경제학박사학위논문

Essays on Macroprudential Policy, Globalization, and Heterogeneity

거시건전성 정책과 세계화에 관한 연구: 이질성을 고려하여

2021 년 8 월

서울대학교 대학원
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심 세 리

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이 논문을 경제학박사 학위논문으로 제출함

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심세리의 박사 학위논문을 인준함

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Abstract

This dissertation is composed of two chapters. The first chapter empirically analyzes the effects of macroprudential policy, especially Loan-to-Value (LTV) and Debt-to-Income (DTI) regulation. The second chapter investigates the dynamic interactions between trade and financial globalization.

The first chapter aims to advance the empirical evidence on the effects of macroprudential policy, especially LTV and DTI regulations, on real estate prices and overall economic activities, by estimating heterogeneous panel VAR models. The sign restriction approach is used to identify two fundamental policy shocks – monetary and macroprudential policy shocks. This study finds that macroprudential policy shocks have faster and more substantial effects on mortgage loans and house prices than monetary policy shocks. In addition, macroprudential policy shocks have similar but weaker effects on output and inflation than monetary policy shocks. Such macroeconomic effects are more significant and stronger when LTV and DTI regulations are binding and mortgage loans are assumed to decline immediately.

The second chapter investigates the relationship between trade globalization and financial globalization. The postwar period has seen rapid growth in trade and financial globalization. However, trade globalization decelerated since the global financial crisis and may decelerate even further after Covid-19. An interesting and significant issue is whether trade deglobalization may lead to financial deglobalization. To investigate this issue, this study empirically estimates the dynamic interactions between trade integration and financial integration by employing the panel VAR models that

allow full heterogeneity among individual countries. This study finds that trade integration affects financial integration positively. This result is robust to various specifications of the model. In addition, financial integration tends to have a positive impact on trade integration. However, such a tendency disappears after the GFC. The results of this paper suggest that the ongoing trade deglobalization may adversely affect financial globalization in the future.

Keywords: Macroprudential policy, Loan-to-Value (LTV), Debt-to-Income (DTI), Sign restriction, Trade integration, Financial integration, Heterogeneity, Panel VAR
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Contents

List of Tables

List of Figures

Chapter I. Measuring the Effects of LTV and DTI Limits: A Heterogeneous Panel VAR Approach with Sign Restrictions

1. Introduction

The Global Financial Crisis (GFC), triggered by the burst of housing bubbles in the U.S., has evoked a need to manage housing and related credit cycles to maintain financial and macroeconomic stability. We have also learned that conventional monetary policy aiming at price and output stability is not sufficient to address macroeconomic spillovers of financial crises (Duca et al., forthcoming). Thus, many countries have increasingly introduced macroprudential policies to mitigate excessive credit expansion and asset price booms since GFC (FSB-IMF-BIS, 2011). Especially, borrower-based macroprudential tools such as Loan-to-Value (LTV) and Debt-to-Income (DTI) have been frequently used to curb credit growth and increase the resilience of borrowers to house price shocks (IMF, 2014).

Accordingly, a growing literature has examined the effects of macroprudential policy on credit growth based on the linkages between credit and housing boom-bust cycles. The literature has shown that macroprudential instruments effectively reduce credit growth, notably household credit growth (Cerutti et al., 2017; Alpanda and Zubiary, 2017). Some papers further examined the impacts of macroprudential policies on curbing house price inflation but provided mixed evidence for their effects (Akinci and Olmstead-Rumsey, 2018; Jacome and Mitra, 2015; Kuttner and Shim, 2016; Alam et al., 2019).

On the other hand, relatively few studies considered the macroeconomic costs of macroprudential policy, i.e., the impact on output

and inflation. Kim and Mehrotra (2018, 2019) showed that monetary and macroprudential policies share similar effects on output, inflation, and credit. Very few studies focused on LTV or DTI. One exception is Richter et al. (2019). Richter et al. (2019) found that LTV limits have relatively modest effects on output and insignificant effects on inflation.

Against this background, this paper aims to advance the empirical evidence on the effects of macroprudential policy on real estate prices and overall economic activities, focusing on borrower-based tools such as LTV and DTI caps, by using structural heterogeneous panel vector autoregression (VAR) models with sign restrictions imposed on impulse responses.

To analyze the issue, monetary and macroprudential policies are considered in a single framework as they are likely to interact with each other and affect macroeconomic and financial conditions simultaneously.[1] For example, in addition to affecting output and inflation, contractionary monetary policy may tighten lending standards and mitigate credit expansion, possibly leading to house price stabilization (IMF, 2008; Alpanda and Zubiary, 2017). At the same time, macroprudential policy is likely to have macroeconomic effects via reduced household credit and residential investment (Richter et al., 2019; Kim and Mehrotra, 2018, 2019). Moreover, Revelo et al. (2020) find that monetary policy conditions matter for the macroprudential policy effectiveness on domestic credit growth.

This paper makes the following important contributions to the

[1] As with macroprudential policy shock, monetary policy shock is identified using sign restrictions. Following Uhlig (2005), a contractionary monetary policy shock is identified as moving interest rates up and monetary base and price levels down, tackling the price and liquidity puzzles. Macroprudential policy shock is set to be orthogonal to monetary policy shock.

literature. First of all, this paper provides a novel identification scheme for macroprudential policy shock by using a sign restriction approach (Uhlig, 2005; Uhlig and Mountford, 2009). First, macroprudential policy shocks are considered the one orthogonal to monetary policy shocks. Since the effects of monetary and macroprudential policies on key macroeconomic and financial variables are similar (Kim and Mehrotra, 2018, 2019), it is essential to separate macroprudential policy shocks from monetary policy shocks. Second, a tightening macroprudential policy shock is defined as tightening macroprudential tools, LTV or DTI, or both. This identifying assumption, close to minimal, is the most basic one in that it does not impose restrictions on any other variables. This paper further considers the case in which LTV or DTI regulations are clearly binding because whether the LTV and DTI regulations are binding is indeed a crucial issue in past studies when analyzing their effects. Thus, an alternative identification scheme additionally assumes that mortgage loans decrease when macroprudential tools are tightened.

Second, this paper allows full heterogeneity across countries. Most existing empirical studies based on panel analysis multi-country data have assumed minimal heterogeneity across countries (for example, country fixed effect). However, policy actions and their impacts likely differ across countries depending on each country's economic conditions, financial cycles, initial levels of macroprudential policy, and various country characteristics such as the level of financial development and debt and exchange rate regime (Kuttner and Shim, 2016; Alam et al., 2019, Kim and Mehrotra, 2019).[2] This paper also finds a clear heterogeneity in the policy effects across countries.

[2] Alam et al. (2019) show that the effects of the tightening of LTV limits are nonlinear; that is, when LTV limits are already tight, the effects of LTV limits on credit are weak. Thus, the initial level of LTV limits matters.

Therefore, this paper relaxes the assumption of homogeneity and employs the structural heterogeneous panel VAR.

Using a recent monthly dataset constructed by Alam et al. (2019), this paper considers six economies with relatively long experience using LTV and DTI tools – Canada, Denmark, Israel, Korea, Singapore, and Taiwan. These countries are selected for two reasons. First, they introduced LTV or DTI relatively early, and long time series can be considered. Second, monthly data for mortgage loans (or housing loans) and house prices are available. While most previous empirical studies used quarterly data to provide cross-country evidence, this paper uses monthly data since it is more advantageous to capture the exact timing of policy actions and their effects over time.

The main findings of the paper are as follows. First, macroprudential policy tightening shocks, specifically tightening LTV and DTI, decrease house prices in the medium to long term. The macroprudential policy has faster and more substantial effects on mortgage loans and house prices than monetary policy. Such impacts of the macroprudential policy are observed regardless of the restriction on mortgage loan responses.

Second, macroprudential policy shocks have macroeconomic effects, and the effects are similar to those of monetary policy shocks. Tightening macroprudential policy shock reduces output and inflation in the long run, which confirms the findings of Kim and Mehrotra (2019) and Richter et al. (2019). Moreover, macroeconomic effects are more substantial when borrowing constraint is binding and macroprudential policy shocks immediately reduce mortgage loans.

The remainder of the paper is organized as follows. The next section discusses some related studies. Section 3 presents the empirical methodology and the data. Section 4 reports the empirical results. Lastly, Section 5

concludes the paper.

2. Related Literature

This paper is related to a growing literature on the impact of macroprudential policy on the financial cycle, especially on the household credit cycle. As one of the first empirical studies, Lim et al. (2011) showed that frequently used macroprudential tools, especially caps on LTV and DTI, limits on credit growth, reserve requirements, and dynamic provisioning, are effective in reducing the procyclicality of private credit and bank leverage. Using a more recent and larger sample of 119 countries, Cerutti et al. (2017) found that borrower-based macroprudential tools such as LTV and DTI caps are associated with lower household credit, especially in emerging economies. They also found that macroprudential policies work better in boom times than bust times. In a related contribution, Alpanda and Zubiary (2017) built a dynamic stochastic general equilibrium (DSGE) model with housing and household debt to find that it is more effective and less costly to reduce mortgage interest deductions or tighten LTV ratios in limiting household credit.

Given that housing credit or mortgage comprises a large share of household credit and house prices are strongly associated with household leverage, macroprudential tools have been used individually or jointly to mitigate real estate booms (FSB-IMF-BIS, 2011). Accordingly, more empirical studies have investigated the effects of macroprudential policies on

the housing markets, but there is still mixed evidence of the effectiveness.[3] For example, Akinci and Olmstead-Rumsey (2018) showed that overall macroprudential measures reduce banking credit growth, while only housing-related tools, including LTV and DSTI caps and other housing measures, can constrain housing credit and house price growth. Similarly, Carreras et al. (2018) used a cointegration framework to confirm that macroprudential policy interventions on household credit and house price growth are effective in the short- and long-run in OECD countries. As for the case studies, Craig and Hua (2011) and Tillmann (2015) confirmed the effectiveness of housing-related tools on residential property prices for Hong Kong and Korea, respectively.

On the other hand, Jacome and Mitra (2015) showed that LTV and DTI limits effectively reduce credit growth but do not always curb house price appreciation. They argued that capital flows in the real estate market or direct lending by foreign banks possibly undermine the effectiveness of policy actions. Kuttner and Shim (2016) also found that housing-related taxes can affect house price growth, while neither LTV nor DTI tightening slows house price growth.[4] They also found that LTV tightening is less effective in curtailing credit growth than DTI tightening or housing-related tax policies.[5] A recent study by Alam et al. (2019) showed that while macroprudential

[3] Araujo et al. (2020) reviewed 58 empirical studies and found that, on average, weaker and less precise effects of macroprudential policies on house prices using a meta-analysis framework.

[4] In the specification allowing for asymmetric effects, however, LTV tightening has statistically significant effects on house prices, while LTV loosening does not.

[5] They argued that this might be because, during the housing booms, house price appreciation increases the amount available to borrow, which could partially offset the effects of LTV tightening.

policies generally have weaker effects on house prices than household credit, loan-targeted tools may reduce house price growth, especially in advanced economies. Interestingly, Armstrong et al. (2019) suggested that LTV policy, whether tightening and loosening, can significantly affect house prices when the LTV ratio becomes binding, applying a difference-in-difference (DiD) methodology.[6]

Some papers used micro-level data to analyze the link between macroprudential policies and credit and house price growth. Zhang and Zoli (2016) used bank-level data and find that LTV caps and housing tax measures help curtail credit growth, housing price growth, and bank leverage in Asia. Using a large sample of more than 4,000 banks from 46 countries, Morgan et al. (2019) showed that LTV policy significantly impacts mortgage loan creation. In Korea, Igan and Kang (2011) used household survey data to find that LTV and DTI limits are associated with house price dynamics and transaction activity.

However, few studies have been done on the macroeconomic effects of macroprudential policies. Kim and Mehrotra (2019) analyzed the macroeconomic effects of macroprudential policy in conjunction with monetary policy since they can interact with similar objectives. Using a structural panel VAR model, they found that macroprudential policy can affect output and inflation similarly to monetary policy, but the transmission mechanism is different. Richter et al. (2019) found that LTV tightening has

[6] Aiyar et al. (2014) suggested that one of the necessary conditions required for macroprudential capital requirements to be effective is that minimum capital requirements must be binding on banks' choice of capital ratios. In addition, Jiménez et al. (2017) found for the case of Spain that the effects of dynamic provisioning on credit supply cycles are asymmetric, that is, more effective in bad times when the changes in bank-firm-level credit are binding at the firm level.

substantial effects on credit and house price growth while relatively modest effects on output and inflation using a local projection approach.[7] Bachmann and Rüth (2020) investigated the systematic interactions between changes in average LTV ratios, not regulatory, and monetary policy in the United States using a structural VAR framework. They showed that residential investment falls after an initial small uptick responding to an expansionary LTV shock since the systematic monetary policy counteracts expansionary LTV shock by raising the interest rates. Also, the changes in LTV ratios have spillovers to nonresidential activities such as output and business investment.

Lastly, recent theoretical literature has studied the interaction between monetary and macroprudential policies and their potential tradeoffs and complementary effects. In the model of Quint and Rabanal (2014), the introduction of macroprudential policy reacting to the credit-to-GDP ratio assists monetary policy by reducing the financial accelerator effects and hence improves welfare. Angelini et al. (2014) investigated whether cooperation between time-varying capital requirements and monetary policy would benefit, using the DSGE model that features the banking sector. They suggested that capital requirements should be viewed as a complement to monetary policy to cope with financial shocks.

However, little is known from the empirical perspective. Kim and Mehrotra (2017) showed short-term trade-offs between monetary policy for price stability and macroprudential policy for reducing credit, using the historical decomposition. However, they also found some episodes in that policies contributed to each other's target. On the other hand, Revelo et al.

[7] Similarly, Alam et al. (2019) showed that loan-targeted tools have a significant impact on household credit, as well as a slight dampening effect on private consumption.

(2020) showed that the effect of macroprudential policy on curbing credit growth is conditional on monetary policy conditions, more effective when both policies work in a tightening direction.

3. Empirical Methodology and Data

Structural heterogeneous panel vector autoregression (VAR) models are used to identify monetary and macroprudential policy shocks and examine the effects of the identified shocks. The shocks are identified by imposing sign restrictions on impulse responses (Uhlig, 2005; Mountford and Uhlig, 2009).

3.1 Heterogeneous Panel VAR

The methodology of the structural heterogeneous panel VAR model with sign restrictions is described briefly in the following. For a country i ($i = 1,2,\dots,I$), the following reduced form of the VAR model is considered:

$$Y_t^i = B(L)^i Y_{t-1}^i + X_t^i + u_t^i \qquad \text{(I.1)}$$

where Y_t^i is an $m \times 1$ vector of endogenous variables, X_t^i is an $h \times 1$ vector of exogenous variables, $B(L)^i$ is a $m \times m$ matrix polynomial in the lag operator L, and u_t^i is an $m \times 1$ vector of one-step-ahead prediction errors, $var(u_t^i) = \Sigma^i$. m and h are the numbers of endogenous and exogenous variables in the model, respectively. Heterogeneity among countries is considered all parameters, $B(L)^i$.

For the simplicity of notation, the country index i is omitted below. The one-step-ahead prediction errors, u_t, can be written as the linear

combinations of m structural shocks that are mutually orthogonal and normalized to be of variance 1:

$$u_t = D\nu_t, \qquad E[\nu_t \nu_t{}'] = I_m \tag{I.2}$$

where D is an $m \times m$ matrix, ν_t is an $m \times 1$ vector of structural shocks.

One of the traditional identification strategies is imposing a recursive structure on contemporaneous structural parameters, developed by Sims (1980), to recover D as a lower triangular matrix by applying Cholesky decomposition on Σ.

However, Uhlig (2005) identified a structural shock by imposing sign restrictions on impulse responses, and Mountford and Uhlig (2009) extended the method of Uhlig (2005) to identify multiple structural shocks. Mountford and Uhlig (2009) defined the impulse matrix as follows.

Definition 1. An impulse matrix of rank n is a $n \times m$ submatrix of some $m \times m$ matrix A, such that $AA' = \Sigma$. An impulse vector a is an impulse matrix of rank 1, i.e., a vector $a \in \mathbb{R}^m$ such that there exists some matrix A, where a is a column of A such that $AA' = \Sigma$.

This paper identifies two structural shocks, monetary and macroprudential policy shocks, which amount to identifying an impulse matrix of rank 2, $[a^{(1)}, a^{(2)}]$. Note that, by construction, the covariance between the structural shocks $\nu_t^{(1)}$, $\nu_t^{(2)}$ corresponding to $a^{(1)}$, $a^{(2)}$ is zero, that is, the structural shocks are orthogonal.

Following Mountford and Uhlig (2009), any impulse matrix $[a^{(1)}, \dots, a^{(n)}]$ can be characterized by $\left[a^{(1)}, \dots, a^{(n)}\right] = \tilde{A}Q$, where $\tilde{A}\tilde{A}' =$

Σ is a Cholesky decomposition of Σ with an $n \times m$ matrix $Q = [q^{(1)}, \dots, q^{(n)}]$ of orthonormal rows $q^{(s)}$. Then, the impulse responses can be calculated as follows. Let $r_{jl}(k)$ be the impulse responses of the *j*th variable at horizon *k* to the *l*th column of $\tilde{A}$, and the *m*-dimensional column vector $r_l(k)$ as $[\, r_{1l}(k), \dots, r_{ml}(k) \,]$. Then the *m*-dimensional impulse response $r_a(k)$ at horizon *k* to the impulse vector $a^{(s)}$ is given by

$$r_a(k) = \sum_{l=1}^{m} q_l r_l(k) \tag{I.3}$$

where q_l is the *l*th entry of $q = q^{(s)}$. See Mountford and Uhlig (2009) and Uhlig (2005) for further technical details.

Then, let's restore the country index i in the notations. As suggested by Canova (2007, chapter 8) and Canova and Ciccarelli (2013), this paper estimates the model, computes the impulse response for each country, and then averages them over the cross-section since *T* is relatively large.[8] Let α be the vector that collects the population mean parameters and α^i the same vector for the parameters of country $i = 1, \dots, I$. Rewrite the impulse response as h_k, a well-defined, continuous function of parameters of the system. Then, assume that:

$$h_k(\alpha^i) = h_k(\alpha) + \varepsilon_{hk}^i \tag{I.4}$$

[8] Canova (2007) showed that when *T* is sufficiently large, one can obtain a "typical" effect by computing the impulse response function and averaging the results over the cross section. When $T \to \infty$, the average time series estimators are consistent.

where ε_{hk}^{i}, $i = 1, \ldots, I$, $k = 1, \ldots, K$ are *i.i.d* $(0,\sigma_k^2)$ and represent the deviation of country i's effect from the typical effect. The average time series estimator (suggested by Canova (2007)) is computed as follows:

$$\hat{h}_k = \frac{1}{I}\sum_{i=1}^{I} h_k(\hat{\alpha}^i) \tag{I.5}$$

An estimate of the variance-covariance matrix of the estimator is given by:

$$\hat{\Sigma}_{hk} = \frac{1}{I(I-1)}\sum_{i=1}^{I}(h_k(\hat{\alpha}^i) - \hat{h}_k)(h_k(\hat{\alpha}^i) - \hat{h}_k)' \tag{I.6}$$

Note that this paper uses the cross-section to estimate the average effects by pooling the estimators of the impulse response functions.

An individual VAR for each country is performed using a Bayesian approach as in Uhlig (2005) and Mountford and Uhlig (2009).[9] Then, based on the mean of the impulse responses for each country, the average time series estimates and the standard error bands are calculated.[10]

3.2 Variables and Data

The vector of endogenous variables, y, is $[IP, CPI, RML, RHP, PP, R, MB]'$. Industrial production (*IP*) and the consumer price index (*CPI*) are included as

[9] This paper uses the pure sign restriction approach, in which all impulse vectors satisfying the sign restrictions are considered equally likely, following Uhlig (2005).

[10] Note that our statistical inference is not affected by the presence of non-stationarity when following a Bayesian inference (see Sims, 1988, and Sims and Uhlig, 1991).

indicators of overall economic activities and traditional target variables for monetary policy. The outstanding stock of mortgage loans (*RML*) and house price index (*RHP*) represent target variables for LTV and DTI policies. Both variables are used in real terms, deflated by the consumer price index. Call rate (*R*) and the monetary base (*MB*) are included to identify monetary policy shocks. An index of LTV and DTI policy actions (*PP*) is used to identify LTV/DTI policy shocks.

Figure I-1 shows the trend in outstanding mortgage loans (or housing loans) and house prices for each sample economy. In most countries except Denmark, mortgage loans have rapidly grown over nearly two decades.[11] House price dynamics are quite different across countries but generally show upward trends, excluding Denmark, which suffered a bubble burst in housing prices in the mid-2000s.

One interesting fact is that Singapore has a unique dual-structured housing market consisting of public and private housing. However, one can re-sale public housing under certain conditions, and expensive private housing drives house price dynamics in Singapore.[12] In addition, Singapore is one of the active users of housing-related macroprudential instruments such as LTV, DTI, and stamp duties. Thus, Singapore is included in the analysis.

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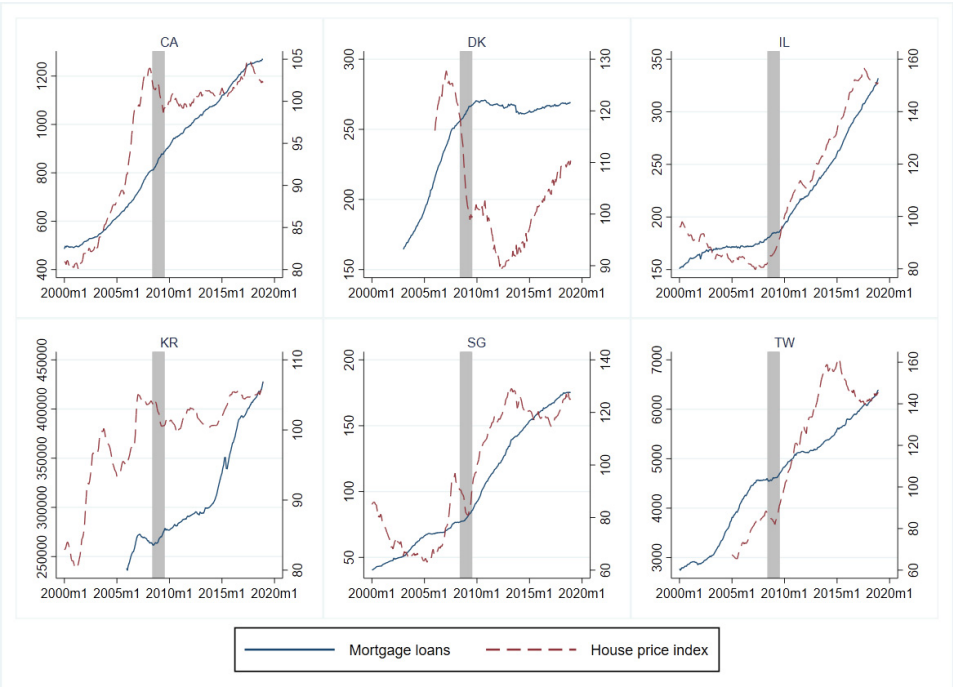
[11] Lending from mortgage banks accounts for a large portion of Denmark's housing finance. However, since lending data from mortgage banks is available from September 2013, this paper considers mortgage lending from the banking sector only.

[12] Singapore's house price index is calculated as the average of the public housing price index and private housing price index provided by the Singapore Real Estate Exchange (SRX).

Figure I-1 Trend in Mortgage Loans and House Price Index



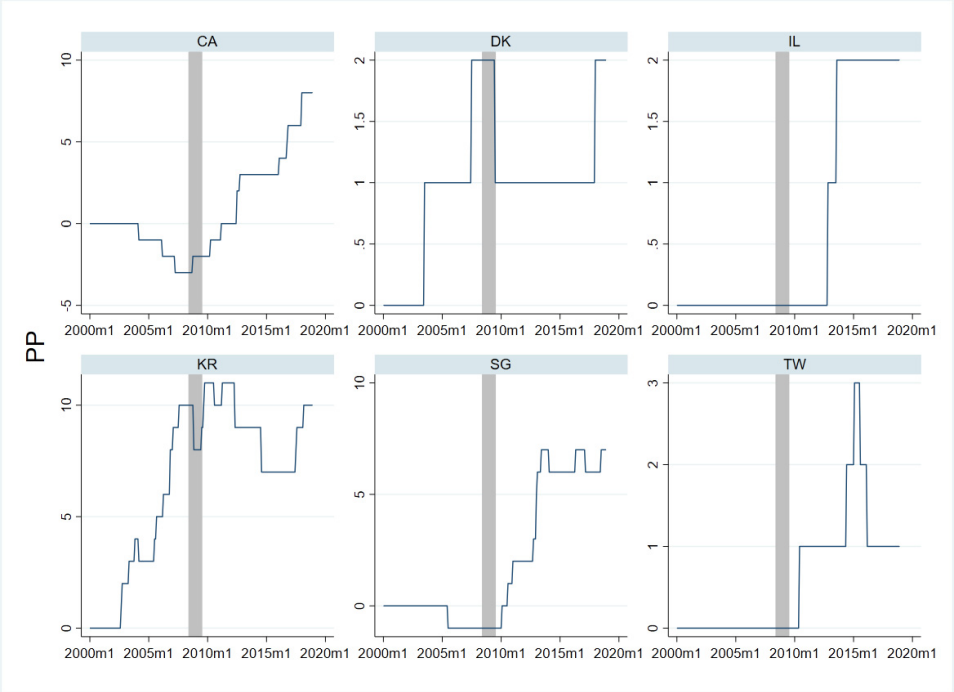
Notes: 1) Mortgage loans=Real outstanding stock of mortgage loans in local currency (billions), House price index=Real house price index, 2) CA=Canada, DK=Denmark, IL=Israel, KR=Korea, SG=Singapore, TW=Taiwan.
Source: Author's calculations

The index of LTV and DTI actions is constructed by using the data from Alam et al. (2019). The dataset covers 17 macroprudential policy instruments, but this paper focuses on the borrower-based instruments – LTV and DTI – in the baseline model. Each policy instrument takes on three values: 1 for tightening actions, -1 for loosening actions, and 0 for no change. The monthly observations for LTV and DTI indices are summed and accumulated over time to construct the *PP* index. For example, if both LTV and DTI are tightened (loosened) within a given month, then the index takes a value of 2

(-2). The cumulative index level is maintained until another policy action is taken.

Figure I-2 shows the cumulative *PP* index for each economy. The most frequent user of LTV and DTI is Korea, using 26 times during the sample period (from M1 2000 to M12 2018). Israel used the least, with twice. On average, borrower-based instruments had been used 10.67 times per economy. The use of macroprudential instruments has rapidly increased after the GFC, especially in Canada and Singapore. For all economies, LTV and DTI are used 18 times until pre-GFC but more than doubled (43 times) after the GFC.

Figure I-2 Cumulative Tightening and Loosening in LTV and DTI



Source: Author's calculations

The vector of the exogenous variables is $[USIP,\ USFFR]'$ where *USIP* denotes industrial production of the U.S. and *USFFR* denotes the Federal Funds rate. These U.S. (or world) variables are likely to affect the real economy, financial conditions, and monetary and macroprudential policies in small open economies.

Monthly data are used. Six lags for endogenous variables are assumed. Only contemporaneous values are included for exogenous variables to save the degree of freedom. Neither a constant term nor time trend is included in the VAR system, following Mountford and Uhlig (2009). For all variables except for *R* and *USFFR*, a logarithm is taken and then multiplied by 100. More details on the variables and data sources are reported in Appendix I.1.[13] A crisis dummy variable to account for the Global Financial Crisis (M7 2008 – M6 2009) is also included.

3.3 Identification with Sign Restrictions

This paper is interested in two fundamental policy shocks – monetary policy and macroprudential policy shocks. The sign restriction approach is used to identify the policy shocks as below.

Monetary policy shock is defined as follows: a contractionary monetary policy shock moves interest rates up and the monetary base and the price level down. It is in line with the identification schemes in Uhlig (2005) and Kim and Lim (2018).[14] In this way, the liquidity and price puzzles are

[13] All variables, except for *USFFR* and *R*, are seasonally adjusted.

[14] Uhlig (2005) used nonborrowed reserves as monetary aggregate for the U.S., and Kim and Lim (2018) used the monetary base as monetary aggregate instead.

avoided by imposing the sign restrictions on impulse responses.[15] The sign restrictions are imposed for the first 12 months after a shock.

The second shock, that is, macroprudential policy shock, is the main interest of this paper.[16] First, this paper imposes the following restriction: (1) contractionary macroprudential policy shocks increase the LTV, DTI policy index. This restriction is the minimum restriction that is necessary to define macroprudential policy shocks. In addition, an additional restriction is considered: (2) contractionary macroprudential policy shocks decrease mortgage loans. Tightening LTV and DTI policy actions directly limit mortgage loans, so such a restriction is considered.

This paper considers two identification methods. First, it considers restriction (1) only (Model 1). Second, it imposes restrictions (1) and (2) (Model 2). In Model 1, restriction (2) is not imposed for the following reason. First, if LTV and DTI regulations are not practically binding, mortgage loans may not decrease immediately after tightening LTV and DTI regulations. Second, restriction (2) is the restriction on the effects of LTV and DTI

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[15] The liquidity puzzle is that monetary aggregates and interest rates increase in response to monetary policy shocks identified with positive innovations of monetary aggregates. The price puzzle is a phenomenon in which the price level increases following a contractionary monetary policy shock, typically identified with an increase in interest rate. Sims (1992) pointed out that these puzzles occur when "exogenous" monetary policy shocks are not properly identified.

[16] Unlike monetary policy shocks, there are scarce studies on identifying macroprudential policy shock, using sign restrictions with macroprudential policy instruments. Greenwood-Nimmo and Tarassow (2016) identified a credit-constraining macroprudential shock as not increase credit and stock prices and not reduce nonborrowed reserves for the U.S. However, they did not explicitly consider a measure for macroprudential policy actions. In addition, they focused on financial stability and did not consider the real estate market.

regulations, so it would like to infer the effects of LTV and DTI regulations without assuming any significant effects. Table I-1 summarizes the corresponding identifying sign restrictions. The sign restrictions for macroprudential policy shock are imposed for the first 12 months after a shock, identical to monetary policy shock identification.

In past studies, whether the LTV and DTI regulations are binding is indeed a crucial issue when analyzing the LTV and DTI regulations. For example, Kuttner and Shim (2016) suggested that the key requirement for DSTI and LTV limits to affect housing credit is that households are borrowing constrained. Similarly, Aiyar et al. (2014) suggested that capital requirements must bind to effectively control credit growth as one of the three necessary conditions.[17] Akinci and Olmstead-Rumsey (2018) noted that if it is not clear whether the macroprudential policy is binding or not, it could cause an attenuation bias. In addition, most theoretical papers investigating the effects of LTV ratios assumed that borrowers face binding constraints (Brzoza-Brzezina et al., 2015b; Alpanda and Zubiary, 2017).[18]

Thus, this paper considers both cases. The first strategy, close to minimal, allows for the possibility that regulation is not practically binding. On the other hand, the second identification strategy assumes that a change in LTV or DTI ratio is binding on the households' borrowing constraints. To the

[17] The other two necessary conditions are as follows: 1) equity, the key variable of interest in bank capital regulation, must be a relatively costly source of finance, and 2) substitutability of alternative funding should be limited.

[18] Brzoza-Brzezina et al. (2015a) constructed a DSGE model with occasionally binding constraints and used a penalty function approach to find that LTV tightening and loosening have asymmetric effects on mortgage loans. However, they focused on the nonlinear, asymmetric effects of policy shocks and did not consider the possible difference between the two cases that this paper considers.

extent of our knowledge, there are no empirical studies that explicitly consider both cases based on if borrowing constraints are necessarily binding and compare the policy effects in both cases.

It is also emphasized that macroprudential policy shock is constructed to be orthogonal to monetary policy shock. As shown in past studies such as Kim and Mehrotra (2018, 2019), monetary and macroprudential policies have similar effects on credit and key macroeconomic variables. In addition, two policies can interact with each other. Therefore, it is important to exclude monetary policy shocks when identifying macroprudential policy shocks.[19][20]

[19] By constructing macroprudential policy shock to be orthogonal to the monetary policy shock, macroprudential policy shock represents the part of the unanticipated change in macroprudential policy that is not accounted for by systemic responses to unanticipated monetary policy shock.

[20] The main results are quite similar in an alternative identification method where the macroprudential policy shock is identified first, and then monetary policy shock is constructed as orthogonal to the macroprudential policy shock.

Table I-1 Identifying Sign Restrictions

Identification 1							
Shocks/Variables	IP	CPI	RML	RHP	PP	R	MB
Monetary policy shock		–				+	–
Macroprudential policy shock					+		
Identification 2							
Shocks/Variables	IP	CPI	RML	RHP	PP	R	MB
Monetary policy shock		–				+	–
Macroprudential policy shock			–		+		

Notes: 1) IP = Industrial production, CPI = Consumer price index, RML = Real mortgage loans, RHP = Real house prices, PP = Borrower-based macroprudential policy measure, R = Call rate, MB = Monetary base, 2) '+' indicates that impulse responses of the variable are restricted to be positive, and likewise, '–' indicates negative responses. A blank entry indicates that no restrictions are imposed.

4. Results of Empirical Analysis

4.1 The Effects of LTV and DTI Regulations

Figure I-3 shows the impulse responses with 90% probability bands over zero to 40 months after the shock in Model 1. The heading of each row indicates the name of the responding variables. The first column of graphs shows the impulse responses to monetary policy shock (MP shock), and the second column shows the impulse responses to macroprudential policy shock (PP shock), respectively. Note that Model 1 does not assume that mortgage loans immediately decrease in response to the shock as LTV and DTI regulations may not be binding.

In response to the contractionary (tightening) macroprudential policy shock of one standard deviation in the second column, the borrower-based macroprudential policy measure, *PP*, increases substantially, significantly at all horizons. *PP* decreases gradually after an increase of approximately 0.09 units on impact but is about 0.02 units at the 40th horizon, still above the initial level.

Such macroprudential policy shocks have insignificant effects on real mortgage loans, *RML*, in the short- and medium-run. However, in the long run, macroprudential policy shock decreases mortgage loans by approximately -0.21%, which differs from zero with a 95% probability. The response of real house prices, *RHP*, is also statistically less significant in the short term. However, the negative response of house prices becomes statistically significant starting on the 11th horizon, falling by approximately -0.40% to the 40th horizon. These results suggest that borrower-based macroprudential instruments effectively reduce housing credit and house prices, especially in the long run. These long-term effects are consistent with

the findings in Carreras et al. (2018).

In addition, the negative response of output (*IP*) to macroprudential policy shock, which is about -0.18% in the 40th horizon after the shock, is consistent with the previous findings in Richter et al. (2019) and Kim and Mehrotra (2019). However, the shock has negative but statistically insignificant effects on the price levels, *CPI*, for almost three years.

On the other hand, in response to a contractionary monetary policy shock of one standard deviation, house prices decrease from the medium run. At the same time, mortgage loans show a long-run negative response to the monetary policy shock. The decrease in house prices is about -0.35% in the long run, which is quite similar to the changes responding to macroprudential policy shocks. The decline in output to the monetary policy shock, by -0.25% during the 40 horizons, is more persistent and substantial than that from macroprudential policy shock. Also, *CPI* responses remain negative for all horizons, given that the sign restrictions are imposed on the initial 12 months.

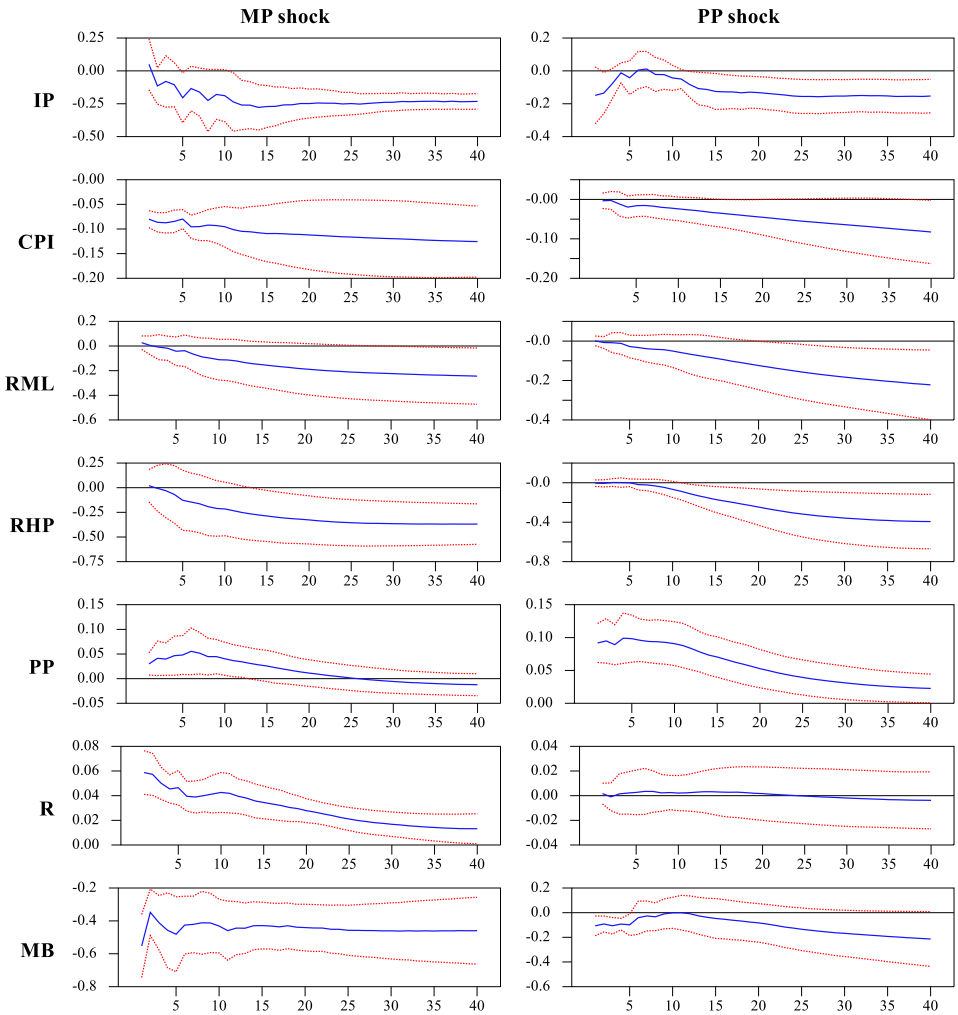
PP also increases significantly, which may suggest that monetary and macroprudential policies are implemented together to stabilize housing markets. This may also suggest that conditioning on monetary policy shocks is important to identify macroprudential policy shocks. Otherwise, macroprudential policy shocks are mixed with monetary policy shocks, and it may not be easy to infer the true effects of macroprudential policy shocks.

To summarize, the effects of monetary and macroprudential policy shocks on real house prices are apparently similar, especially in the long run. In terms of mitigating housing credit expansion, the macroprudential policy appears to be relatively more effective. In addition, macroprudential policy has macroeconomic effects. Still, monetary policy is more comprehensive in that it has a more significant and broader impact on macroeconomic activities

as well as housing sectors.[21] Also, when monetary policy and macroprudential policy aim for price stability and financial stability, which are their respective goals, it is expected that there will be more complementary effects rather than conflicting effects in the long term. This result is in line with Revelo et al. (2020), which showed that contractionary monetary policy enhances the effects of macroprudential tightening on containing credit growth.

[21] In a related contribution, Kim and Mehrotra (2019) showed that monetary policy has a broader impact on consumption and investment, thus aggregate expenditure, than macroprudential policy.

Figure I-3 Impulse Responses: Model 1



Notes: 1) MP shock denotes contractionary monetary policy shock, and PP shock denotes contractionary macroprudential policy shock, 2) The row headings denote the response variables, 3) The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

Now consider a model in which macroprudential policy shock becomes binding on the borrowing constraints. Thus, mortgage loans decrease during the initial 12 horizons following macroprudential tightening (increase in *PP*). Figure I-4 reports the results from the model with binding macroprudential policy shock (Model 2). Other specifications, including monetary policy shock identification, are the same as above.

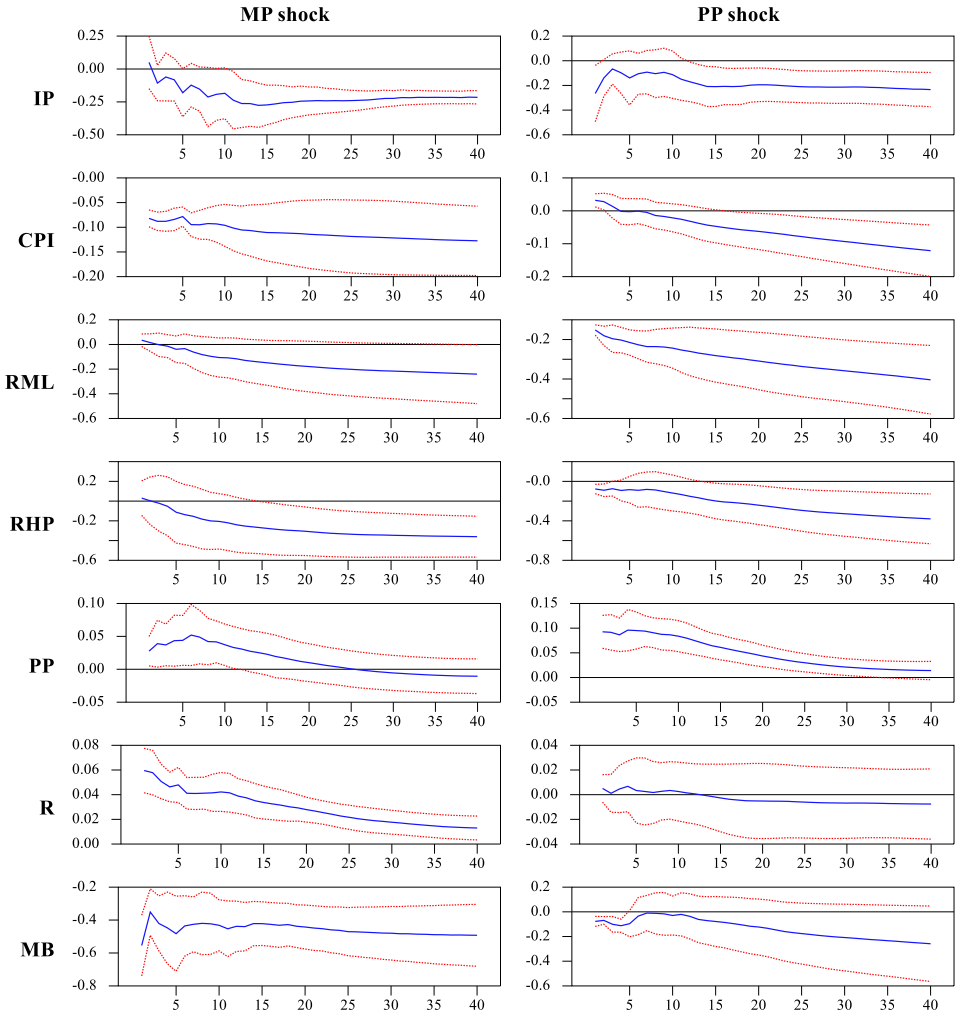
In response to binding macroprudential policy shocks, the negative response of mortgage loans is much more persistent and substantial, given that sign restrictions are imposed on the first 12 months. The size of the long-run effects on mortgage loans is approximately -0.40%, almost twice as large as the previous model, which is statistically different from zero at all horizons. The response of house prices (*RHP*) to a newly identified macroprudential policy shock is not much different from the previous model. Still, it is noticeable that the point estimate shows a negative response for the initial few horizons, although insignificant. It falls approximately by -0.40% in the long run, which differs from zero with a 95% probability.

The maximum decrease of *IP* responding to binding macroprudential policy shocks is approximately -0.25% in impact. The magnitude of the long-run effects is also relatively large, approximately -0.22%. The negative *CPI* response is statistically significant to the binding macroprudential policy shock, in contrast to insignificantly responding when the shock is not binding. *CPI* decreases by about -0.12% across the horizons in Figure I-4.

Contractionary monetary policy shock still has comprehensive effects on real economic activities as well as house prices. To summarize, binding or not, macroprudential policy shocks have significant and substantial effects on the level of house prices. However, their macroeconomic effects are more considerable when the shocks are binding on households' borrowing

constraints. It may be because LTV or DTI tightening limiting the available amounts of borrowings forces households to reduce consumption and housing spending and thus shrinks residential investment (Kim and Mehrotra, 2019).

Figure I-4 Impulse Responses: Model 2



Notes: See Figure I-3.

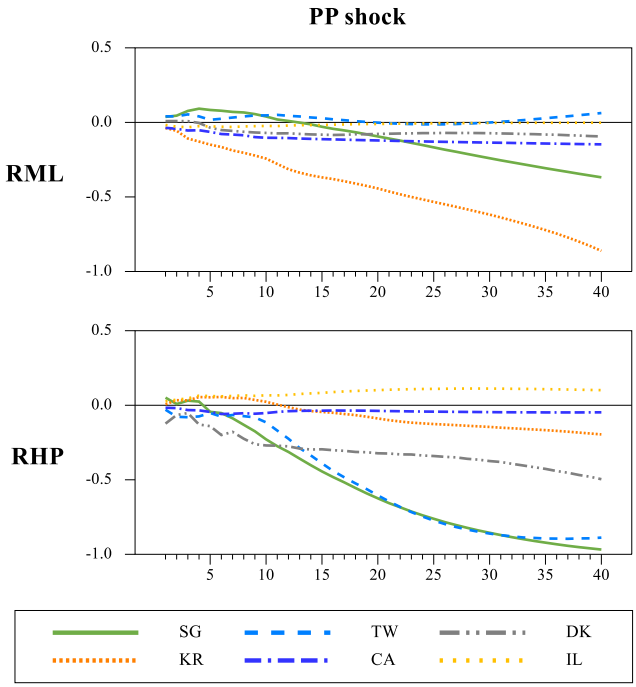
Figure I-5 and Figure I-6 show the estimated impulse response functions of RML and RHP to macroprudential policy shocks for individual countries for Models 1 and 2, respectively. The figures confirm that individual heterogeneity is considerable, notably in the long run, which suggests that allowing heterogeneity in the panel VAR models is suitable.[22]

Figure I-5 shows that the responses of mortgage loans to macroprudential policy shocks are quite diverse across countries. In a couple of countries (Israel and Taiwan) where LTV and DTI are used only a few times, mortgage loans hardly change in response to macroprudential policy shocks. On the other hand, mortgage loans decline substantially in the long run, responding to the shocks in countries where LTV and DTI are used relatively frequently. Heterogeneity also matters in terms of house price responses. The effects on house prices are mild in some countries (Korea, Canada, Israel), while the effects are substantial and negative in other countries (Denmark, Taiwan, Singapore).

In Figure I-6 for Model 2, mortgage loans in every economy decline for all horizons, given that the sign restrictions are imposed only on the first 12 horizons. The economies with a large decrease in mortgage loans are still Singapore and Korea. Also, house prices generally fall immediately in response to the binding macroprudential shocks. However, only one impulse response function (Taiwan) out of six economies is remarkably positive in the short- and medium-run. The rest of the responses are significantly negative or close to zero. Interestingly, although Canada is one of the frequent users of LTV and DTI, LTV and DTI tightening have weak impacts on mortgage loans and house prices compared to Singapore and Korea.

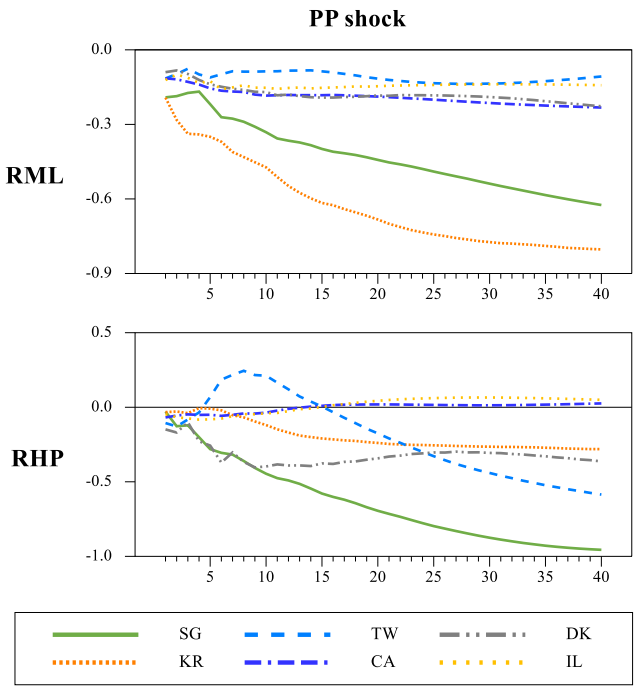
[22] Full impulse response functions with confidence bands for each economy are reported in Appendix I.2.

Figure I-5 Impulse Responses of Individual Countries: Model 1



Notes: Confidence bands are removed to avoid cluttering.

Figure I-6 Impulse Responses of Individual Countries: Model 2



Notes: Confidence bands are removed to avoid cluttering.

4.2 Extended Analysis

This section provides various experiments to provide a deeper understanding and confirm the robustness of the main findings.

4.2.1 Effects of LTV Limits

While LTV limits have been used relatively frequently in all sample countries, two out of six countries (Denmark and Taiwan) have never used DTI during the given sample period. Thus, this paper further explores whether LTV limits alone help mitigate housing credit expansion and house price appreciation. In order to identify LTV tightening shock, the cumulative LTV index (*LTV*) replaces *PP* in the sign restrictions. As before, the restrictions are imposed for

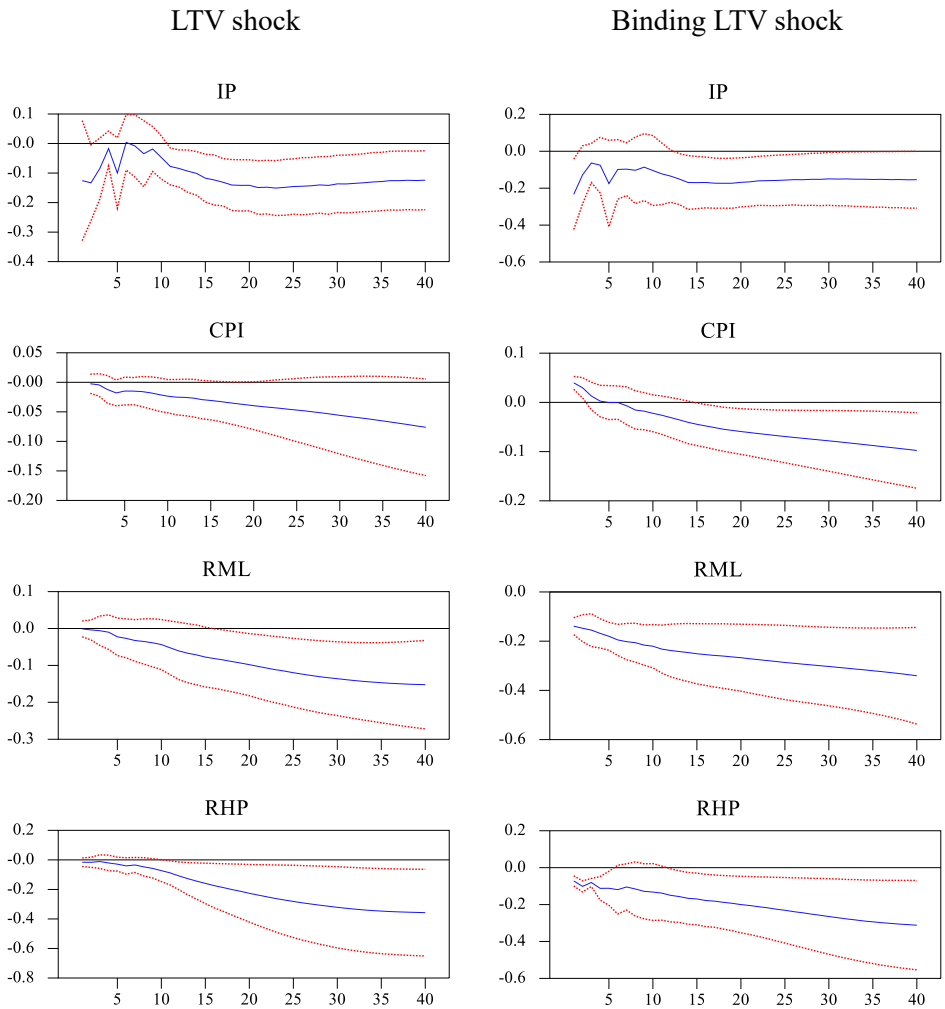
the initial 12 months.

Figure I-7 shows the results of models using the LTV dummy-type index instead of *PP*. The left column reports the selected impulse responses of key macroeconomic variables and target variables to LTV shocks that may and may not bind (hereafter 'LTV shock'). The right column reports the impulse responses to LTV shocks that must bind (hereafter 'binding LTV shock').

LTV tightening shocks have long-run negative impacts on mortgage loans in both cases, but the impacts are more sizeable when the shocks are binding. Mortgage loans fall approximately by -0.15% responding to the LTV shock and by -0.35% responding to the binding LTV shocks. Also, LTV limits alone are found to ease house prices effectively. LTV tightening shocks, whether occasionally binding or always binding, drop house prices by approximately -0.40% in the long run, which is statistically significant in both cases.

In terms of macroeconomic effects, both the LTV shocks and the binding LTV shocks still decrease *IP*, and the sizes of *IP* responses to both LTV shocks are similar to those in the baseline model with PP shocks. The response of *CPI* is negative in the medium to long run but statistically significant only when the LTV shocks are binding. It is also consistent with the results from the baseline models.

Figure I-7 Impulse Responses: LTV Shock



Notes: 1) LTV shock denotes LTV ratio tightening shock, 2) Each heading denotes the response variables, 3) The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

4.2.2 Effects of Comprehensive Macroprudential Policies

The dataset built by Alam et al. (2019) provides dummy indices for 17 macroprudential policy instruments.[23] This section further analyzes the effects of comprehensive macroprudential policy shocks by aggregating all the instruments. Like *PP*, a comprehensive measure, *PPI*, is constructed by summing up the monthly observations from all instruments and accumulating them over time. Then, the sign restrictions are imposed on *PPI*, replacing *PP*, to be positive during the initial 12 horizons to identify tightening comprehensive macroprudential policy shocks.[24]

Figure I-8 shows the results of models with comprehensive macroprudential policy (PPI) shocks. The left column reports the impulse responses of output, price levels, mortgage loans, and house prices to the macroprudential policy shock that may and may not bind (hereafter 'PPI shock'). The right column reports the impulse responses to the binding shock that immediately reduces mortgage loans as *PPI* increases (hereafter 'binding PPI shock').

Comprehensive macroprudential policy shocks lower house prices effectively in the medium and long run in both columns. However, *RHP* responds slightly weaker to overall macroprudential policy (PPI) shocks than PP shocks, directly targeting the demand for credit. Also, the comprehensive

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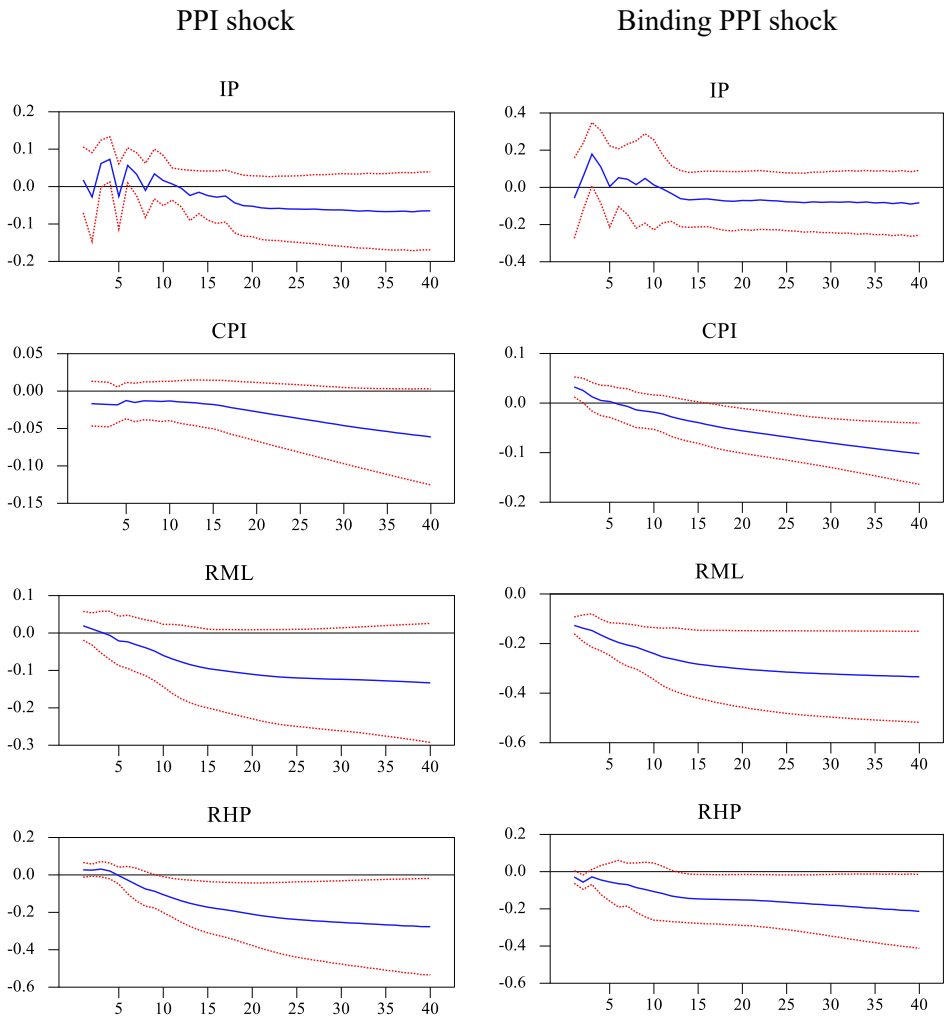
[23] Alam et al. (2019) provided dummy-type indicators of various macroprudential policy tools as follows: countercyclical capital buffer, capital conservation buffer, capital requirements, leverage limits, loan loss provisions, limits on credit growth, loan restrictions, limits on foreign currency lending, limits on LTV ratio, limits on DSTI ratio, tax measures, liquidity requirements, limits on loan-to-deposit (LTD) ratio, limits on foreign exchange positions, reserve requirements, SIFI measures, and others.

[24] The correlation between *PP* and *PPI* is about 0.86.

macroprudential policies are less effective in curbing mortgage loans, especially when the policies do not practically bind. This result supports that borrower-targeted tools have more significant impacts on housing (or household) credit than overall macroprudential tools (Cerutti et al., 2017; Alam et al., 2019).

Interestingly, the macroeconomic effects of macroprudential policy shocks are less clear when considering all the macroprudential instruments than focusing on LTV and DTI limits. The responses of *IP* are hardly significant to both PPI shocks and binding PPI shocks. It may be because the channel where reduced demand for housing loans and a decrease in house prices would dampen residential investment and consumption is weakened.

Figure I-8 Impulse Responses: Comprehensive Macroprudential Policy Shock



Notes: 1) PPI shock denotes contractionary comprehensive macroprudential policy shock, 2) Each heading denotes the response variables, 3) The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

4.2.3 Conditioning on Additional Structural Shocks

In the baseline model, macroprudential policy shocks are identified as those orthogonal to monetary policy shocks. In this way, monetary policy shocks are clearly excluded from the identified macroprudential policy shocks. A further experiment in this section clearly excludes more structural shocks from the identified macroprudential policy shocks by identifying macroprudential policy shocks as those orthogonal to more structural shocks. Here two popular structural shocks are considered additionally, aggregate supply shock and non-monetary aggregate demand shock, and examine the robustness of the results on the effects of macroprudential policy shocks.

First, in aggregate supply shocks, *IP* and *CPI* move in the opposite direction according to typical macroeconomic theory. Thus, the positive aggregate supply shock is defined as *IP* moves up and *CPI* moves down. Second, *IP* and *CPI* move in the same direction in aggregate demand shocks. That is, positive aggregate demand shocks move *IP* and *CPI* up. However, non-negative responses of *IP* and *CPI* can be confused with the effects of expansionary monetary policy shocks. Therefore, to disentangle aggregate demand shocks and expansionary monetary policy shocks, interest rate responses are additionally constrained to be positive. Thus, the positive non-monetary aggregate demand shock is identified as moving *IP*, *CPI*, and *R* up (Peersman, 2005; Mountford, 2005).[25]

The monetary and macroprudential policy shocks are set to be orthogonal to both aggregate supply and demand shocks. The sign restrictions

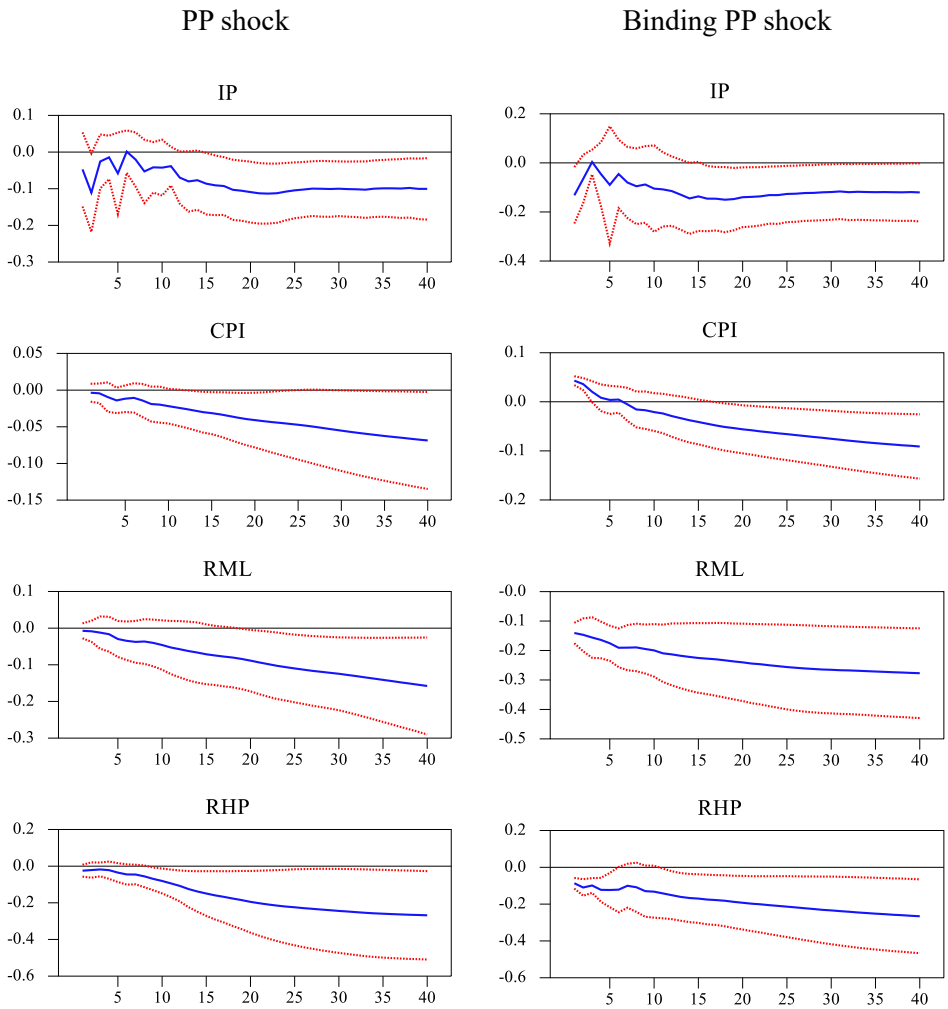
[25] However, IP may not be an adequate proxy for GDP due to its weak representation of overall macroeconomic activities and large volatility. Therefore, aggregate supply and demand shocks are included in alternative models for robustness check instead of the baseline models.

are imposed on the initial six horizons in these experiments, and the other specifications are the same as above. In Figure I-9, the left column shows the selected impulse responses to the PP shock, and the right column shows those to the binding PP shocks.

The overall results are qualitatively similar to the baseline results even when the business cycles are controlled. Mortgage loans fall by approximately -0.15% responding to the PP shocks and by -0.3% to the binding PP shocks, which are slightly smaller than the baseline results without aggregate supply and demand shocks. In addition, the sizes of a long-run decline in house prices are less than -0.3% in both columns, which are also weaker than when the business cycles are not taken into account. These results reconfirm that LTV and DTI impact households' housing credit and house prices effectively.

Given the aggregate supply and demand shocks, LTV and DTI limits still have negative impacts on output and price levels. However, such macroeconomic effects generally lessen, as are the effects on mortgage loans and house prices.

Figure I-9 Impulse Responses: Conditioning on Additional Structural Shocks



Notes: See Figure I-3.

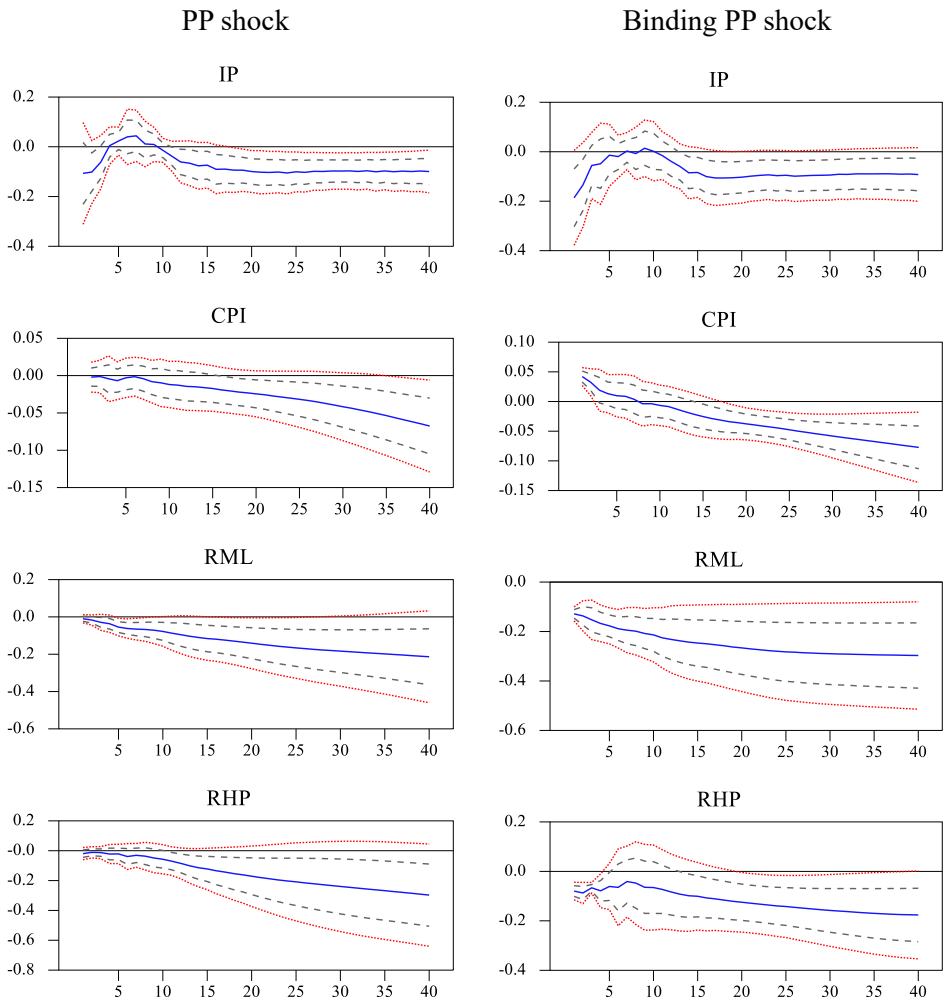
4.2.4 Excluding Singapore

Lastly, unlike other countries, since Singapore has an exchange rate-based monetary policy mechanism, it may not be appropriate to identify monetary policy shocks based on the interest rate. Therefore, this section examines the

policy effects for five countries, excluding Singapore. Other specifications are the same as the baseline models. Figure I-10 shows the selected impulse responses to the PP shocks in the left column and those to the binding PP shocks in the right column.

The results for the reduced sample are qualitatively similar to the baseline results but statistically less significant at 90% probability. However, at 68% probability represented by the dashed lines, both PP shocks and binding PP shocks effectively reduce mortgage loans and house prices in the long run. Furthermore, the negative responses of IP and CPI are significant at 68% probability in the long run. These results consistently show that LTV and DTI limits are effective tools in curbing mortgage loans and house prices.

Figure I-10 Impulse Responses: Excluding Singapore



Notes: 1) PP shock denotes contractionary macroprudential policy shock, 2) Each heading denotes the response variables, 3) The solid lines refer to the mean group estimates, the dashed lines show 68% probability bands, and the dotted lines show 90% probability bands.

5. Concluding Remarks

This paper uses the structural heterogeneous panel VAR approach with sign restrictions imposed on impulse responses to investigate the effects of macroprudential policy, focusing on the borrower-targeted instruments – LTV and DTI caps. By estimating the heterogeneous panel VAR models, this paper draws a general conclusion of the policy impacts by fully exploiting the information from panel data but allowing full heterogeneity of policy effects across economies. In addition, the sign restriction approach allows identifying monetary and macroprudential policy shocks with less restrictive assumptions.

The main result of this paper suggests that macroprudential policy has substantial effects on house prices as well as mortgage loans. Moreover, such effects are substantial and robust across various experiments. In addition, LTV and DTI are more effective in curbing mortgage loans than overall macroprudential instruments. This paper further explores how macroprudential policy affects output and inflation to draw some implications for the macroeconomic costs of policy implementation. Empirical results show that macroprudential policy has a similar but weaker impact on output and inflation than monetary policy. Moreover, such macroeconomic effects are more significant and stronger when LTV and DTI regulations are clearly binding, and mortgage loans are assumed to decline.

One policy implication of this paper is that there may, at least in the long term, be no conflicting effects when monetary and macroprudential policies are used for their respective goals – price stability and financial stability. However, this policy combination may conflict with each other when business cycles and credit cycles do not coincide, for example, expanded credit and deep recession during the pandemic. In such a case, tightening

macroprudential policy to curb credit can lead to further recession, while monetary policy expansion to stimulate the economy can contribute to financial instability (Kim and Mehrotra, 2018, 2019).

However, LTV and DTI policy actions have more immediate effects on financial stability, while monetary policy actions have stronger effects on the macroeconomy, as documented in this paper. Therefore, two policies are not entirely a substitute for each other, and thus each policy can target each policy objective, although the side effects of the other policy should be accounted for properly. In addition, implementing a sophisticated macroprudential policy to target a specific type of credit or sector may be worthwhile. For example, this paper confirmed that LTV and DTI policy actions are more effective in curbing mortgage loans than other macroprudential policy instruments.

Future work would examine the interaction between monetary policy and macroprudential policy, especially how monetary policy conditions affect the effectiveness of macroprudential policy and vice versa.

Appendixes

Appendix I.1. Data Descriptions and Sources

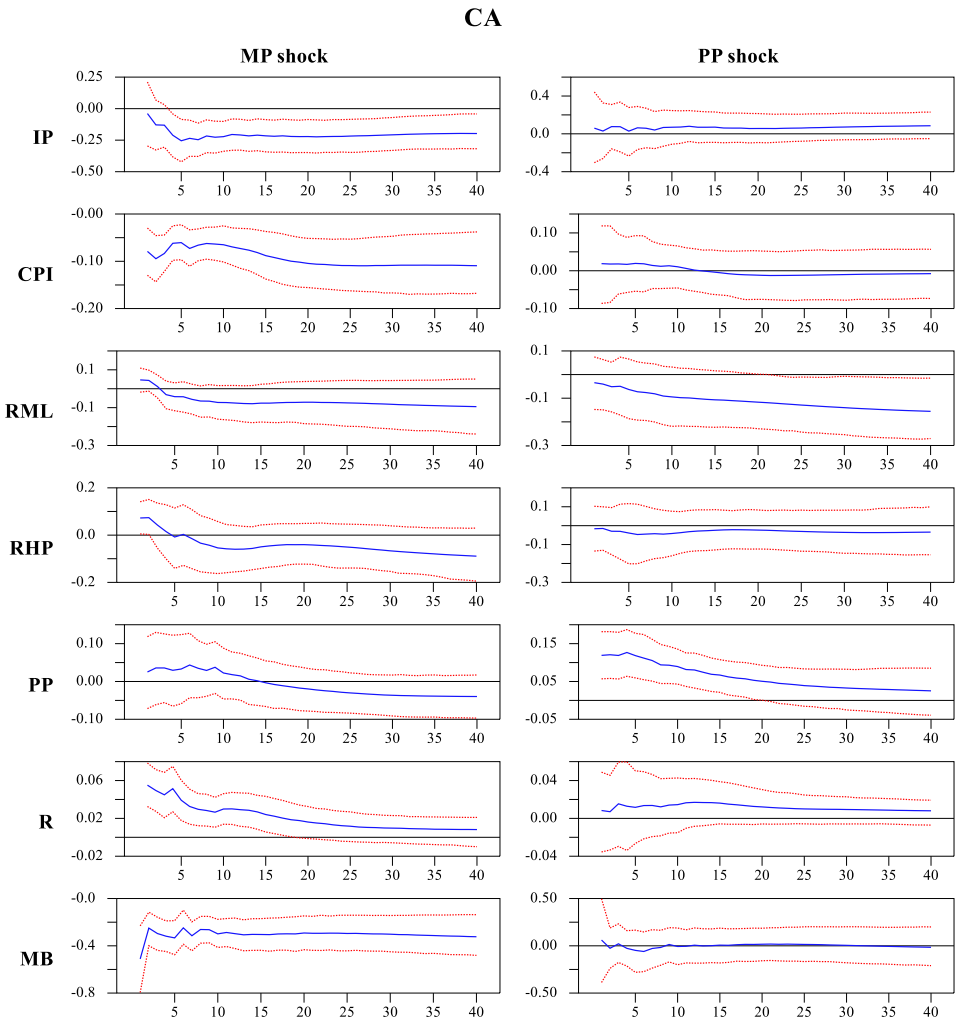
Country	Variable Names	Variable Descriptions	Sources
CA	IP	Industrial Production Index	CEIC
	CPI	Consumer Price Index	CEIC
	MB	Monetary Base	CEIC
	R	Money Market Rate	CEIC
	RML	Household Credit: Residential Mortgage	CEIC
	RHP	House Price Index: New Housing	CEIC
DK	IP	Industrial Production Index	CEIC
	CPI	Consumer Price Index	Datastream
	MB	Currency in Circulation	CEIC
	R	Call Money Rate	FRED
	RML	MFIs Loans: OA: Households: Lending for House Purchase	CEIC
	RHP	Property Price Index: One Family Houses	CEIC
IL	IP	Industrial Production Index	CEIC
	CPI	Consumer Price Index	CEIC
	MB	Monetary Base	CEIC
	R	Money Market Rate	CEIC
	RML	Credits: Outstanding: Borrowers: HO: Loans: ow Housing	CEIC
	RHP	Dwellings Price Index: Owner Occupied	CEIC
SG	IP	Industrial Production Index	CEIC
	CPI	Consumer Price Index	CEIC

Country	Variable Names	Variable Descriptions	Sources
	MB	Reserve Money	CEIC
	R	Money Market Rate	CEIC
	RML	DBU: LA: CL: Housing & Bridging Loans	CEIC
	RHP	SRX Property Index, Average of Private Non-Landed, Private Landed, and HDB indexes	SRX
KR	IP	Industrial Production Index	CEIC
	CPI	Consumer Price Index	CEIC
	MB	Monetary Base	CEIC
	R	Call Rates	CEIC
	RML	Credit to Households: LH: DC: CSB: Mortgage Loans	CEIC
	RHP	Housing Price Index	CEIC
TW	IP	Industrial Production Index	CEIC
	CPI	Consumer Price Index	CEIC
	MB	Reserve Money	CEIC
	R	Money Market Rate	CEIC
	RML	Consumer Loans: Outstanding: DB: House Purchasing	CEIC
	RHP	Sinyi Residential Property Price Index: Taipei Area	CEIC

Notes: 1) Except for the interest rates, the data that are not seasonally adjusted by the data provider is seasonally adjusted using X-12 ARIMA, 2) SRX = Singapore Real Estate Exchange.

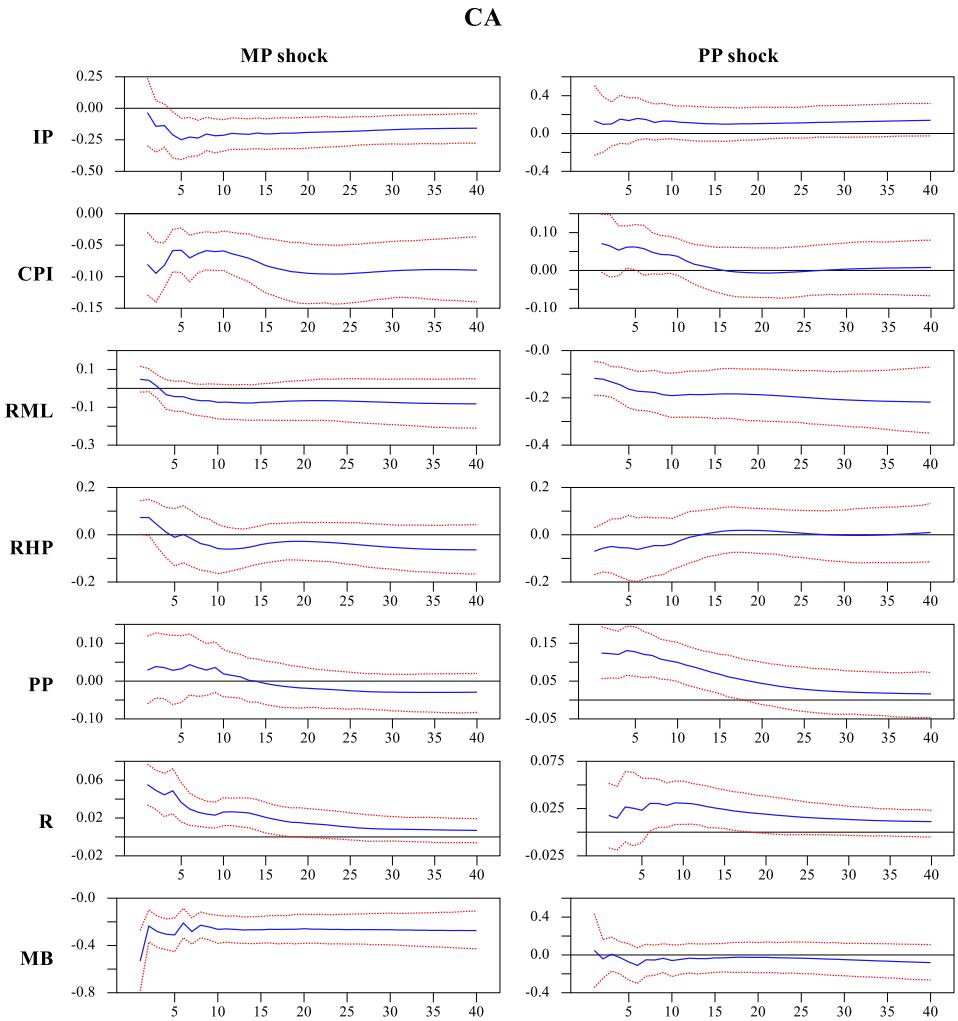
Appendix I.2. Impulse Responses for Individual Economies

Figure A I-1 Impulse Responses for Canada: Model 1



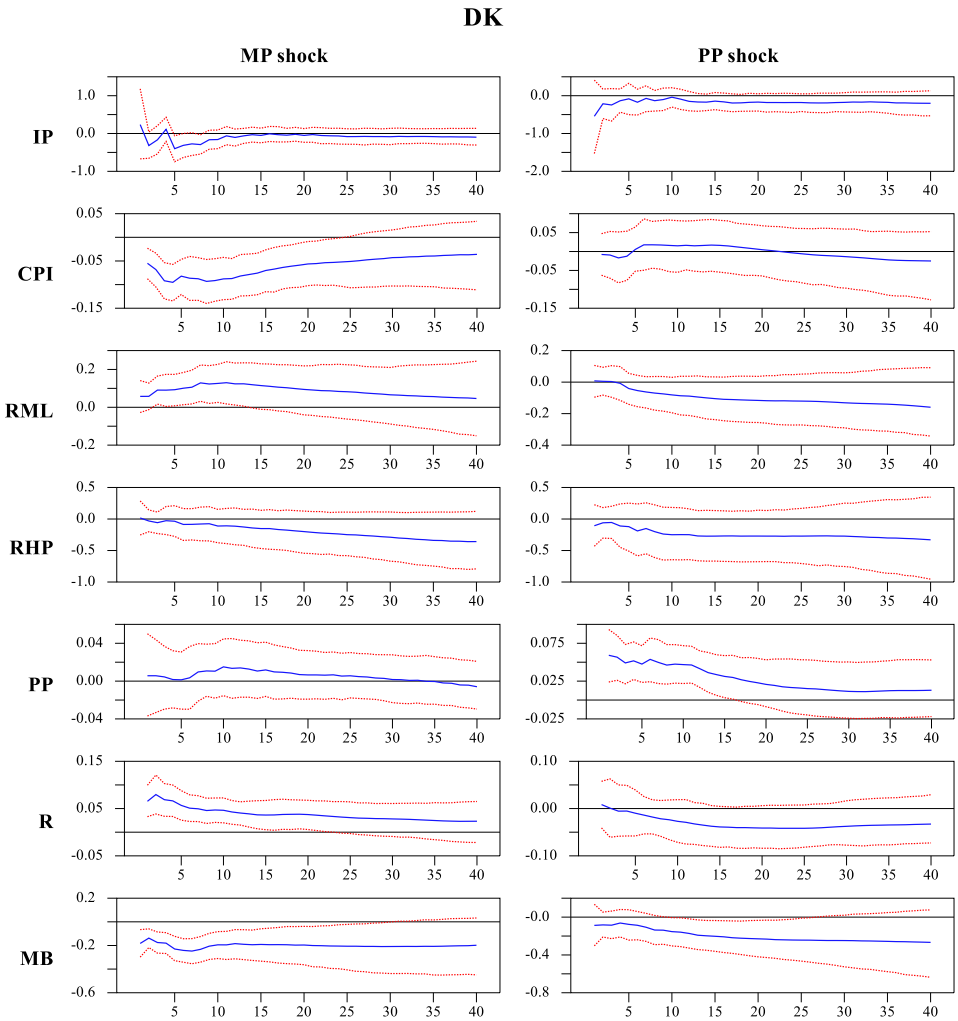
Notes: The solid lines refer to the mean group estimates, and the dotted lines show 68% probability bands.

Figure A I-2 Impulse Responses for Canada: Model 2



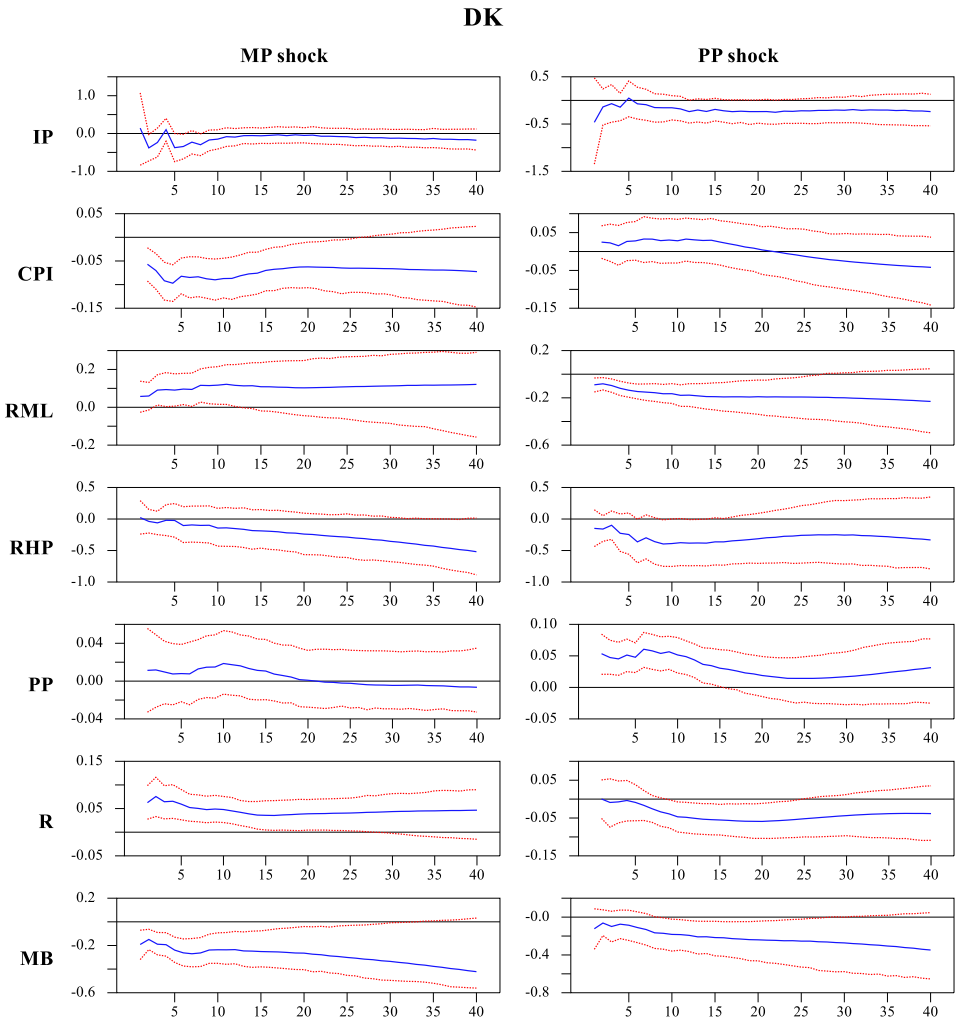
Notes: See Figure A I-1.

Figure A I-3 Impulse Responses for Denmark: Model 1



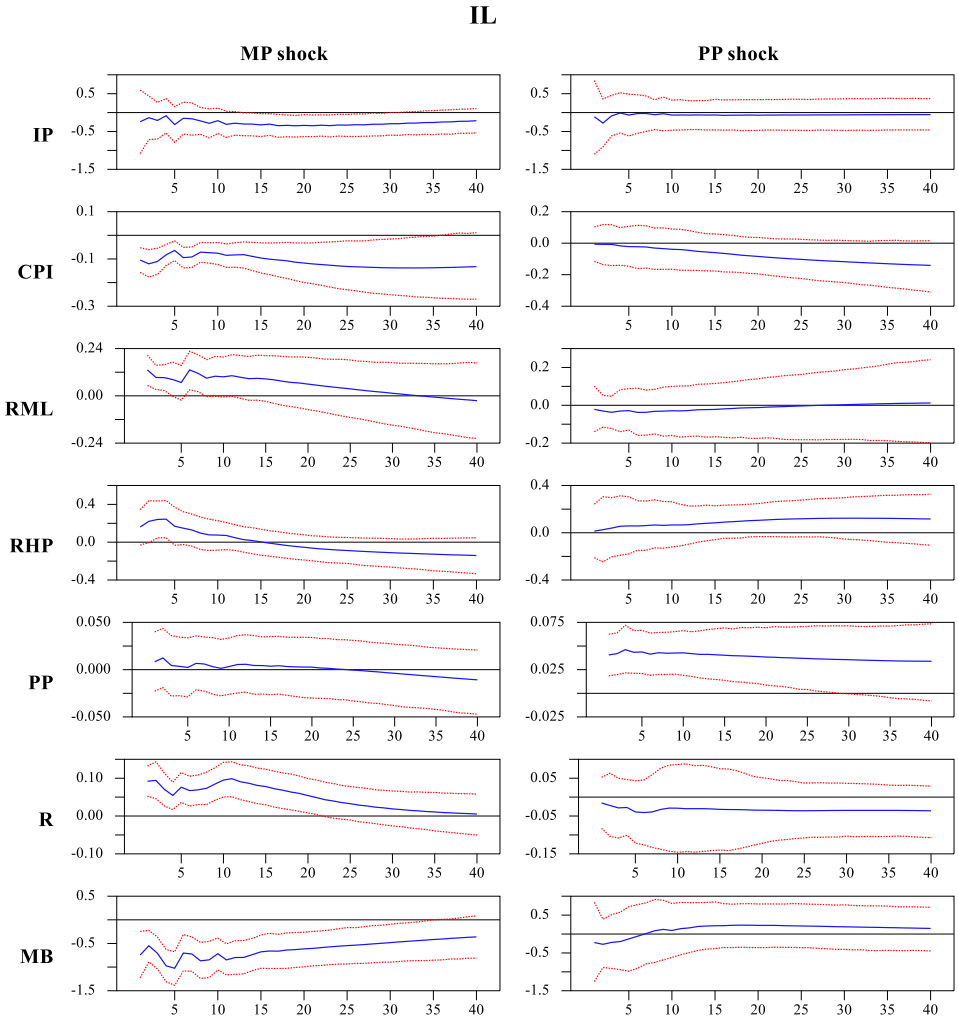
Notes: See Figure A I-1.

Figure A I-4 Impulse Responses for Denmark: Model 2



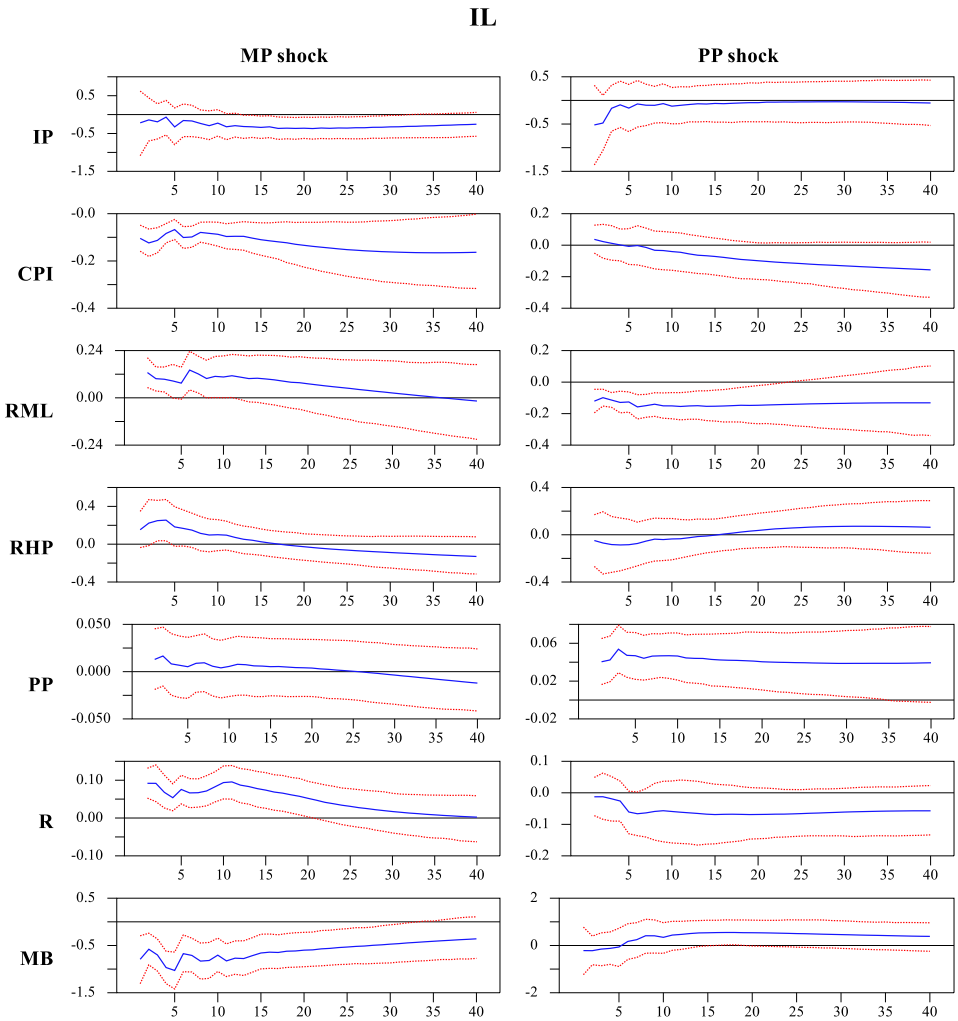
Notes: See Figure A I-1.

Figure A I-5 Impulse Responses for Israel: Model 1



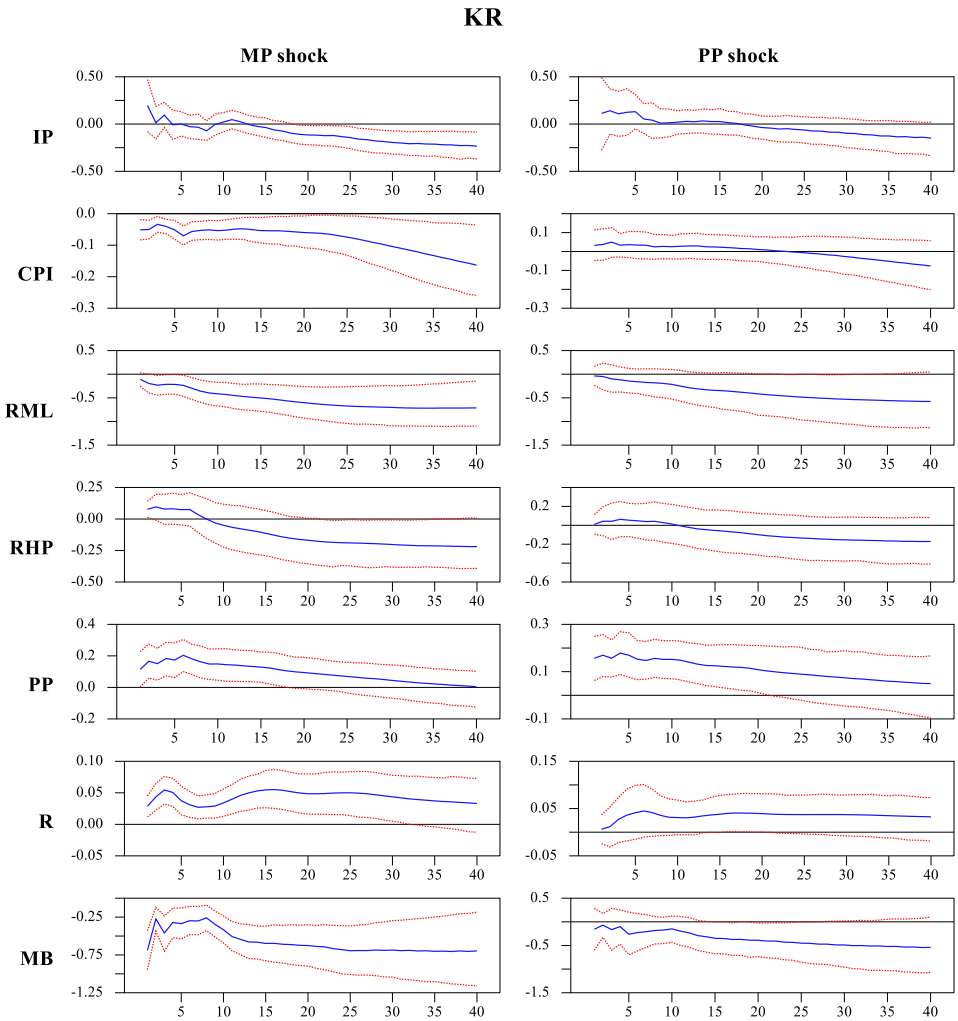
Notes: See Figure A I-1.

Figure A I-6 Impulse Responses for Israel: Model 2



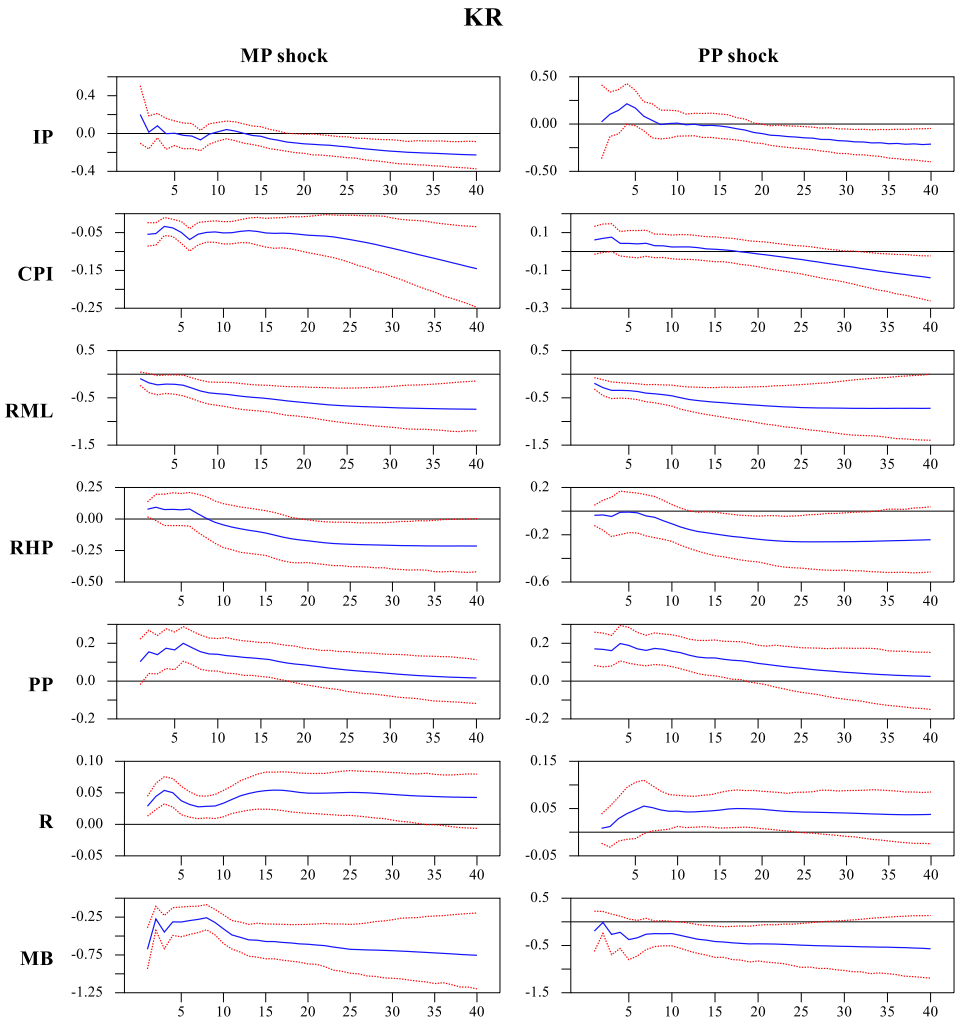
Notes: See Figure A I-1.

Figure A I-7 Impulse Responses for Korea: Model 1



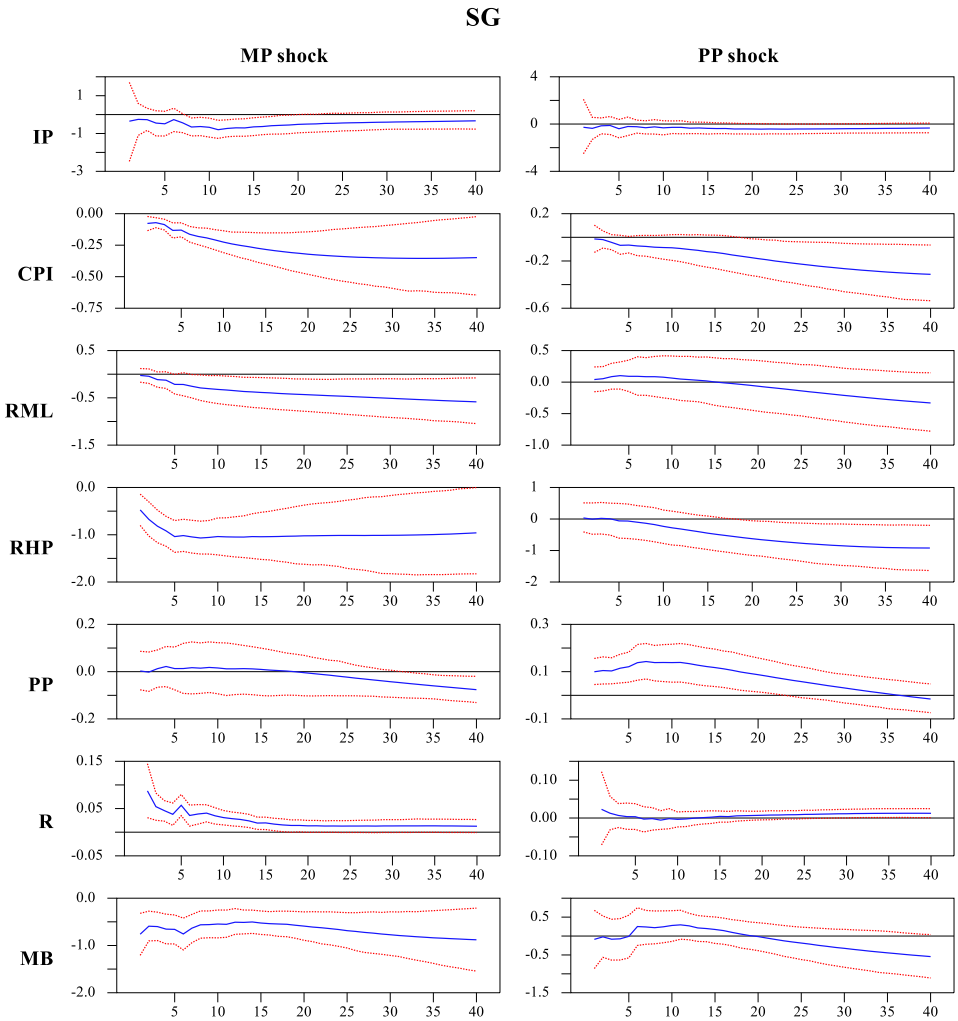
Notes: See Figure A I-1.

Figure A I-8 Impulse Responses for Korea: Model 2



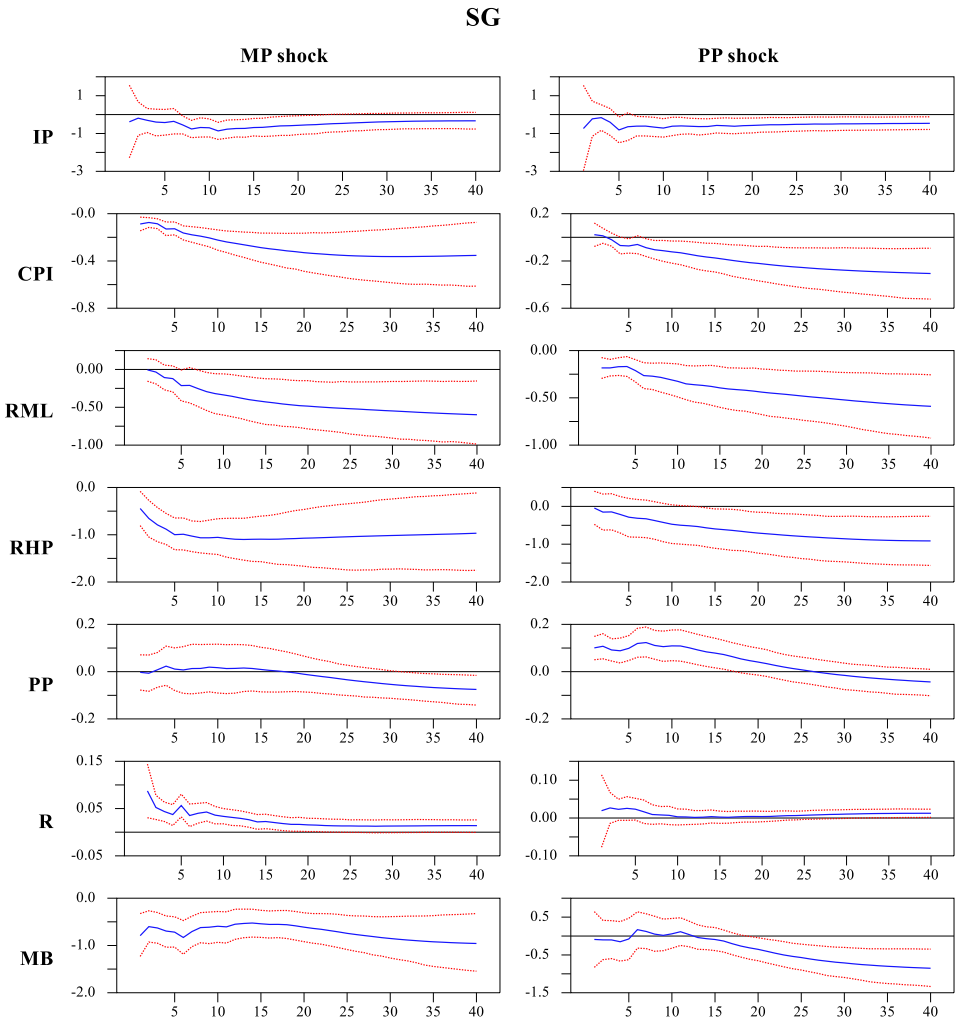
Notes: See Figure A I-1.

Figure A I-9 Impulse Responses for Singapore: Model 1



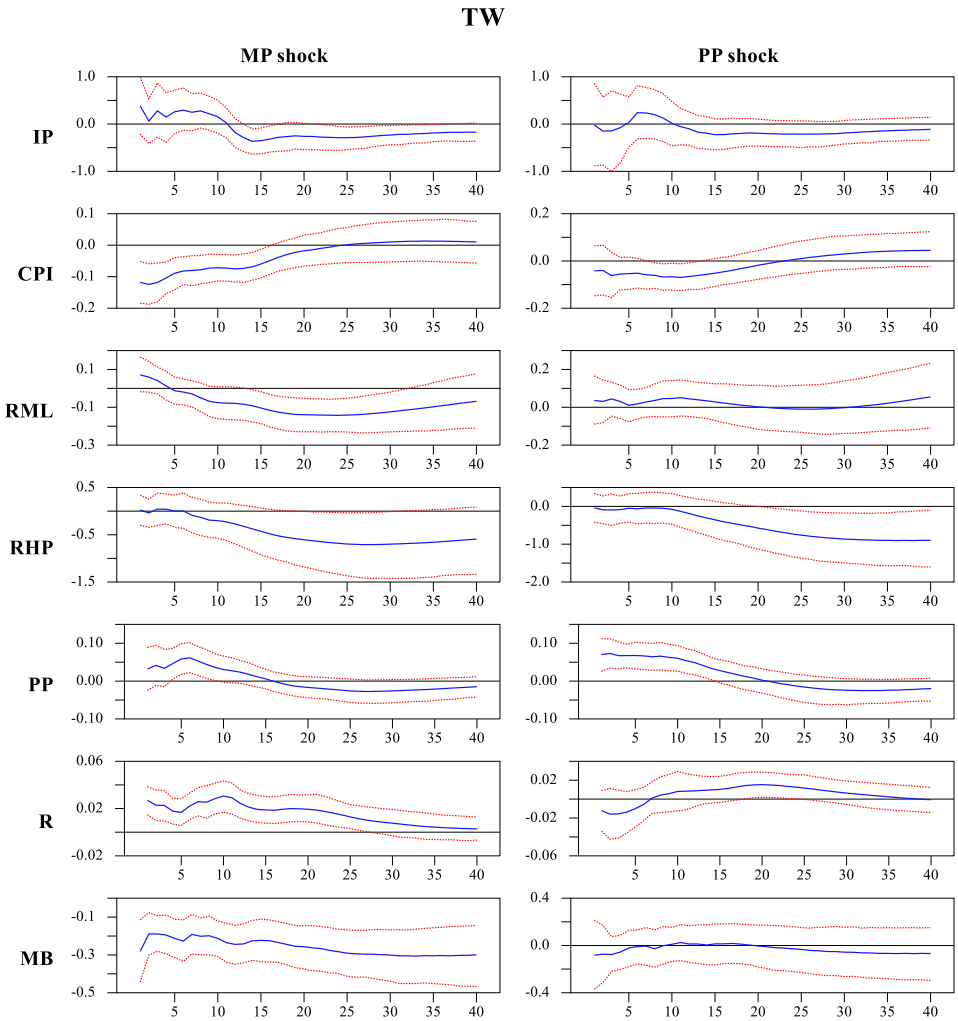
Notes: See Figure A I-1.

Figure A I-10 Impulse Responses for Singapore: Model 2



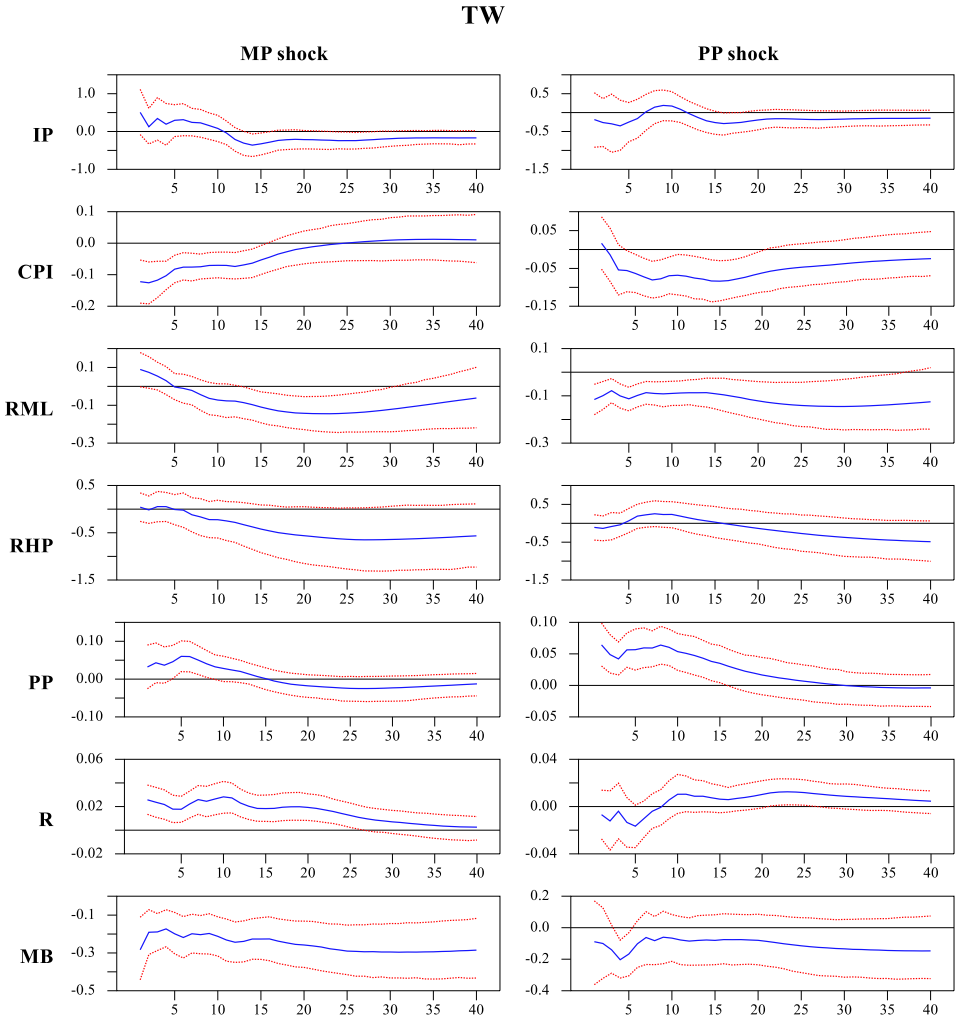
Notes: See Figure A I-1.

Figure A I-11 Impulse Responses for Taiwan: Model 1



Notes: See Figure A I-1.

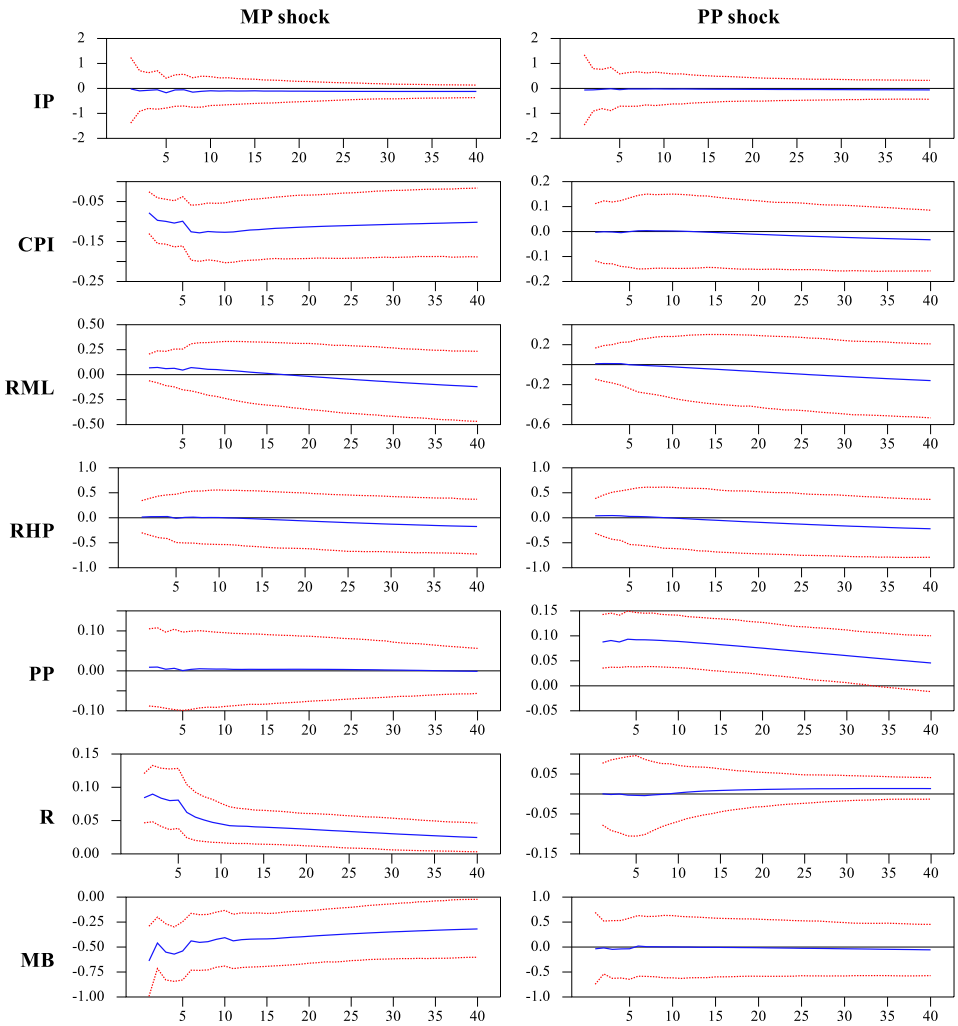
Figure A I-12 Impulse Responses for Taiwan: Model 2



Notes: See Figure A I-1.

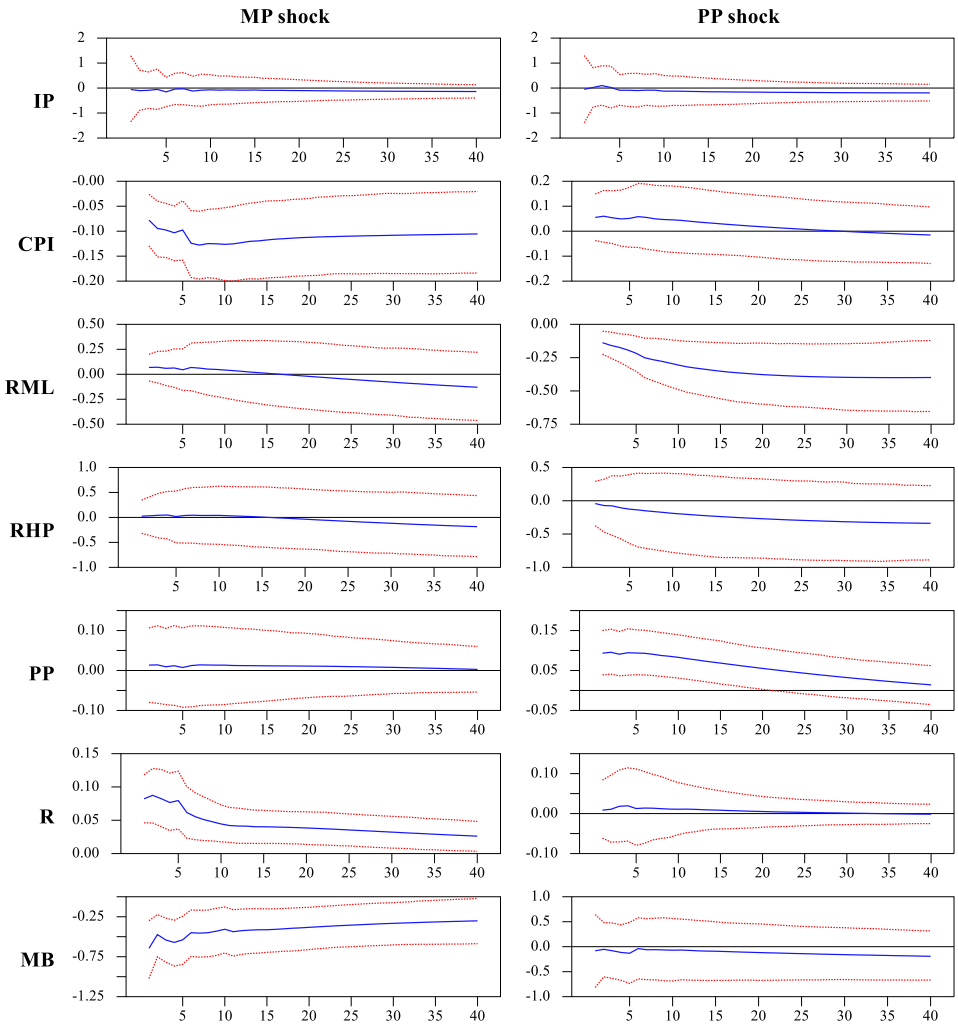
Appendix I.3. Impulse Responses: Pooled Panel VAR

Figure A I-13 Impulse Responses for Panel VAR with Country Fixed Effect: Model 1



Notes: See Figure A I-1.

Figure A I-14 Impulse Responses for Panel VAR with Country Fixed Effects: Model 2



Notes: See Figure A I-1.

Chapter II. Dynamic Interactions between Trade Globalization and Financial Globalization: A Heterogeneous Panel VAR Approach[26]

1. Introduction

The postwar period has witnessed a rapid growth in trade and financial globalization. However, the persistent momentum of trade globalization decelerated after the global financial crisis (GFC). Moreover, COVID-19 highlighted the vulnerability of long and distant global supply chains to shocks and the risk of over-dependence on imports of vital goods, such as medical supplies and equipment. Resultantly, the pandemic is likely to accelerate post-GFC trade deglobalization trends further. However, how the ongoing trade deglobalization will affect financial globalization remains unclear. This paper mainly aims to analyze how trade (de) globalization affects financial (de) globalization and, generally, the interactions between the two types of globalization.

Several past studies empirically examined how international trade integration affects international financial integration.[27] Lane and Milesi-Ferretti (2003) showed that trade integration promotes international financial integration, measured by the sum of foreign assets and liabilities relative to GDP. They provided some reasons for the positive effect of trade integration

[26] This chapter (joint work with Soyoung Kim (SNU) and Donghyun Park (ADB)) is under review in *Journal of International Money and Finance*.

[27] In this paper, "integration" and "globalization" are used interchangeably following past studies, such as Lane and Milesi-Ferretti (2003, 2007), Koren (2003) and Baltagi et al. (2009).

on financial integration. First, trade mostly involves corresponding financial transactions (for example, trade credit and export insurance). Second, trade and financial positions are mutually determined in some cases, such as FDI, given the importance of intra-firm intermediate goods trade. Third, trade openness against a particular country may increase the familiarity or information on the country and motivate cross-border financial transactions with that country. Fourth, as in Obstfeld and Rogoff (2000), trade costs can lead to home bias in assets markets, in addition to small trade openness.

Chambet and Gibson (2008) decomposed trade openness into natural and residual components, both of which contribute to financial integration, specifically stock market integration, in emerging markets. Aizenman (2008) also identified a hidden link, the public finance channel, through which *de facto* trade openness promotes *de facto* financial openness.[28] Forbes and Chinn (2004) suggested that bilateral trade is an important determinant of bilateral linkages in the financial market. Similarly, Ananchotikul et al. (2015) found that bilateral trade integration is one of the positive drivers of bilateral financial integration in Asia.

These studies mostly analyzed the effects of trade integration on financial integration, but financial integration can also affect trade integration. Various reasons exist on how financial integration can promote trade integration. First, financial integration with a particular country may increase the familiarity or information on that country and motivate international trade in goods with that country. Second, high transaction costs in financial markets

[28] Aizenman (2008) suggested that greater trade openness increases the effective cost of enforcing financial repression, reducing the usefulness of financial repression as an implicit tax. In this context, financial reforms can be a by-product of trade openness.

can complicate transactions in international trade. Third, financial integration and developments can increase availability of hedging instruments, which can reduce the cost of exchange rate uncertainty and promote international trade (Koren, 2003; Wei, 1999).[29]

Therefore, the feedback relationship between the two types of integration must be considered. However, studies that investigated the relation by explicitly considering the interactions between the two types of integration remain relatively few. A few exceptions are Aizenman and Noy (2006, 2009) that applied the causality test and Geweke decomposition test to assess the relationship between the two types of integration. Aizenman and Noy (2006) found the interactive feedback between trade and FDI by the Granger causality. Aizenman and Noy (2009) reconfirmed this interaction between financial openness, measured by the sum of capital inflows and outflows, and trade openness. Aviat and Coeurdacier (2007) investigated causality between bilateral trade integration and bilateral asset holdings using simultaneous gravity equations and found that bilateral trade and bilateral asset holdings have positive causality in both directions. These past studies investigated the period before the GFC. However, the recent trade deglobalization and related debates started from the GFC, thus reinvestigating the issue for the sample comprising the post-GFC period is worthwhile.

This paper investigates the relationship between trade and financial integration. The preliminary analysis analyzes the predictive relationship between these two types of globalization by applying the Granger causality

[29] Koren (2003) suggested that increased availability of hedging instruments can reduce trade barriers and increase trade volume by lowering the cost of exchange rate uncertainty incurred by exporters. However, Wei (1999) empirically examined this channel but did not find supporting empirical evidence.

test as in some past studies. It investigates whether trade (de) globalization Granger-causes financial (de) globalization and vice versa. However, drawing a clear conclusion is not easy because the results quite differ across countries. This motivates the main analysis of this paper, which can take account of heterogeneity across countries and draw a clear conclusion simultaneously.

The main part of the empirical analysis is to analyze the dynamic relationship between trade globalization and financial globalization by constructing heterogeneous panel structural VAR models. VAR models consider the dynamic interactions between two variables of interest and can show the dynamic effects of one integration on the other over time. This paper also allows heterogeneity among different countries because the relation between two types of integration can differ across countries, as suggested by the preliminary analysis. Using the heterogeneous panel structural VAR model, we aim to draw a general conclusion on the relationship between two types of integration by fully exploiting the information from panel data and considering the full heterogeneity in the relationship across countries.

The remainder of this paper is organized as follows. Section 2 shows the measures of trade and financial integration and the results of the Granger causality test. Section 3 explains the empirical framework. Section 4 reports and discusses the empirical results from the baseline model. Section 5 investigates various experiments to provide a deeper understanding of the main findings. Lastly, Section 6 concludes the paper.

2. Data and Preliminary Analysis

This section shows the measures of trade and financial integration and reports the results of the Granger causality test between the two variables.

2.1 Measures of Trade and Financial Integration

International trade integration (TRADE) is measured as the sum of exports and imports of goods and services relative to GDP. International financial integration (FIN) is measured as the sum of foreign assets and liabilities relative to GDP, following past studies, such as Lane and Milesi-Ferretti (2003).[30] That is,

$$TRADE = \frac{Exports + Imports}{GDP}$$
$$FIN = \frac{Foreign\ assets + Foreign\ liabilities}{GDP} \qquad \text{(II.1)}$$

Quarterly data for Q1 1987–Q4 2019 for 39 developed and developing countries are used in the empirical analysis. The sample countries are selected primarily based on data availability of foreign assets and liabilities, exports, and imports. The empirical models include countries with at least 40 quarters of time-series observations to reserve enough degree of freedom in estimating the individual VAR models.[31] The sample countries included in the analysis are listed in Table II-1. The main sources of data are the International Financial Statistics (IFS), the Balance of Payment and the International Investment Position (BOP/IIP) of the IMF, and the Global Economic Monitor of the World Bank. In addition, data from national sources and the CEIC database are used if necessary. Details on data sources are provided in

[30] The annual rates of GDP, exports, and imports are used.

[31] China is not included in the sample due to relatively short time-series data of foreign assets and liabilities.

Appendix I.1.

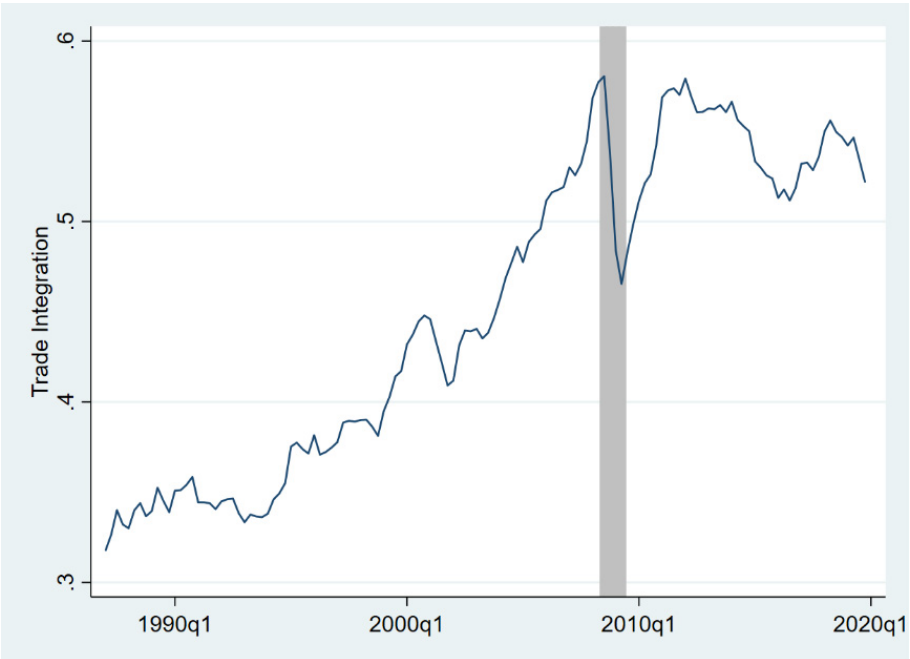
Figure II-1 and Figure II-2 show the trends in trade and financial integration, respectively, of the whole sample countries. The measures are constructed as the weighted average of the individual country measures, weighted by the relative shares of GDP in aggregate GDP of all countries in the sample (in US dollar). Both integration measures have increased rapidly over time until the GFC. Trade and financial integration have nearly doubled over two decades. During the GFC, trade integration fell rapidly, reflecting the sharp shrinkage of global trade. Meanwhile, financial integration did not fall much, given that the fall in GDP tends to be as large as the fall in financial assets and liabilities during the GFC.

For trade and financial integration, the rate of increase tends to decelerate after the GFC. Although financial integration remains relatively stable after the GFC, trade integration tends to decrease. These trends indicate some interesting issues regarding the interaction between trade and financial integration. For example, will the recent decline in trade integration negatively affect financial integration? Were there any interactions between trade and financial integration before the GFC when trade and financial integration increased rapidly? Does trade integration positively affect financial integration? Conversely, does financial integration positively influence trade integration?

Table II-1 summarizes the sample period averages of trade and financial integration measures for each country. The most financially open countries are advanced European economies, such as the Netherlands, Switzerland, and Belgium, with values of 18.48, 10.56, and 9.37, respectively. Meanwhile, developing countries tend to show limited financial integration. India, Guatemala, and Turkey have values of 0.63, 0.79, and 0.94,

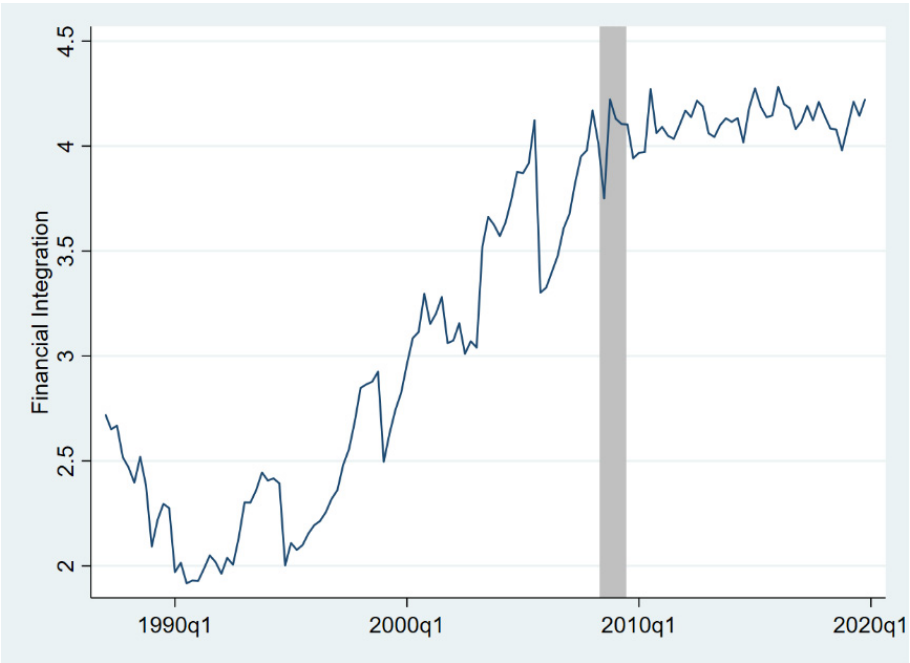
respectively. The measure of trade integration is the highest for Belgium (1.57), Hungary (1.40), and Netherlands (1.4), and the lowest for the U.S. (0.24), Brazil (0.25), and Columbia (0.35).

Figure II-1 Trend in Global Trade Integration



Notes: The weighted average of the trade integration measure for 39 countries. The shaded area indicates the GFC periods.

Figure II-2 Trend in Global Financial Integration



Notes: The weighted average of the financial integration measure for 39 countries. The shaded area indicates the GFC periods.

Table II-1 Trade and Financial Integration

Country	Trade Integration	Financial Integration	Country	Trade Integration	Financial Integration
United Kingdom	0.520	7.215	Hungary	1.404	3.533
Australia	0.397	2.037	India	0.482	0.632
Austria	1.166	4.489	Israel	0.662	1.507
Belgium	1.570	9.373	Italy	0.528	2.570
Bolivia	0.667	1.255	Kazakhstan	0.802	1.616
Brazil	0.248	0.939	Korea Rep.	0.761	1.054
Bulgaria	1.235	2.176	Netherlands	1.397	18.482
Canada	0.662	2.579	New Zealand	0.585	2.296
Chile	0.640	2.513	Peru	0.407	1.146
Colombia	0.347	0.993	Poland	0.884	1.376
Costa Rica	0.725	1.219	Portugal	0.721	4.231
Czech Republic	1.282	1.837	Romania	0.736	1.036
Denmark	1.002	4.923	Slovenia	1.348	2.044
Finland	0.686	3.704	Spain	0.588	3.279
France	0.581	5.003	Sweden	0.827	4.858
Georgia	0.872	1.530	Switzerland	1.096	10.557
Germany	0.815	4.326	Turkey	0.523	0.939
Greece	0.579	3.170	Ukraine	1.016	1.771
Guatemala	0.560	0.790	United States	0.243	2.949
Honduras	0.835	1.244	Average	0.764	3.263

Notes: The table lists the sample countries and reports the average of trade and financial integration measures over the sample periods for each country.

2.2 Granger Causality Test

Before estimating the VAR model, this paper tests the Granger causality between trade and financial integration measures of each country to gain some insights into the relationship between trade and financial integration in both directions at the individual country level.

First, this section performs the Augmented Dickey–Fuller unit root test for each variable in each country to check whether each measure is stationary. Given that trade and financial integration tend to show a time trend, a trend term is included in each regression, and the lag length is selected based on the Akaike information criteria (AIC). Table II-2 reports the results. The null hypothesis of the unit root is rejected for TRADE in most countries. It is rejected at a 10% level in all but five countries and a 5% level in all but 10 countries. The null hypothesis of a unit root in the measure of FIN is rejected in most countries but still not rejected in quite a few countries. It is rejected at a 10% level in 24 out of 39 countries and at a 5% level in 20 out of 39 countries.

Based on the unit root test results, the case where TRADE and FIN are stationary is considered first when performing the Granger causality test. However, given that the null hypothesis of a unit root is not rejected in some countries, the case where TRADE and FIN have a unit root is also considered. Table II-3 reports the results. Columns (1) and (2) show the results when TRADE and FIN, respectively, are assumed stationary. Columns (3) and (4) present the results when TRADE and FIN, respectively, are assumed to have a unit root, and the first differenced measures are used in the test. Columns (1) and (3) show the results for the Granger causality test from TRADE to FIN, meanwhile Columns (2) and (4) present the results for the Granger causality test from FIN to TRADE.

The null hypothesis that TRADE does not Granger-cause FIN is not rejected in most countries but still rejected in quite a few countries. Out of 39 countries, it is rejected in 11 and 12 countries at a 10% level in Columns (1) and (3), respectively. It is rejected at a 5% level in only 8 and 9 countries, respectively, in Columns (1) and (3). The test for the Granger causality from FIN to TRADE shows a mixed result. Out of 39 countries, it is rejected in 22 and 18 countries at a 10% level, respectively, in Columns (2) and (4), and 19 and 12 countries at a 5% level.

To summarize, the results vary across countries, showing a clear heterogeneity across countries in terms of the interactions between trade and financial integration. This result supports the modeling approach that explicitly considers full heterogeneity across countries, as discussed in Section 3.1.

Table II-2 Unit Root Test

Country	TRADE	FIN	Country	TRADE	FIN
United Kingdom	-4.1805***	-1.3794	Hungary	-2.0566**	-0.8745
Australia	-3.9999***	-3.3585***	India	-0.9079	-2.7958***
Austria	-2.854***	-0.4496	Israel	-1.9511**	-1.4219
Belgium	-4.0419***	-2.3821**	Italy	-3.4483***	-2.9756***
Bolivia	-0.983	-3.3922***	Kazakhstan	-1.8229*	-2.5119**
Brazil	-1.9707**	-1.9067*	Korea Rep.	-1.8196*	-3.0906***
Bulgaria	-3.7218***	-1.9532**	Netherlands	-3.8159***	-1.0927
Canada	-1.3072	-1.1284	New Zealand	-4.4316***	-3.7149***
Chile	-0.9298	-3.4335***	Peru	-1.2644	-1.4207
Colombia	-3.0775***	-1.3081	Poland	-3.477***	0.4297
Costa Rica	-2.5534**	-1.9417*	Portugal	-2.094**	-0.5993
Czech Republic	-1.8883*	-3.3892***	Romania	-2.9798***	-0.5468
Denmark	-2.6498***	-2.4422**	Slovenia	-2.6656***	-0.6693
Finland	-2.6423***	-2.8003***	Spain	-3.3409***	-1.5359
France	-3.3793***	-1.6653*	Sweden	-2.4163**	-1.0029
Georgia	-4.2267***	-2.0573**	Switzerland	-2.8398***	-2.6673***
Germany	-2.1012**	-2.2353**	Turkey	-2.9158***	-4.0875***
Greece	-1.7952*	-1.4472	Ukraine	-2.1644**	-1.7239*
Guatemala	-2.068**	-2.8379***	United States	-1.894*	-3.3295***
Honduras	-3.5907***	-2.7745***			

Note: The results from the Augmented Dickey–Fuller (ADF) unit root test. “***,” “**,” and “*” indicate statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Table II-3 Granger Causality Test

Country	(1) TRADE to FIN	(2) FIN to TRADE	(3) ΔTRADE to ΔFIN	(4) ΔFIN to ΔTRADE
United Kingdom	5.226	5.823	4.291	0.54
Australia	5.499	24.59***	7.703	24.744***
Austria	2.292	12.065**	2.151	12.766**
Belgium	2.463	2.292	1.899	1.245
Bolivia	8.572*	13.181**	5.777	15.693***
Brazil	10.19**	7.473	2.932	5.794
Bulgaria	7.469	14.669***	7.681	8.188*
Canada	4.732	14.418***	12.737**	19.73***
Chile	7.529	33.053***	3.552	37.835***
Colombia	3.499	3.782	3.957	7.754
Costa Rica	3.133	7.822*	3.401	7.928*
Czech Republic	6.105	5.371	5.136	5.369
Denmark	4.173	8.736*	3.556	9.287*
Finland	2.665	4.575	2.934	3.89
France	2.726	16.808***	2.407	16.579***
Georgia	14.795***	10.503**	9.793**	9.551**
Germany	5.544	3.898	7.829*	1.504
Greece	1.451	5.886	1.391	6.074
Guatemala	16.248***	12.983**	8.856*	13.263**
Honduras	4.433	13.18**	7.51	5.947
Hungary	4.077	4.504	2.803	1.169
India	8.292*	3.984	12.072**	1.91
Israel	2.281	4.352	2.503	15.766***
Italy	2.531	14.408***	4.249	5.226
Kazakhstan	9.082*	9.481*	6.915	4.218
Korea Rep.	11.683**	10.164**	15.096***	8.484*
Netherlands	4.163	4.68	2.585	3.652
New Zealand	5.325	24.543***	8.412*	24.106***
Peru	14.484***	15.583***	11.532**	13.747***
Poland	2.896	10.294**	2.076	7.141
Portugal	6.39	11.401**	2.782	9.114*
Romania	17.839***	9.698**	11.631**	3.366
Slovenia	7.776	5.806	12.431**	1.972
Spain	3.019	7.597	5.28	5.643
Sweden	5.161	5.985	2.819	6.59

Switzerland	2.763	5.032	4.486	4.65
Turkey	12.457**	10.627**	12.109**	8.12*
Ukraine	10.041**	2.966	12.281**	4.246
United States	5.486	14.014***	4.305	16.278***

Notes: "***," "**," and "*" indicate statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

3. Empirical Methodology

3.1 Heterogenous Panel VAR

This paper examines the relationship between trade and financial integration by using panel VAR models, which allow full heterogeneity across countries. VAR models are a useful methodology to investigate this issue for many reasons. First, dynamic feedback effects between two types of integration can be inferred from VAR models. The framework can provide the results on how changes in one type of integration affect changes in the other type of integration over time. Second, VAR models are relatively free of ad-hoc identifying assumptions so that data-oriented empirical results can be generated. In addition, full heterogeneity among countries is allowed because the relation between two types of integration can slightly differ across countries, as the result of the Granger causality test shows.

Assume that a country $i = 1, \dots, I$ is described by the following structural form equation:

$$\mathrm{G}(L)^i y_t^i = d^i + e_t^i \tag{II.2}$$

where $G(L)^i$ is a matrix polynomial in the lag operator L, y_t^i is an $m \times 1$ data vector, d^i is a $m \times 1$ constant vector, m is the number of variables in the model, and e_t^i denotes a vector of structural disturbances. By assuming that structural disturbances are mutually uncorrelated, $var(e_t^i)$ can be denoted by Λ^i, which is a diagonal matrix where diagonal elements are the variances of structural disturbances. Heterogeneity among countries is considered not only for the constant term (d^i) but also for all other parameters

$(G(L)^i)$.

Then, estimate the reduced form VAR:

$$y_t^i = c^i + \mathrm{B}(L)^i y_{t-1}^i + u_t^i \qquad \text{(II.3)}$$

where c^i is a $m \times 1$ constant vector, $\mathrm{B}(L)^i$ is a matrix polynomial in the lag operator L, and $var(u_t^i) = \Sigma^i$.

There are several ways of recovering the parameters in the structural form equation from the estimated parameters in the reduced form equation. The identification schemes under consideration impose recursive zero restrictions on contemporaneous structural parameters by applying Cholesky decomposition to the reduced form residuals, Λ^i, as in Sims (1980).

As suggested by Canova (2007, chapter 8) and Canova and Ciccarelli (2013), this paper estimates the model, computes the impulse response functions for each country, and averages them over the cross-section since T is relatively large in this case. Let α be the vector that collects the population mean parameters and α^i the same vector for the parameters of country $i = 1, \dots, I$. Let h_k be the impulse response function evaluated at horizon $k = 1, \dots, K$, a well-defined, continuous function of the parameters of the system.

Assume that:

$$h_k(\alpha^i) = h_k(\alpha) + \nu_{hk}^i \qquad \text{(II.4)}$$

where ν_{hk}^i, $i = 1, \dots, I$, $k = 1, \dots, K$ are *iid* $(0,\sigma_k^2)$. The average time series estimator (suggested by Canova (2007)) is computed as follows:

$$\hat{h}_k = \frac{1}{I}\sum_{i=1}^{I} h_k(\hat{\alpha}^i) \qquad \text{(II.5)}$$

An estimate of the variance-covariance matrix of the estimator is given by:

$$\hat{\Sigma}_{hk} = \frac{1}{I(I-1)}\sum_{i=1}^{I}(h_k(\hat{\alpha}^i) - \hat{h}_k)(h_k(\hat{\alpha}^i) - \hat{h}_k)' \qquad \text{(II.6)}$$

The cross-section is used to estimate the common or average effects by pooling the estimators of the impulse response functions.

An individual VAR is estimated for each country, and the impulse responses of each country are estimated with the Monte Carlo integration method, a Bayesian method, following RATS (2013). Then, based on the median of the impulse responses of each country, the average time series estimator and its standard error bands are calculated. Thus, the statistical inference is not affected by the presence of non-stationarity when following a Bayesian inference (see Sims, 1988; Sims and Uhlig, 1991).

3.2 Empirical Model

First, an empirical model is constructed as a simple two-variable model (Model 1) to infer the interactions between TRADE and FIN. The data vector, y_t^i , is {TRADE_t^i, FIN_t^i}. The model assumes that TRADE is contemporaneously exogenous to FIN. This identifying assumption relies on the timing of the data construction. TRADE is based on flow data for a given quarter, whereas FIN is based on the end-of-period stock data (i.e., assets and liabilities at the end of each quarter). This data property provides a natural identifying assumption on the contemporaneous relationship between these

two measures in a recursive VAR model.

Second, the model is extended to construct a six-variable model (Model 2). In addition to TRADE and FINANCE, four variables are considered to control economic activities and financial conditions that may affect trade and financial integration. The variables are the real gross domestic product (RGDP), consumer price index (CPI), policy interest rate (R), and exchange rate (ER, expressed as local currency per US dollar). Macroeconomic conditions captured by key macroeconomic variables, such as RGDP and CPI, likely affect trade and financial transactions. For example, a rise in domestic output can increase imports and increase the value of domestic assets and foreign liabilities. In addition, key financial variables, such as R and ER also likely affect trade and financial transactions. For example, an exchange rate depreciation increases exports and increase the value of foreign assets and liabilities denominated in foreign currencies.

For the six-variable model, the following identifying assumptions are used. (1) RGDP and CPI are contemporaneously exogenous to TRADE and FIN. (2) R and ER are contemporaneously exogenous to FIN. (3) RGDP, CPI, and TRADE are contemporaneously exogenous to R, ER, and FINANCE. First, Assumption (3) is the extension of the previous identifying assumption based on data construction timing. That is, the end-of-period data for R, ER, and FIN are used, but the period average data or flow data for a given quarter for RGDP, CPI, and TRADE. Second, Assumption (1) is assumed to control RGDP and CPI movements that are likely to affect TRADE and FINANCE contemporaneously. Lastly, Assumption (2) is assumed to control R and ER movements likely to affect FINANCE contemporaneously.

Both models include some exogenous variables, such as real GDP (USRGDP) and the Federal Funds Rate (USFFR) of the United States. These

U.S. (or world) variables are likely to affect each country's economic and financial relations with the rest of the world. Given that these U.S. variables are included as exogenous variables, U.S. is excluded from the sample countries when estimating the VAR models.

Following the Bayesian inference described above, the variables, such as RGDP, CPI, and exchange rates (ER), are used in the form of a level. A logarithm transformation is applied to these variables and then multiplied by 100. The integration measures—TRADE and FIN—are also multiplied by 100. More details on the variables and data sources are reported in Appendix II.1.[32] Four and two lags are included in the two- and six-variable models, respectively. A dummy variable to account for the GFC (Q3 2008–Q2 2009) is also included. In the six-variable model, some countries are excluded from the sample because their sample period is overly short, given that many parameters are needed to be estimated in the six-variable model.[33]

4. Results of Empirical Analysis

Figure II-3 shows the impulse responses with 90% probability bands. Each column of the graphs shows the impulse responses to each shock over 20 quarter horizons. The column and row headings indicate the name of the shock and responding variables, respectively. In the first column of the graphs, a positive TRADE shock increases FIN. The increase in FIN continues to

[32] All variables except for the financial variables, such as domestic interest rates, exchange rates, and the US Federal Funds rates, are seasonally adjusted.

[33] The countries with at least 60 quarters of time-series observations of each variable are considered. The excluded countries are Brazil, Bulgaria, Chile, Georgia, Honduras, India, Kazakhstan, Slovenia, Turkey, and Ukraine.

differ from zero with a 95% probability at all horizons. The size of the effects on FIN is also substantial. TRADE shocks increase TRADE by approximately 2.8% point on impact, then TRADE decreases back toward the initial level but remains above the initial level by approximately 0.5% point at 20 quarter horizons. In response to such TRADE shocks, FIN increases by 2.5% point on impact, and it is at a similar level even at 20 quarter horizons. This result suggests that trade integration is followed by financial integration, as found in past studies, such as Aizenman (2008) and Chambet and Gibson (2008). To summarize, the effect of trade integration on financial integration is positive and persistent, and the size of the effect is substantial.

In response to the positive FIN shock, TRADE falls for four quarters, and the negative effect significantly differs from zero with a 95% probability. However, from the fifth quarter after the shock, the effect is not significant. The point estimate shows a positive response from the eighth quarter after the shock but is insignificant. This result suggests that the medium- to long-run effects from financial integration to trade integration are uncertain. In addition, the size of FIN response is relatively small. In response to FIN shocks, FIN increases approximately by 13.5% point and remains above the initial level by approximately 5.44% point after five years. The maximum decrease of TRADE is approximately −0.40% point.[34] To summarize, the effect of financial integration on trade integration is negative in the short run, and the medium- and long-run effects are insignificant in this two-variable model.

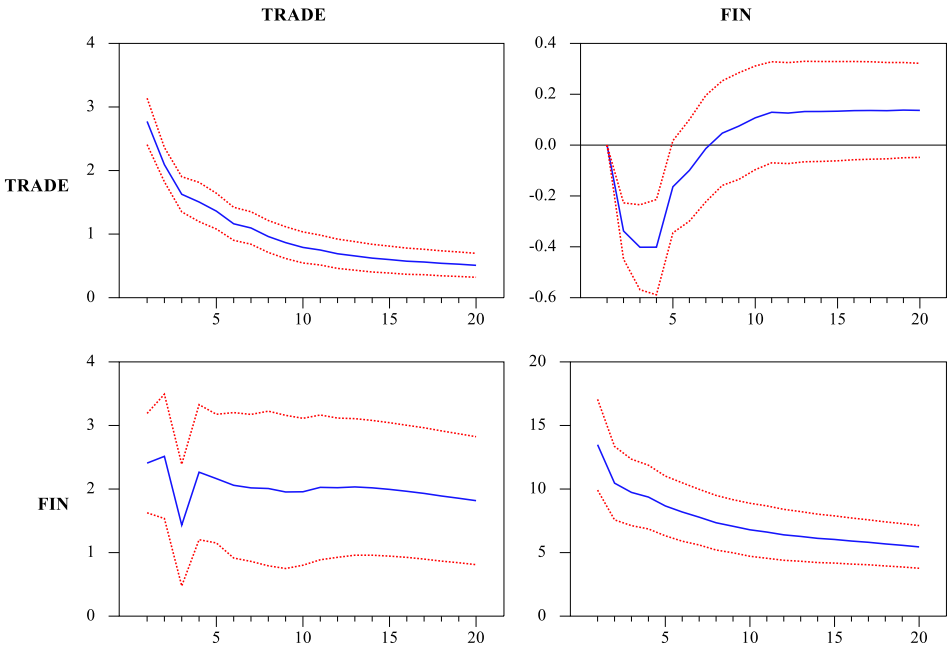
Figure II-4 reports the results from the six-variable model. Each column shows the impulse responses to each shock. Particularly, the third and

[34] The size of the change in TRADE is far smaller than the size of changes in FIN. However, the difference is smaller than that shown in those numbers because TRADE is smaller than FIN on average as reported in Table **II-1**.

sixth columns show the impulse responses to TRADE and FIN shocks, respectively. In response to TRADE shock, financial integration increases for 20 quarters, which differs from zero with a 95% probability at all horizons. This positive and persistent effect is similar to the result of the bivariate model. The size of FIN response, compared with TRADE changes, is smaller than that in the two-variable model but still substantial.

Meanwhile, after controlling relevant variables, some notable differences exist in the impulse responses of TRADE to FIN shocks. FIN shocks positively affect TRADE, which differs from the negative effect found in the two-variable model. Increases in TRADE from the fourth to the 13th quarters after the shock differs from zero with a 95% probability. This result is quite interesting. After controlling for relevant variables, the effects of financial integration on trade integration turn out to be positive. TRADE response peaks by 0.21% point increase in the sixth quarter and decreases back toward the initial level. In response to FIN shocks, FIN increases approximately by 11.39% point on impact and remains above the initial level by 2.71% point after five years.

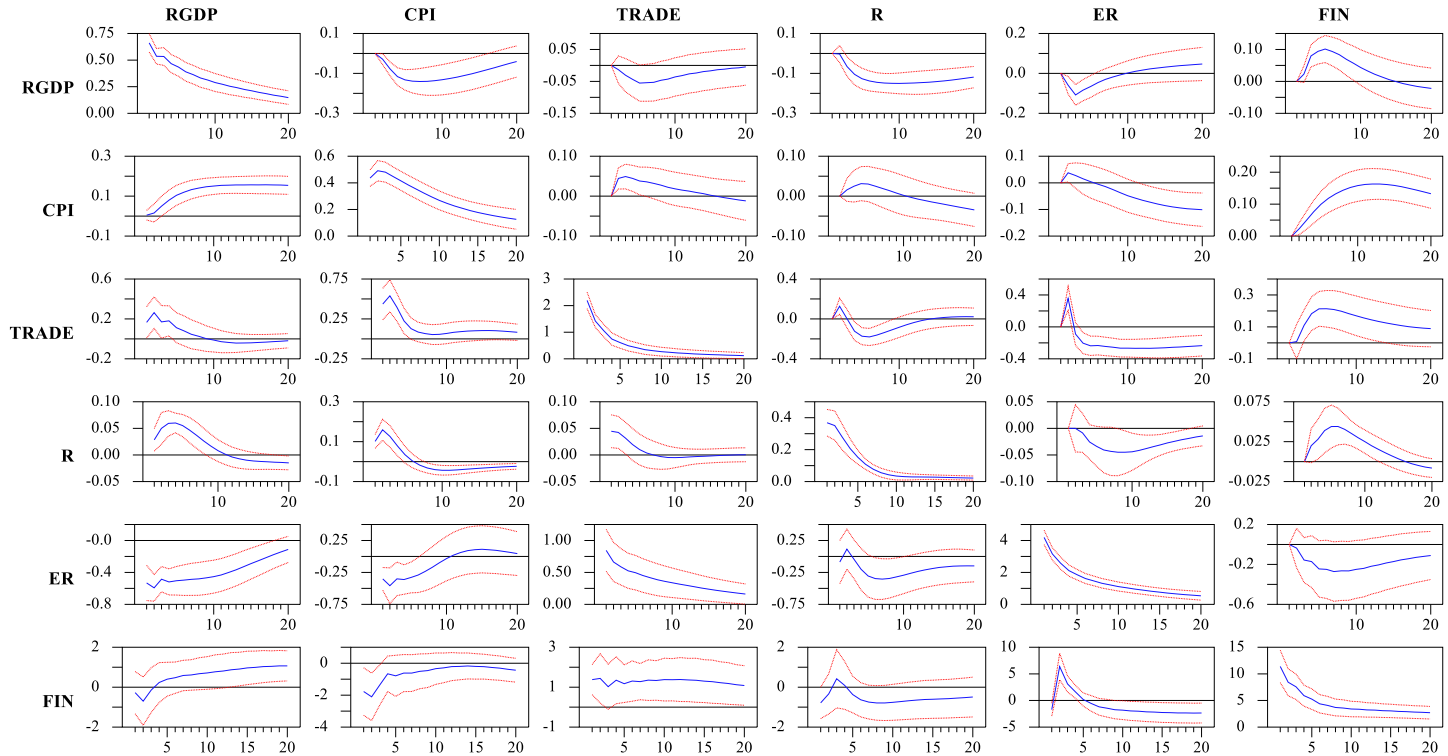
Figure II-3 Impulse Responses for the Heterogeneous Panel VAR: Model 1



TRADE = trade integration; FIN = financial integration.

Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

Figure II-4 Impulse Responses for the Heterogeneous Panel VAR: Model 2

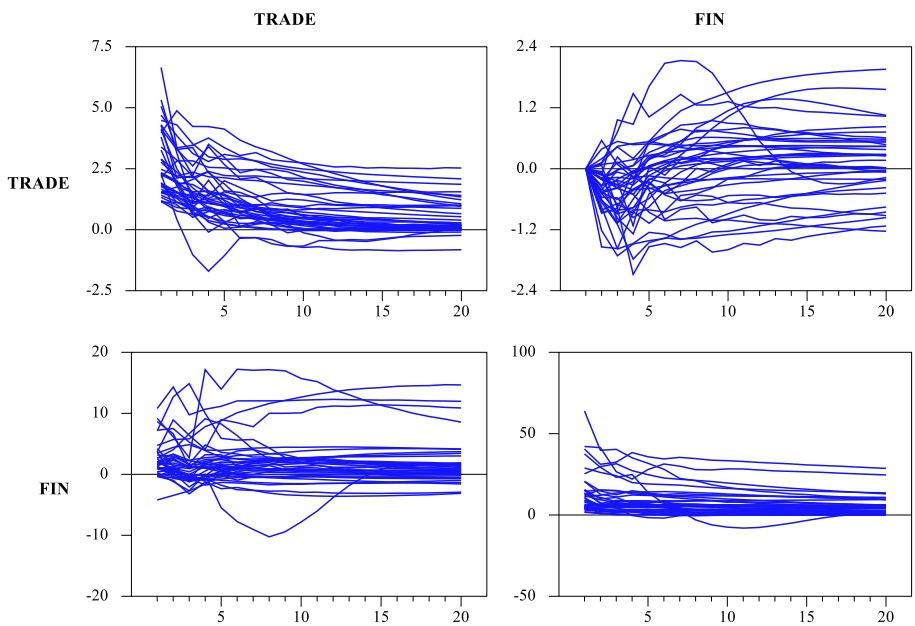


TRADE = trade integration; FIN = financial integration; RGDP = real gross domestic product; CPI = consumer price index; R = policy rate; ER = exchange rate.

Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

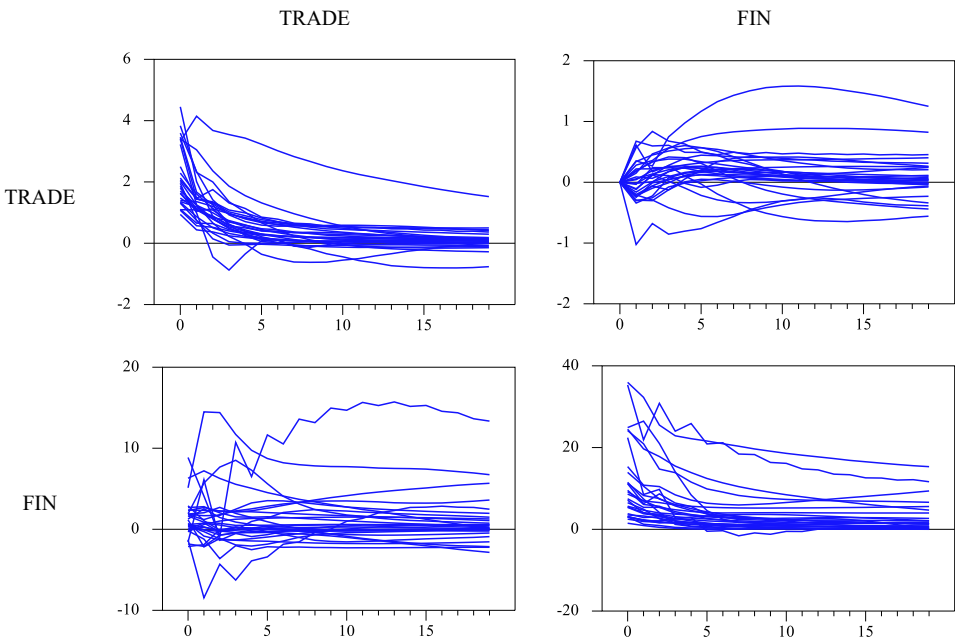
Figure II-5 and Figure II-6 show the results of individual countries for Models 1 and 2, respectively. The results confirm that individual heterogeneity is significant, which suggests that allowing heterogeneity in the panel VAR model is appropriate in this case. The responses of FIN to TRADE shocks are quite diverse across countries. In some cases, the response of FIN is negative. This paper finds an even larger heterogeneity in the responses of TRADE to FIN shocks.

Figure II-5 Impulse Responses of Individual Countries: Model 1



Notes: The solid line is the median of the impulse response of each country. Confidence bands are removed to avoid cluttering.

Figure II-6 Impulse Responses of Individual Countries: Model 2



Notes: The solid line is the median of the impulse response of each country. Confidence bands are removed to avoid cluttering.

5. Extended Experiments

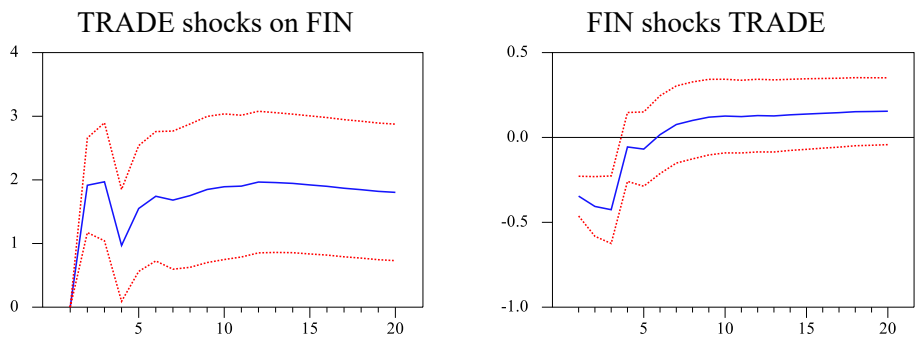
5.1 Alternative Identifying Assumptions

Based on the data construction timing of the integration measures, it is assumed that TRADE is contemporaneously exogenous to FIN in the baseline models. However, this section considers alternative orderings between the two integration measures by assuming that FIN is contemporaneously exogenous to TRADE. In this model, one-period lagged values of FIN are used. Through this, FIN at time *t* represents the value at the beginning of time *t*, and thus FIN is naturally contemporaneously exogenous to TRADE, which

is the flow data during period *t*.

Figure II-7 shows the results of the two-variable model. The main results remain unchanged. In response to TRADE shock, FIN increases after the shock, and its effect continue to differ from zero with a 95% probability at all horizons. In response to FIN shocks, TRADE falls significantly for three quarters and then increases above the initial level from the seventh quarter after the shock, although insignificant. The medium- and long-run effects from FIN shocks to TRADE is insignificant. These results are consistent with those of the baseline model.

Figure II-7 Impulse Responses in 2-Variable Model: Alternative Identifying Assumptions 1



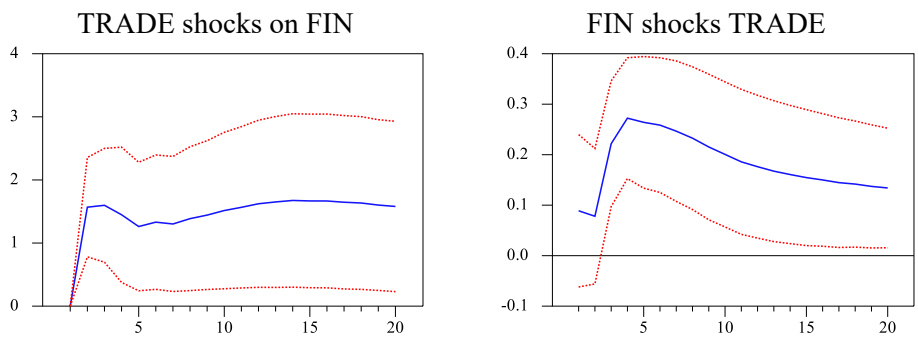
Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands. The one-period lagged values of FIN are used.

The six-variable model uses the following ordering: {R, ER, FIN, RGDP, CPI, TRADE} where contemporaneously exogenous one is ordered first. Given that the data for the policy rate (R) and exchange rate (ER) are end-of-period data, one-period lagged values of R and ER, in addition to FIN,

are used as their values at time *t*.

The main results are generally similar to those from the baseline model. As shown in Figure II-8, TRADE shocks significantly and positively affect FIN. The positive effect is extremely persistent. FIN shocks also significantly and positively affect TRADE.

Figure II-8 Impulse Responses in 6-Variable Model: Alternative Identifying Assumption 1



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands. The one-period lagged values of FIN are used.

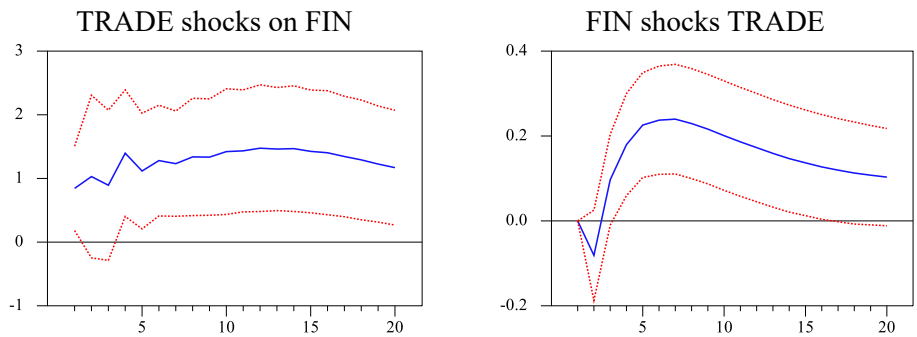
For the six-variable model, further alternative orderings among TRADE (or FIN) and control variables are considered. It is assumed that TRADE is contemporaneously exogenous to RGDP and CPI, and FIN is contemporaneously exogenous to R and ER from the baseline model. Figure II-9 reports the results, and the results are qualitatively similar.

Further experiments with all possible alternative orderings among six variables are investigated, the results are qualitatively similar.[35] In addition,

[35] The results are available from the authors upon request.

the generalized impulse responses (Pesaran and Shin, 1998) show the similar results (see Appendix II.4).

Figure II-9 Impulse Responses in 6-Variable Model: Alternative Identifying Assumptions 2



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

5.2 Two versus Six Variable Models

The baseline six-variable model uses a sample of only 28 countries because the data are not available for some countries. Thus, this section investigates whether the change in sample countries is the main reason for the different results on the effects of FIN on TRADE in two- and six-variable models. It is done so by estimating the two-variable model with a sample of only 28 countries.

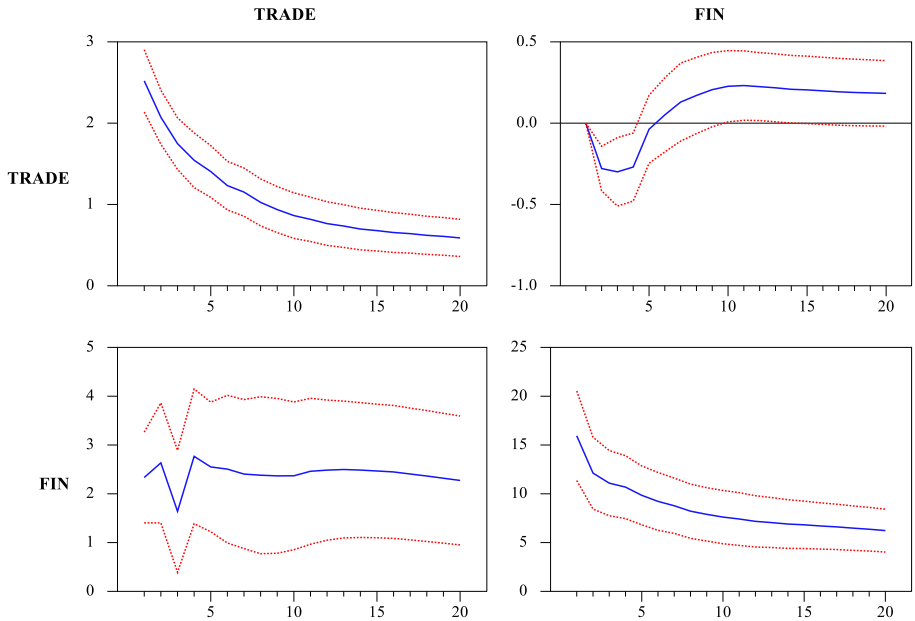
Figure II-10 reports the results. Compared with the baseline model with the whole sample countries, the effects of trade integration shocks to TRADE and FIN are qualitatively and quantitively similar. However, the effects of FIN shocks on TRADE slightly differ. TRADE decreases in the

short run but subsequently increases above the initial level. In the baseline model, the medium- and long-run increases are not significant at any horizon. Nonetheless, the positive effects from 10 quarters to 13 quarters are significant.

This result suggests that the positive effect of FIN shocks on TRADE found in the six-variable model may be partly due to the reduced country sample used in the six-variable model. However, for the reduced sample, the two-variable model still shows a short-run negative effect and significant positive effects at only a few horizons. Therefore, the strong positive effect of FIN shocks on TRADE found in the six-variable model is not entirely due to the reduced sample.

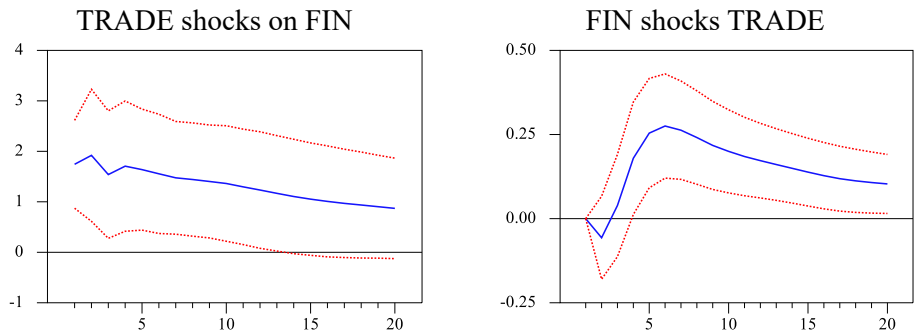
In addition, this section further explores which control variables are needed to have significant positive interactions between FIN and TRADE. Various combinations of the four control variables are examined, and it is found that RGDP, CPI, and ER are needed. Figure II-11 reports the results from the five-variable model that includes RGDP, CPI, and ER as control variables.

Figure II-10 Impulse Responses in 2-Variable Model: Reduced Sample Countries



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

Figure II-11 Impulse Responses: Combinations of Control Variables



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands. Since the sample period of the exchange rate is too short for some countries, this experiment includes 2 lags.

5.3 Sub-Sample Analysis

The increasing trend of trade and financial integration has decelerated since the GFC, as shown in Figure II-1 and Figure II-2. This suggests that a structural break likely existed around the GFC. In fact, there exists a break in trade and financial integration in Q3 2008 in most countries.[36] Therefore, this section re-analyzes the models for the pre- and post-GFC periods.

In the sub-period analysis, the null hypothesis of unit root is rejected in most countries but not all countries, as in the full period analysis. However, the rejection is more frequently found in the sub-periods, especially in post-GFC period. In addition, again, largely heterogeneous results from the Granger causality test between TRADE and FIN are found for pre- and post-GFC periods, supporting the empirical strategy that allows full heterogeneity. The results for unit root and Granger causality tests are reported in Appendix II.2).

Then, this section further investigates the six-variable model for the pre- and post-GFC periods.[37] The results are reported in Figure II-12 and Figure II-13, respectively. FIN responses to TRADE shocks are positive at all horizons in both periods, which is similar to the results for the whole sample period, although not significant at medium- and long-run horizons, which may be due to the small degree of freedom and low persistence of TRADE

[36] The Wald test is performed for a known break date, Q3 2008. The null hypothesis of no structural break in TRADE is not rejected in all countries except for Canada and Ukraine, and the null hypothesis of no structural break in FIN is not rejected in all countries except for Guatemala and Honduras.

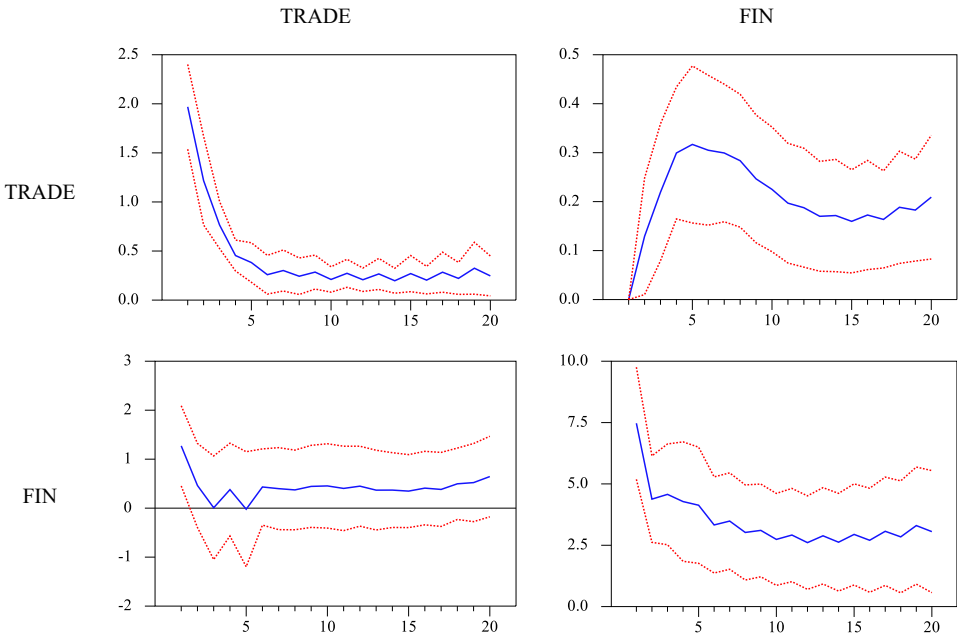
[37] The pre-GFC analysis includes only 17 countries, whereas the post-GFC analysis includes all 28 countries. However, the main results are extremely similar when considering only 17 countries in the pre-GFC analysis in the post-GFC analysis. All other specifications are the same as those in the baseline six-variable models.

shocks in the sub-period estimations.

The major difference in the sub-period analyses is that TRADE shows unclear and insignificant responses to FIN shocks in the post-GFC period, although positive and significant responses are found in the pre-GFC period. The results for the post-GFC period are shown in Figure II-13. These results imply that a structural difference exists in the dynamic interactions between trade and financial integration before and after the GFC, particularly regarding the responses of TRADE to FIN shocks.[38]

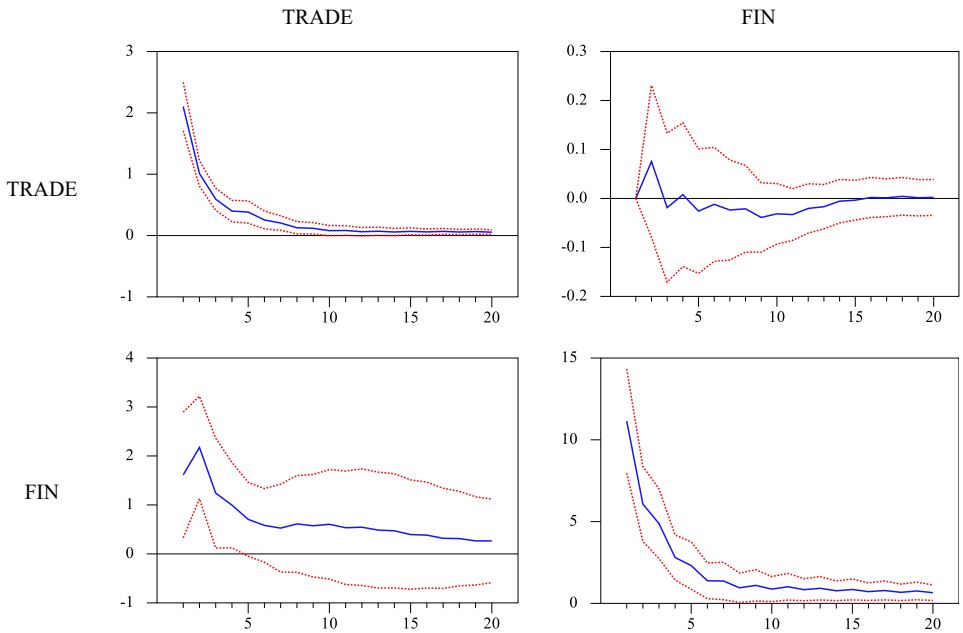
[38] The TRADE responses to FIN shocks also differ for two sub-periods in the two-variable model. TRADE responses to FIN shocks are insignificant and positive in the pre-GFC period, but they are significantly negative in the post-GFC period. FIN responses to TRADE shocks are positive in both sub-periods but more significant in the post-GFC period. The results are in Appendix II.2.

Figure II-12 Impulse Responses: Pre-GFC Period



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

Figure II-13 Impulse Responses: Post-GFC Period



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

5.4 Policies and Country Characteristics

The economic arrangements and policies are considered in this section because these factors can affect trade and financial integration. First, EU countries have special economic arrangements, thus the relations for EU countries may differ from others. In this regard, Euro area countries are excluded in the sample. When excluding EU countries, the results are qualitatively similar, although they are less significant, which is expected given that the number of sample countries decreases. The results are reported in the first row of Figure II-14.

Second, the degree of integration of a country with the rest of the world is likely influenced by its economic policies, such as trade and capital

control policies. To control for such effects, it is additionally included tariff rates and a measure of capital control policies as endogenous variables in the VAR model.[39] Data on tariff rates are obtained from the World Bank. The financial openness index constructed by Chinn and Ito (2006) is used. It is assumed that these policies are contemporaneously exogenous to all other variables in the model, considering policy implementation lags. The bottom panels in Figure II-14 show that the results are qualitatively similar.[40]

Major differences exist in the interactions between TRADE and FIN across the country groups. Generally, interactions between TRADE and FIN tend to be stronger in the economies with high TRADE, high FIN, high income, or positive current account level than those with low TRADE, low FIN, low income, or negative current account level. First, the effects of TRADE shocks on FIN tend to be stronger in countries with high TRADE or FIN than in those with low TRADE or FIN. This suggests that the positive effects of TRADE on FIN increase as TRADE or FIN increases, which is a non-linear relation. Second, the effects of FIN shocks on TRADE are positive and significant in countries with high TRADE or FIN but not significant in those with low TRADE or FIN. This may suggest that a threshold level exists for a significant positive effect. These two results may not be surprising. When the trade or financial integration is limited for some reasons, for

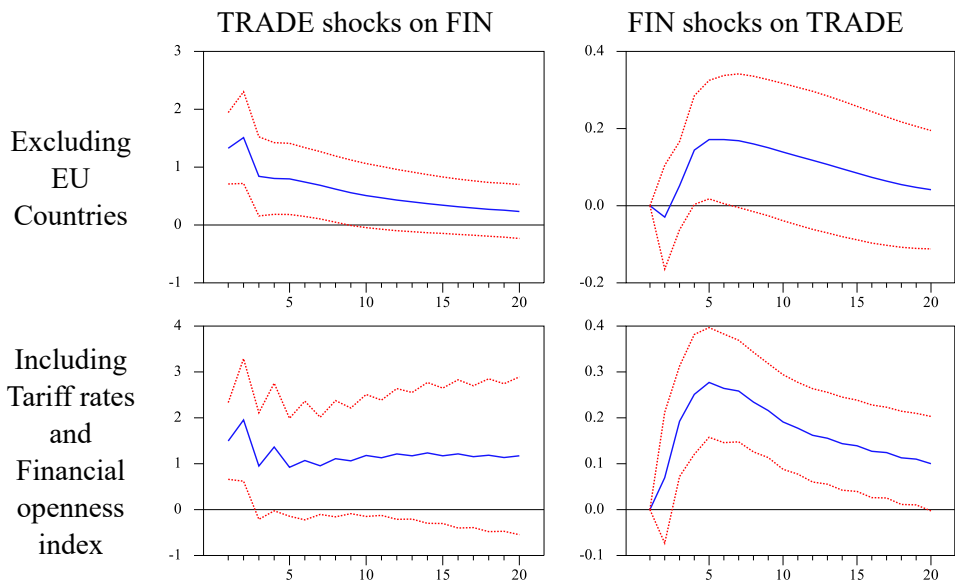
[39] The sample period of this experiment only covers Q1 1987 to Q4 2018 because the Chinn-Ito index is available only up to 2018. In addition, Costa Rica is dropped due to lack of tariff rates data, and thus 28 countries are included in the experiment.

[40] Beck et al. (2021) unveiled that trade openness shows minimal change after financial liberalization events identified as major changes in the Chinn-Ito index of *de jure* financial openness. This paper also finds that capital control policies proxied by the Chinn-Ito index insignificantly impact trade openness, consistent with Beck et al. (2021).

example, trade or financial restrictions thus changing the integration level for the same reasons may be difficult.

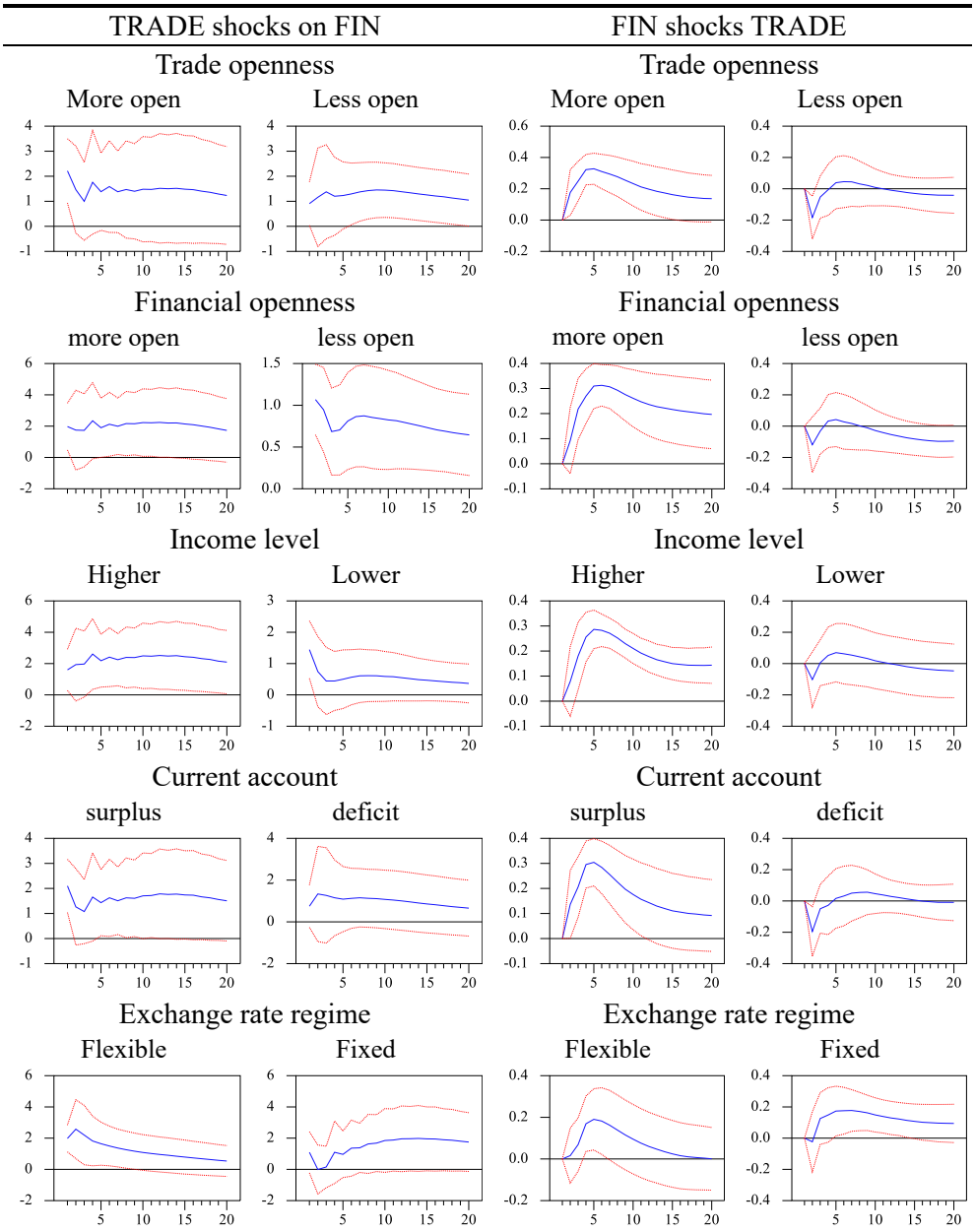
Third, the positive effects of one measure on the other are stronger in high-income countries than low-income countries. This may be related to the positive relationship between income level and trade or financial integration level. Fourth, the positive interactions are stronger in the countries with positive current account levels or flexible exchange rate regimes than those with negative current account levels or rigid exchange rate regimes.

Figure II-14 Impulse Responses: Considering Economic Arrangements and Policies



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

Figure II-15 Impulse Responses: Different Country Groups

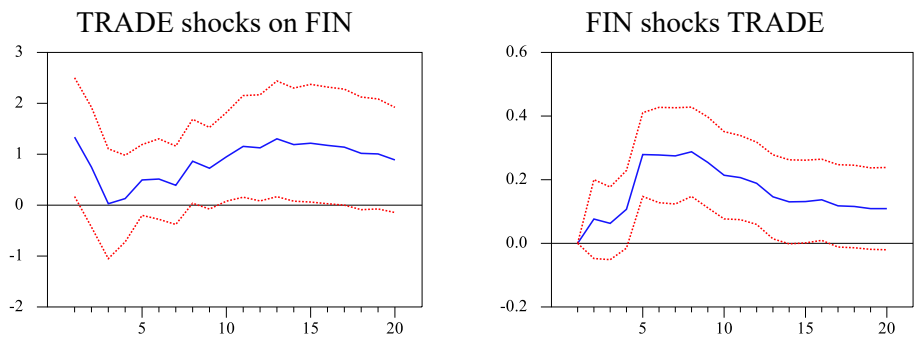


Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

5.5 Other Experiments

The baseline six-variable model includes two lags, but now includes four lags for the robustness check. Figure II-16 shows the impulse responses for a six-variable model with four lags. The main results are generally similar to those of the baseline six-variable model, although the probability bands widen as the degree of freedom is reduced.

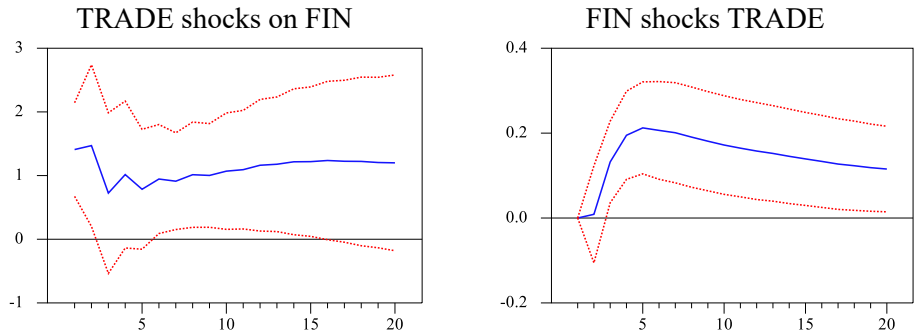
Figure II-16 Impulse Responses: 6-Variable Model Including 4 Lags



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

This section further considers the dummies for the country- and region-specific crises and for the U.S.-China trade war (from the third quarter of 2018) and the dummy for GFC. The main results are generally similar to the baseline results, as shown in Figure II-17, but responses of FIN to TRADE shocks are relatively less significant.

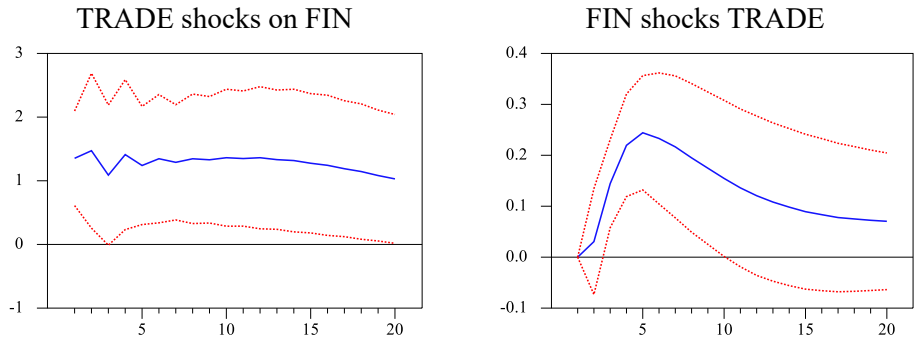
Figure II-17 Impulse Responses: 6-Variable Model Including Various Dummies



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

The real exchange rate is used instead of the nominal exchange rate in Figure II-18. The main results are similar to those of the baseline model.

Figure II-18 Impulse Responses: Real Exchange Rate instead of Nominal Exchange Rate

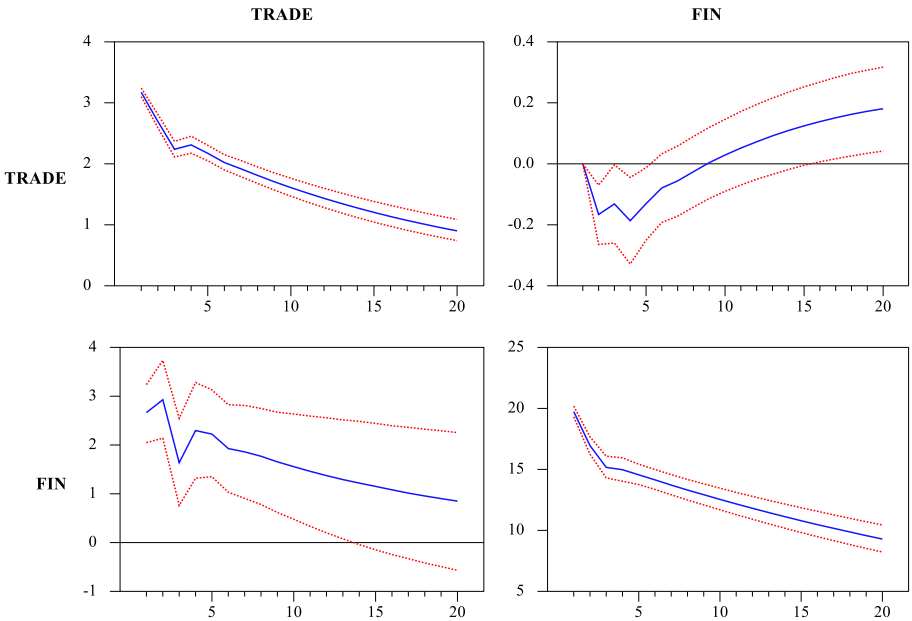


Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

Lastly, additional experiments pool the data and estimate the panel VAR with individual fixed effects. All other specifications are the same as the baseline models.

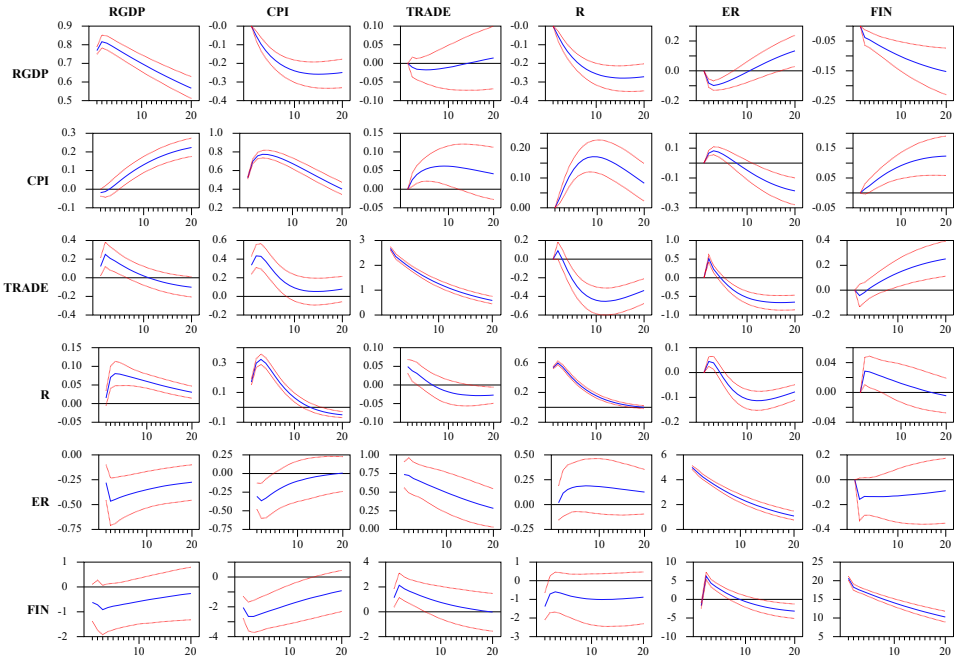
Figure II-19 and Figure II-20 show the impulse responses with 90% probability bands for the two- and six-variable models, respectively. Some results are similar to those of baseline models, but others are not. The positive effects of TRADE shocks on FIN in this model are less persistent than those in the baseline model. Meanwhile, the positive effects of FIN shocks on TRADE in this model are far stronger than those in the baseline model, especially in the long run. This suggests that the results can be misleading if not properly account for cross-country heterogeneity.

Figure II-19 Impulse Responses for Panel VAR with Country Fixed Effect: Model 1



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

Figure II-20 Impulse Responses for Panel VAR with Country Fixed Effect: Model 2



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

6. Concluding Remarks

The incessant momentum of postwar economic globalization has decelerated since the global financial crisis. Particularly, trade globalization, as measured by trade relative to GDP, has not only slowed down but gone into reverse. The COVID-19 pandemic, which painfully revealed the sizable downside risks of trade globalization, is likely to intensify the momentum of trade deglobalization.

Intuitively, there exist good reasons to suspect that trade globalization

and financial globalization may affect each other. Some empirical literature has emerged to examine the relationship between the two types of globalization. Given the prospect of post-COVID-19 deglobalization, re-visiting the relationship now is most opportune.

Specifically, this paper estimated the dynamic interactions between trade and financial integration using the panel VAR models that allow heterogeneity among individual countries. As the individual Granger causality tests and the individual country VAR estimations showed, the interactions between trade and financial integrations were not homogenous across countries. Thus, this paper relaxed the homogeneity assumption and employed the heterogeneous panel VAR. Tackling heterogeneity across countries while providing a clear general conclusion is an original contribution of this paper to the literature.

The most consistent finding is that trade integration positively and persistently affects financial integration, and the size of the effect is quite substantial. This result is highly robust to the various specifications of the empirical models. In addition, this paper found that financial integration positively affects trade integration. This result is obtained after controlling for key macro and financial variables that likely affect the two types of integration measures. These positive feedback between two channels are reported in some past studies. It is further found that the positive effect of financial integration to trade integration disappeared after GFC, which was not unveiled in past studies only using the pre-GFC samples.

The central result of the empirical analysis—the positive effect of trade integration on financial integration—has provided some important implications for financial integration in the post-COVID-19 era. If the COVID-19 shock does accelerate trade deglobalization, the evidence oof this

paper implies that financial globalization will be adversely affected. However, the world will not necessarily experience financial de-globalization because other countervailing forces promote the financial globalization process. For example, the ongoing financial opening up and liberalization of China, the world's second-biggest economy, will be a significant driver of financial globalization. Moreover, financial globalization can be accelerated through FinTech and information technology developments, which have been highly favored during the COVID-19. Ultimately, financial globalization may help decelerate the de-globalization of trade after COVID-19 given the positive effect of financial integration on trade integration.

Appendixes

Appendix II.1. Data Descriptions and Sources

The variables used in the heterogeneous panel VAR estimation are described below. The data that are not seasonally adjusted by the data provider are seasonally adjusted using X-12 ARIMA, except for the financial variables, such as R, USFFR, and ER.

Table A II-1 Data Descriptions and Sources

Variable Name	Description	Source
RGDP	Real Gross Domestic Product, constant 2010 US$ millions	World Bank
CPI	Consumer Price Index, 2010=100	World Bank
R	Policy Rate, end of period,%	IFS, CEIC
ER	Exchange Rate, local currency per US$	IFS, CEIC
GDP	Nominal Gross Domestic Product, current US$ millions	World Bank
TRADE	Exports: CA: Goods and Services: Credit, US$ millions Imports: CA: Goods and Services: Debit, US$ millions	BOP
FIN	Assets: IIP: Assets (with Fund Record), US$ millions Liabilities: IIP: Liabilities, US$ millions	IIP
USRGDP	US Real Gross Domestic Product, constant 2010 US$ millions	FRED
USFFR	Effective Federal Funds Rate, average of period,%	FRED

Appendix II.2. Subperiod Analysis: Pre- and Post-GFC

Table A II-2 Unit Root Test: Pre- and Post-GFC

Country	Pre-GFC		Post-GFC	
	TRADE	FIN	TRADE	FIN
United Kingdom	-3.3321***	1.2147	-1.8831*	-1.8678*
Australia	-2.4811**	-3.4437***	-3.2888***	-2.4073**
Austria	-2.0666**	-1.8634*	-3.502***	-2.5067**
Belgium	-	-	-2.769***	-3.0222***
Bolivia	-1.0033	-2.625**	-1.5152	-2.5297**
Brazil	-1.7259*	-1.7716*	-5.7643***	-2.8057***
Bulgaria	-	-	-1.9227*	-1.506
Canada	-0.7005	-1.7787*	-1.6939*	-2.724***
Chile	-	-	-5.2427***	-3.386***
Colombia	-3.6885***	-1.2603	-2.7299***	-2.6773***
Costa Rica	-2.9275***	-1.5312	-7.3907***	-4.0883***
Czech Republic	-2.5342**	-3.0173***	-0.9201	-3.2263***
Denmark	-1.6962*	-3.5007***	-3.304***	-2.8524***
Finland	-2.11**	-2.8467***	-3.3856***	-2.4037**
France	-2.7699***	-3.0204***	-3.2674***	-5.4926***
Georgia	-5.0561***	-3.1242***	-4.0594***	-1.8004*
Germany	-1.1528	-6.5142***	-5.21***	-2.5202**
Greece	-1.8138*	-1.5721	-3.6934***	-2.7219***
Guatemala	-	-	-2.9184***	-3.1735***
Honduras	-	-	-4.8659***	-3.341***
Hungary	-1.8615*	-0.8927	-2.2308**	-4.3655***
India	-	-	-3.5181***	-2.6163***
Israel	-2.9788***	-2.7817***	-3.1163***	-3.5627***
Italy	-2.517**	-3.2946***	-3.2627***	-4.6243***
Kazakhstan	-3.4095***	-1.8896*	-2.8761***	-2.1087**
Korea Rep.	-2.4196**	-1.7089*	-4.7739***	-3.6286***
Netherlands	-2.6675***	-2.5868**	-1.7796*	-0.7823
New Zealand	-1.9937**	-2.3928**	-3.3789***	-3.2842***
Peru	0.4774	-2.0439**	-4.201***	-1.8253*
Poland	-4.0825***	-4.4003***	-2.8875***	-1.7069*
Portugal	-1.2311	-3.9998***	-3.4981***	-3.5915***
Romania	-2.4312**	-2.6431***	-6.0738***	-5.3716***
Slovenia	-1.9789**	-2.1268**	-4.7307***	-1.9271*
Spain	-2.6141***	-2.6937***	-1.8148*	-6.2744***

Sweden	-1.8215*	-2.8739***	-3.6185***	-5.4739***
Switzerland	-1.8063*	-1.7535*	-3.1764***	-2.9108***
Turkey	-	-	-2.6432***	-3.9618***
Ukraine	-2.8842***	-0.2633	-1.1532	-1.7408*
United States	-	-	-2.9883***	-3.7128***

Note: The results from the Augmented Dickey-Fuller (ADF) unit root test, where "***," "**," and "*" indicate statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

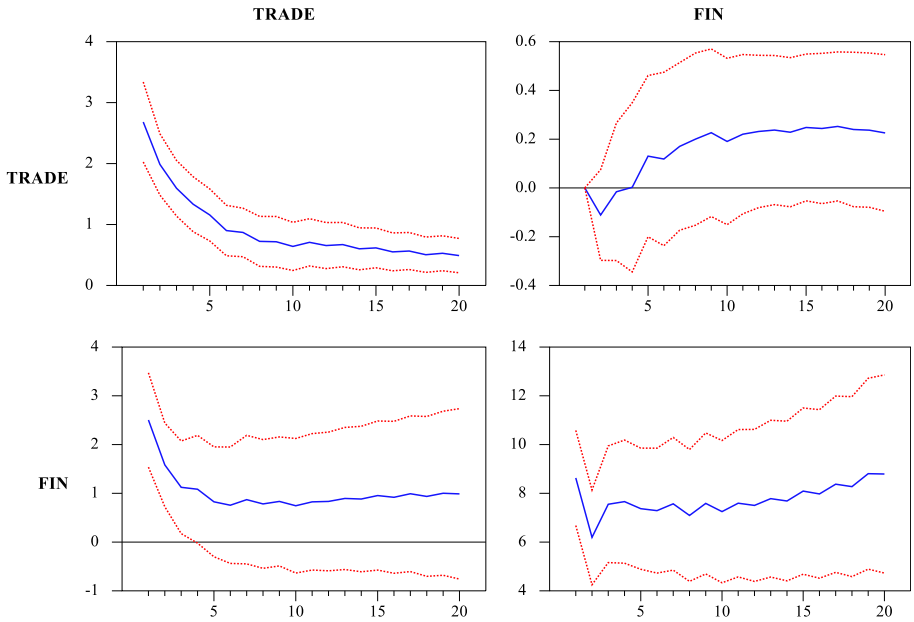
Table A II-3 Granger-Causality Test: Pre- and Post-GFC

Country	Pre-GFC		Post-GFC		Pre-GFC		Post-GFC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
United Kingdom	13.541***	8.185*	5.681	0.639	15.116***	7.043	4.813	3.171
Australia	2.3	8.053*	4.767	11.445**	2.545	5.468	9.926**	13.23**
Austria	9.173*	16.782***	10.445**	4.411	10.189**	11.513**	7.117	8.29*
Belgium	-	-	4.629	5.062	-	-	3.094	4.994
Bolivia	13.75***	7.722	13.191**	2.625	5.535	4.624	2.292	5.514
Brazil	12.124**	11.69**	7.116	2.738	3.435	4.034	4.995	2.157
Bulgaria	-	-	5.511	5.377	-	-	3.897	8.115*
Canada	0.839	8.317*	8.883*	12.122**	5.764	10.355**	6.317	13.623***
Chile	-	-	2.136	31.622***	-	-	2.663	25.137***
Colombia	13.741***	4.832	4.618	2.521	5.655	3.75	7.512	7.121
Costa Rica	11.873**	18.323***	12.057**	5.412	-	-	8.319*	6.041
Czech Republic	5.276	2.525	2.504	9.742**	3.082	4.395	3.303	6.476
Denmark	13.334**	42.845***	1.576	5.068	-	-	3.508	3.77
Finland	5.195	13.422***	1.444	1.447	4.199	12.116**	1.236	1.592
France	2.208	4.883	5.186	3.876	1.185	6.205	1.046	5.393
Georgia	7.73	3.084	12.765**	12.576**	8.437*	4.814	10.553**	9.566**
Germany	5.125	13.167**	8.699*	2.498	8.553*	6.926	6.514	2.027
Greece	15.326***	22.511***	2.015	4.536	8.076*	13.881***	0.283	6.359

Guatemala	-	-	9.007*	14.3***	-	-	5.221	3.486
Honduras	-	-	5.426	13.658***	-	-	7.127	7.45
Hungary	1.174	4.329	2.593	7.237	0.87	4.489	4.133	2.056
India	-	-	18.785***	7.105	-	-	12.543**	5.596
Israel	6.357	16.188***	9.07*	2.866	4.992	10.435**	3.801	6.1
Italy	9.328*	10.566**	4.164	8.08*	9.419*	5.899	1.149	6.505
Kazakhstan	13.337**	3.925	23.012***	2.556	12.245**	6.085	10.012**	0.41
Korea Rep.	4.037	7.966*	5.425	9.914**	5.332	3.188	11.175**	5.219
Netherlands	5.655	16.664***	3.326	6.833	7.375	16.676***	2.005	4.33
New Zealand	8.00*	3.017	4.973	20.9***	8.274*	2.811	9.43*	22.48***
Peru	11.664**	14.163***	20.022***	7.061	3.706	14.065***	23.551***	2.531
Poland	10.792**	0.128	6.145	12.069**	14.851***	5.095	2.906	5.581
Portugal	4.651	5.858	5.908	4.247	5.947	3.765	1.099	5.193
Romania	9.146*	6.589	12.424**	10.709**	4.633	3.197	6.895	2.729
Slovenia	7.974*	4.634	10.814**	9.313*	8.291*	3.313	7.468	5
Spain	2.617	2.939	11.698**	3.054	2.32	1.952	10.296**	2.739
Sweden	6.03	3.421	1.955	6.076	6.854	3.186	1.929	5.355
Switzerland	2.472	9.43*	2.355	3.618	2.792	3.181	4.598	2.916
Turkey	-	-	13.687***	3.046	-	-	11.838**	7.131
Ukraine	6.468	3.386	6.483	0.343	1.914	5.156	9.551**	1.994
United States	-	-	5.982	14.979***	-	-	5.263	7.619

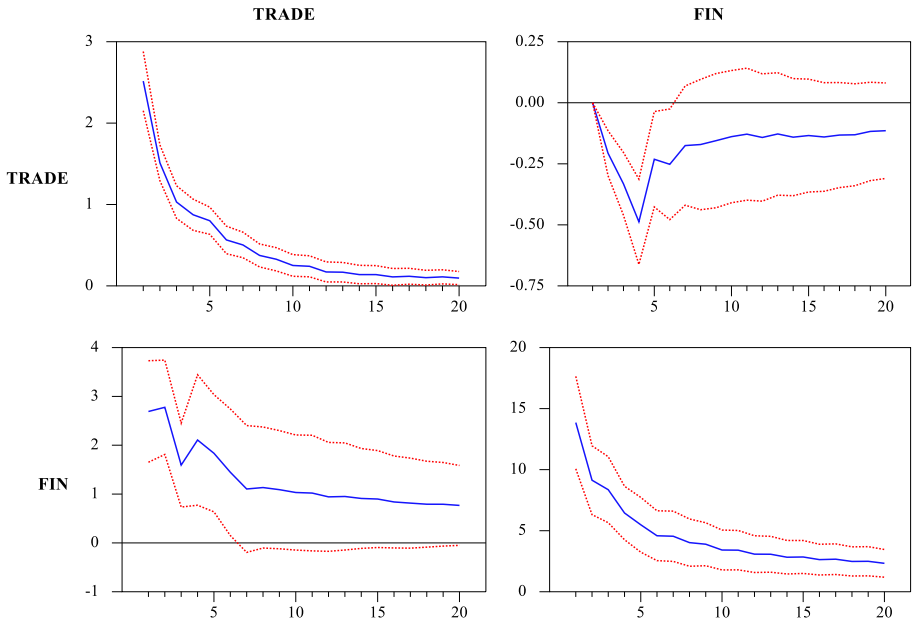
Notes: 1) Columns (1) and (2) report the Granger-causality from TRADE to FIN and from FIN to TRADE, respectively, for the pre-GFC period. Columns (3) and (4) report the results for the post-GFC period. Similarly, Columns (5) to (8) report the results of the tests using first-differenced measures, ΔTRADE and ΔFIN; 2) Note: "***," "**," and "*" indicate statistical significance at the 0.01, 0.05, and 0.1 levels, respectively.

Figure A II-1 Impulse Responses in Two-Variable Mode: Pre-GFC



Notes: The solid lines refer to the mean group estimates and the dotted lines show 90% probability bands.

Figure A II-2 Impulse Responses in Six-Variable Model: Post-GFC



Notes: The solid lines refer to the mean group estimates and the dotted lines show 90% probability bands.

Appendix II.3. List of Countries by Groups

More trade open: Austria, Belgium, Costa Rica, Czech Republic, Denmark, Germany, Hungary, Korea Rep., Netherlands, Poland, Portugal, Romania, Sweden, Switzerland

Less trade open: Australia, Bolivia, Canada, Colombia, Finland, France, Greece, Guatemala, Israel, Italy, New Zealand, Peru, Spain, United Kingdom

Financially more open: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Hungary, Netherlands, Portugal, Spain, Sweden, Switzerland, United Kingdom

Financially less open: Australia, Bolivia, Canada, Colombia, Costa Rica, Czech Republic, Guatemala, Israel, Italy, Korea Rep., New Zealand, Peru, Poland, Romania

Flexible exchange rate regime: Canada, Colombia, Czech Republic, Guatemala, Hungary, Israel, Korea Rep., New Zealand, Peru, Poland, Romania, Sweden, Switzerland, United Kingdom

Fixed exchange rate regime: Australia, Austria, Belgium, Bolivia, Costa Rica, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain

Higher income: Australia, Austria, Belgium, Canada, France, Germany, Italy, Korea Rep., Netherlands, Poland, Spain, Sweden, Switzerland, United Kingdom

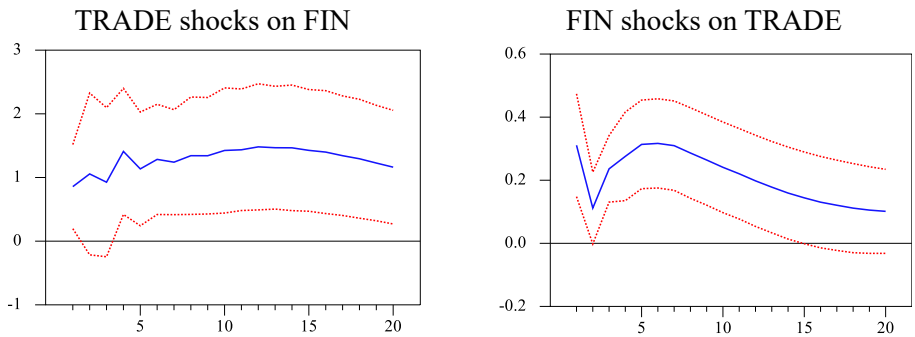
Lower income: Bolivia, Colombia, Costa Rica, Czech Republic, Denmark, Finland, Greece, Guatemala, Hungary, Israel, New Zealand, Peru, Portugal, Romania

Current account surplus: Austria, Belgium, Canada, Czech Republic, Denmark, Finland, Germany, Hungary, Italy, Korea Rep., Netherlands, New Zealand, Peru, Poland, Sweden, Switzerland

Current account deficit: Australia, Bolivia, Colombia, Costa Rica, France, Greece, Guatemala, Israel, Portugal, Romania, Spain, United Kingdom

Appendix II.4. Generalized Impulse Response for Six-Variable Model

Figure A II-3 Generalized Impulse Responses



Notes: The solid lines refer to the mean group estimates, and the dotted lines show 90% probability bands.

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Abstract in Korean

거시건전성 정책과 세계화에 관한 연구: 이질성을 고려하여

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본 논문은 두 개의 독립적인 연구로 구성되어 있다. 첫 번째 장에서는 거시건전성 정책, 특히 LTV (주택담보대출비율)과 DTI (총부채상환비율) 규제가 주택가격 및 거시경제 전반에 미치는 효과를 실증 분석한다. 두 번째 장에서는 무역 세계화와 금융 세계화 간의 동태적인 상호작용에 대해 분석한다.

첫 번째 장은 이질성을 허용한 패널 VAR 모델을 추정하여 거시건전성 정책, 특히 LTV와 DTI 규제가 부동산 가격 및 거시경제에 미치는 효과를 분석한다. 부호제약 접근법을 이용하여 통화정책과 거시건전성 정책 충격을 식별하였다. 거시건전성 정책 충격은 통화정책 충격보다 주택담보대출과 주택가격에 더 빠르고 실질적인 영향을 미치는 것을 확인하였다. 또한, 거시건전성 정책 충격은 생산과 물가에도 유의미한 영향을 미쳤다. 이러한 거시경제적 효과는 통화정책과 유사하였으나 효과의 크기는 통화정책보다 작은 것을 확인하였다. 또한, 거시경제적 효과는 LTV 및 DTI 규제가 가계의 차입제약에 구속력을 가지며 주택담보대출

이 즉각적으로 감소한다고 가정할 때 더 강하게 나타났다.

두 번째 장은 무역 세계화와 금융 세계화의 관계를 실증 분석한다. 무역 및 금융 세계화는 전후에 빠르게 성장하였다. 하지만 글로벌 금융 위기 이후 무역 세계화가 둔화하였으며, Covid-19 이후 더욱 둔화할 가능성이 있다. 이에 따라 무역 탈세계화가 금융 탈세계화로 이어질 것인가는 중요한 이슈라고 할 수 있다. 본 연구는 개별 국가 간 이질성을 허용한 패널 VAR 모형을 분석함으로써 무역 세계화와 금융 세계화 간의 동태적인 상호작용을 추정한다. 무역 세계화는 금융 세계화에 긍정적인 영향을 미치는 것을 확인하였으며, 이러한 결과는 다양한 실증분석에서 강건한 것으로 나타났다. 또한, 금융 세계화는 무역 세계화에 긍정적인 영향을 미치는 것으로 나타났으나, 이러한 긍정적인 영향은 글로벌 금융 위기 이후에 유의하지 않았다. 본 연구의 결과는 지속적인 무역 탈세계화가 향후 금융 세계화에 부정적인 영향을 미칠 수 있음을 시사한다.

주 제 어 : 거시건전성 정책, 주택담보대출비율, 총부채상환비율, 부호 제약, 무역 세계화, 금융 세계화, 이질성, 패널 VAR

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