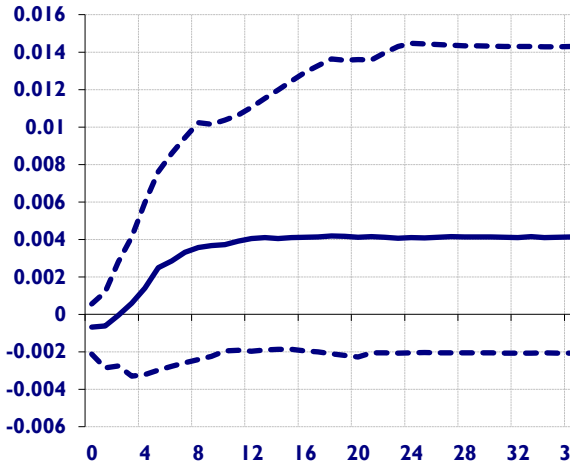
0.008
0.006
0.004
0.002
0
-0.002
-0.004
-0.006
0 4 8 12 16 20 24 28 32 3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0
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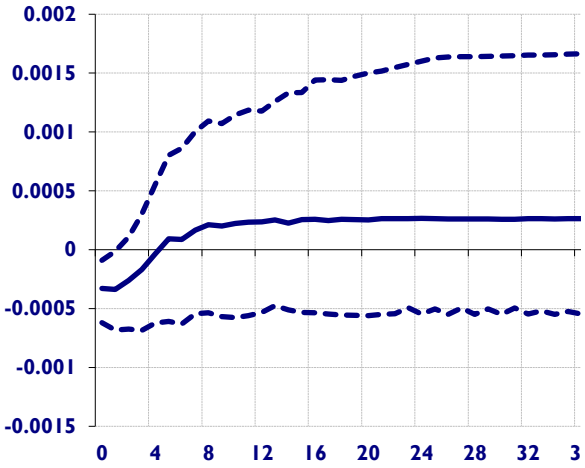
0 4 8 12 16 20 24 28 32 3

rs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0.0005
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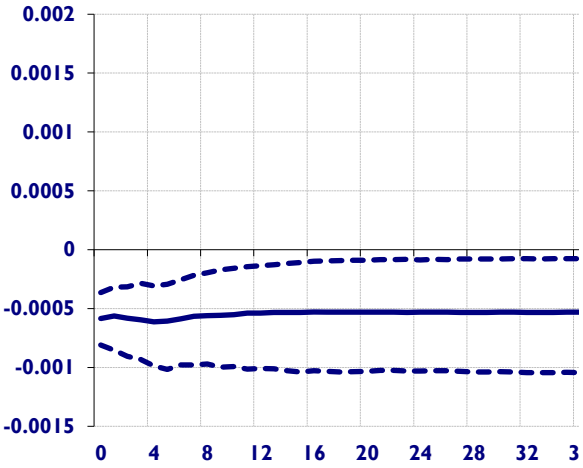
0 4 8 12 16 20 24 28 32 3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0.001
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0
-0.0005
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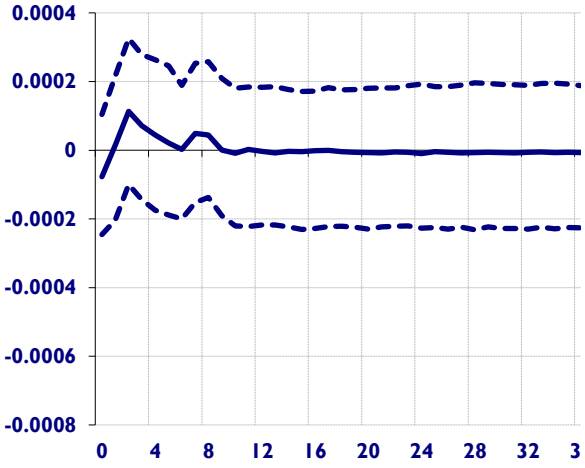
-0.0015
0 4 8 12 16 20 24 28 32 3

rl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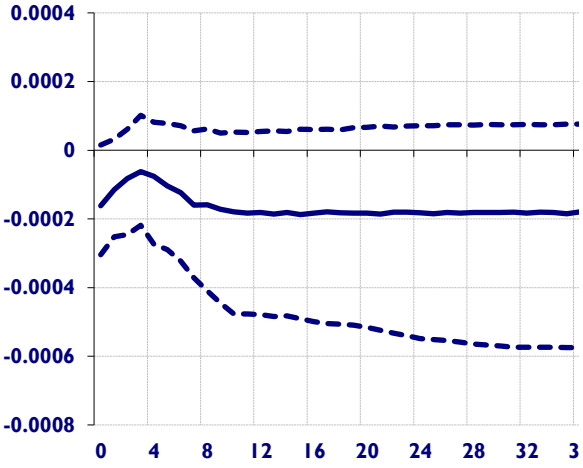
-0.0008
0 4 8 12 16 20 24 28 32 3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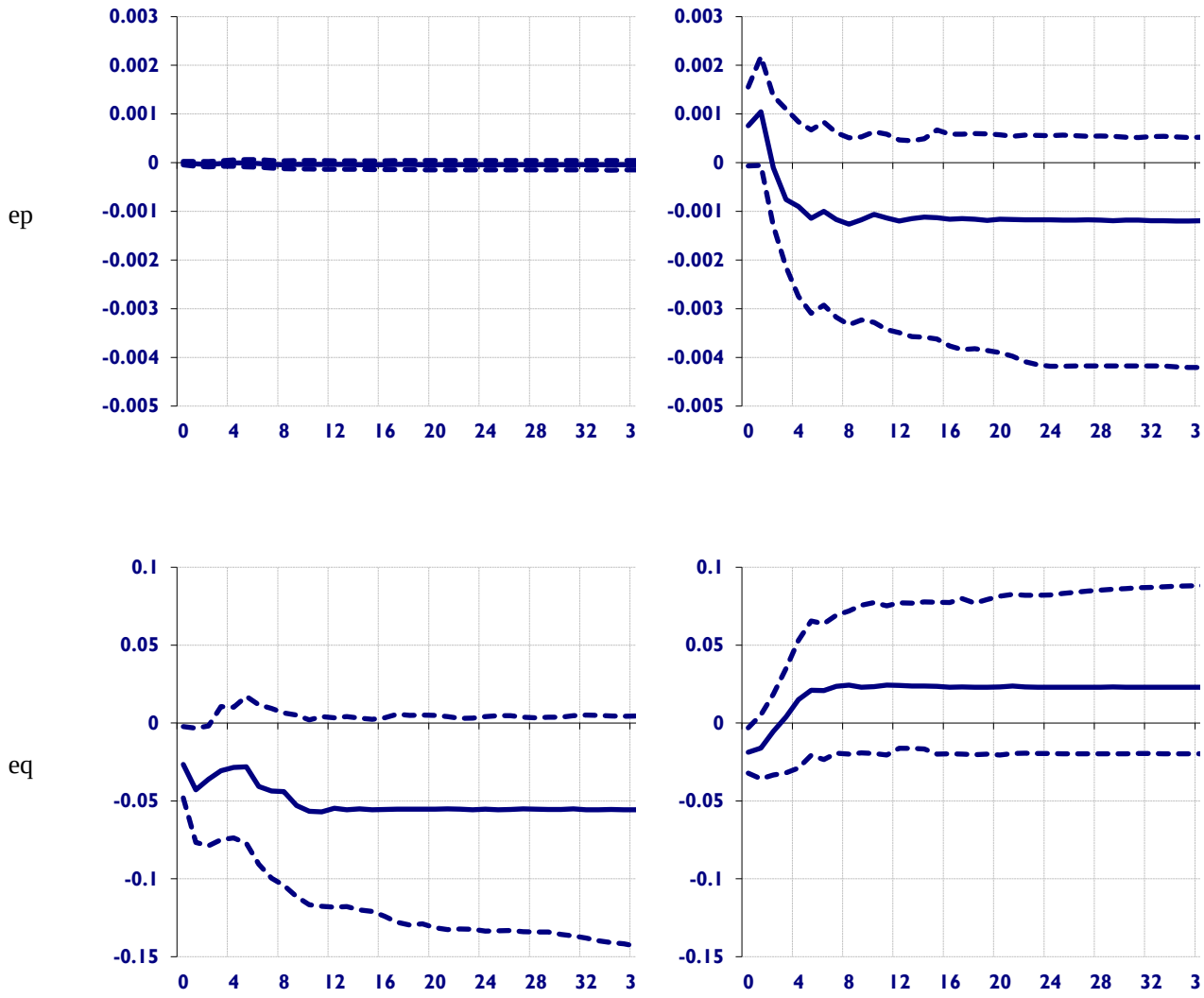

In conclusion, when the global economic development is sluggish (such as the economic crisis in 2008 and the COVID-19 epidemic in 2020), the United States recovers its economy through unconventional monetary policies such as quantitative easing. At the same time, the U.S. monetary policy not only affects the domestic economic trend, but also affects the economic variables of other countries to a certain extent, that is, the U.S. monetary policy has spillover effects. The response of countries or regions with different characteristics of economic development to external shocks is heterogeneous.

In terms of output, since the quantitative easing policy was implemented against the backdrop of sluggish global economic growth, when the United States implemented the policy, all countries were in the background of economic recession, so the output was negative in the early stage, and with the

positive promotion of subsequent monetary and fiscal policies, its output would recover; In terms of interest rates, short-term interest rates in various countries or regions have shown a downward trend in the short term due to the impact of the external economy and in order to restore their real economy. Some economies have even experienced a long-term decline, and long-term interest rates in some more vulnerable economies will also decline accordingly; In terms of price index, as the price index generally has a positive correlation with economic growth, when the domestic economy is sluggish, the price index will also decline; In terms of stock indexes, the decline in overall economic growth will be reflected in the domestic stock market, which can also prove that the financial market is a barometer of the real economy. However, due to the implementation of low interest rate policies at the same time, it may offset some of the negative effects of the economic downturn in the short term; In terms of exchange rates, the basic economic conditions of different countries vary greatly, resulting in different performance in terms of output, trade, capital flows, and other aspects after external shocks, leading to differences in exchange rate trends.

5.conclusion

This article uses a generalized vector autoregressive model to explore the changes in economic variables in countries or regions with different economic development characteristics after receiving the quantitative easing policies of the United States, in order to explore the points for attention when countries around the world respond to external shocks in economic development in the future.

In terms of economic structure, actively optimizing the economic structure is conducive to resisting external shocks, while the momentum of economic recovery is strong, promoting foreign trade and investment, leading to currency appreciation; In terms of innovative development, promoting the transformation and upgrading of high-tech industries is conducive to accelerating the recovery of the domestic economy and promoting currency appreciation. However, due to the vulnerability of high-tech companies to external risks, in order to ensure the smooth operation of the domestic high-tech industry, the economy has significantly lowered interest rates, the rapid economic recovery, and low interest rate policies have offset some of the decline in the stock market; In terms of resource allocation and market mechanism, accelerating the improvement of resources and markets usually means closer

trade with other countries or regions and closer external ties. Therefore, under the dual impact of the global economic downturn and quantitative easing in the United States, the economy's actual output, price index, interest rate, and stock index fluctuate significantly, resulting in short-term devaluation pressure on the currency; In terms of economic growth, due to the weakness of the global economy as a whole, net exports, investment, and consumption will be affected to a certain extent. Therefore, output and stock indexes have significantly decreased, while external ties are relatively close, and interest rates have also significantly decreased. However, due to strong economic growth momentum, the depreciation of exchange rates is relatively low; In terms of infrastructure construction, when affected by the external environment, strengthening infrastructure construction is conducive to reducing the negative impact on output and economic volatility; In terms of the ecological environment, strengthening the construction of the ecological environment is beneficial to the improvement of the environment, but it may increase the proportion of human resource intensive industries in economic development, and these industries are greatly affected by external environmental shocks, resulting in a significant decline in the exchange rate, which promotes the depreciation of the exchange rate; In terms of economic benefits to the people, improving the happiness of the people generally requires strengthening environmental protection, improving technological innovation, and improving the market resource allocation mechanism, while the impact is more vulnerable to the impact of the external environment, while there is pressure on the currency to depreciate; In terms of residents' leverage ratio, low residents' leverage ratio means that their willingness to consume is weak. When the economy is in a downturn, their consumption driving ability is poor, and the economy needs a relatively low interest rate to stimulate the economy; In terms of the leverage ratio of government departments, highly leveraged governments generally spend more on social finance and intervene more in the market economy. When exposed to external shocks, they have a poor response, resulting in a significant decline in output and stock indexes. However, economies with low government participation are more closely connected to the outside world, and their interest rates have a greater decline; In terms of the leverage ratio of the non-financial enterprise sector, a high leverage ratio of an enterprise usually means that its business risks are high, and when interest rates change and the external economic environment shocks, the impact is high, which drives the depreciation of the exchange rate. At the same time, the economy is more cautious in adjusting interest rates; In terms of the leverage ratio of the banking sector, the capital adequacy ratio of the banking sector with high leverage ratio is

relatively low. When the world economy is in a downturn and the United States implements quantitative easing, it will be greatly impacted. At the same time, in order to reduce the possibility of a banking crisis, its economies have made significant adjustments in interest rates. More uncertainty and risks have led to a decline in the demand for their currencies in the international market, leading to a devaluation of the exchange rate.

In the post COVID-19 era, the world economy is recovering difficultly, and geopolitical conflicts and unconventional monetary policies are more frequent. Therefore, countries and regions should formulate reasonable economic policies and industrial development policies according to their actual economic conditions, treat external shocks cautiously, and adjust their own real economy and financial markets at the same time.

First, optimize the economic structure. A more rational economic structure usually means that various sectors of the economy have a stronger productive capacity, recover faster growth in the face of external environmental shocks and the global economic downturn, and have a more resilient economy. Governments should actively develop other industries based on the development of existing industries, enrich their respective industrial structures, and support the development of weak and small industries with monetary or fiscal policies.

The second is to treat opening up prudently. Generally speaking, after implementing the opening up policy, one's own country will absorb high-quality foreign investment, advanced production technology, and advanced management concepts, thereby improving one's own technological strength, resource allocation efficiency, ecological environment protection, and people's happiness. However, due to closer ties with countries around the world, when affected by external environmental shocks, the country or region will also be more affected by the shocks, Therefore, while opening up to the outside world, countries should also pay attention to the systemic risks that may be caused by the uncertainty of the external environment, establish sound risk response measures, and prevent the domestic economy from exploding into a recession crisis.

Third, optimize the debt structure of various departments. A high debt structure usually means that there is more incentive to expand the economy, but also higher risk. If the debt structure of various sectors in a country or region is too high, the risks it bears when exposed to external environmental shocks and the overall economic downturn are also higher. Therefore, countries need to treat the debt structure of various sectors with caution, and conduct leveraged operations on the basis of ensuring

stability, liquidity, and safety.

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