Finance, Growth, and Inequality: New Evidence from the Panel VAR Perspective

Hyeok Jeong and Soyoung Kim

This study analyzes the relationship among financial development, economic growth, and income inequality using cross-country panel VAR models. Most theoretical models state that these variables interact with one another and generate feedback dynamics. Under the presence of such interactive dynamics, single-equation regression analysis cannot capture the genuine relationship among finance, growth, and inequality. We use the panel VAR models to reflect these interactive feedback dynamics. Our estimation results suggest that the real GDP per capita decreases in response to financial deepening shock in private credit or liquid liability but increases to stock market capitalization shock. The effects of financial deepening on inequality are only weakly positive and short-lived. Positive income shock tends to increase inequality but this effect is not robust to financial deepening measures. However, inequality is harmful for growth controlling for every financial deepening measure.

Keywords: Economic growth, Inequality, Finance, Dynamic interactions, Panel VAR

JEL Classification: O11, O47, E44, D31

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I. Introduction

Long-standing debates exist on the empirical relationship between economic growth and inequality. Since Kuznets (1955) suggested an inverted-U shaped empirical relationship between economic growth and inequality among the industrialized economies of his age, various studies followed to establish the genuine relationship between economic growth and inequality. However, empirical evidence in this regard is discordant in the literature. For example, the canonical studies of Alesina and Rodrik (1994), Alesina and Perotti (1996), and Benabou (1996) indicated that a negative relationship exists between growth and inequality, in which high inequality causes low growth. Forbes (2000) overturned these findings by showing that the relationship between growth and inequality turns to be positive when controlling country-specific fixed effects. In view of the treating measurement error problems using the 3SLS, Barro (2000) showed that no relationship exists for the overall sample but the relationship is negative among poor countries whereas positive among rich countries. By contrast, considering the potential nonlinear relationship between inequality and growth using non-parametric methods, Banerjee and Duflo (2003) claimed that the changing rate, not the level, has an inverted-U shaped relationship between growth and inequality. That is, any changes in inequality, either in increasing or decreasing direction, will lower growth. Economic growth and inequality are two key determinants of social welfare, and the reliable identification of the relationship between the two phenomena is crucial in understanding the evolution of social welfare. Hence, the unsettling series of reversal about the empirical relationship between economic growth and inequality are rather of great concern.

A common feature of the aforementioned set of empirical studies is that although they address various types of identification issue, they rely on *single-equation methods*. However, most theoretical models about growth and inequality state that the two phenomena interact with each other through various possible channels and generate interactive feedback dynamics.

Applying a comprehensive structural general equilibrium model to all countries of the world may be infeasible; thus, the reduced-form approach seems to be inevitable in handling cross-country data in characterizing such complex issue of the relationship between

growth and inequality. However, most structural models show that the interactive evolution between growth and inequality is the genuine nature of their relationship. That is, all types of single-equation methods, such as simple OLS methods, instrumental variable methods (controlling endogeneity issues), or non-parametric methods (allowing arbitrary nonlinear relationship), do not seem to estimate the genuine relationship between growth and inequality properly because these methods cannot capture the *interactive feedback dynamics*. From this perspective, we propose the use of a *panel VAR model* to capture such interactive feedback dynamics. This way, our paper sheds new light on identifying the relationship between economic growth and inequality.

Various channels may link growth and inequality. One of the most frequently discussed channels is finance, which is the focus of the present study. A vast set of empirical works have attempted to establish the relationship between finance and economic growth, such as that of King and Levine (1993). Levine (2005) provided an extensive survey of the literature on the positive relationship between finance and growth at aggregate, industry, and firm levels. These findings seem intuitive because the nature of finance is about expanding the set of available state-contingent claims to improve the efficiency of resource allocation, particularly in terms of risks, as well as intertemporal trades. Diamond and Dybvig (1983) and Greenwood and Jovanovic (1990) established canonical theoretical models for the positive association between finance and growth. However, a set of recent evidence and counter-arguments show the negative relationship between finance and growth, such as the "too much finance" literature by Arcand *et al.* (2015) and Cecchetti and Kharroubi (2012, 2015), who showed that further deepening of financial sector lowers growth and increases economic instability after some critical point level of financial development. However, Cline (2015) questioned the validity of these findings and claimed that the empirical works of these too-much-finance studies do not fully consider endogeneity issues.

Demirgüç-Kunt and Levine (2009) provided a survey of works seeking the empirical evidence on the relationship between finance and inequality. Beck *et al.* (2007) highlighted the distributional effects of finance among the poor. Park and Shin (2017) emphasized the non-monotonicity of the effects of financial development on inequality in cross-country data. Specifically, they showed that financial development decreases inequality during the initial stage of development but

increases inequality after some critical point of development. They also revealed that the positive effects of reducing inequality from financial development seem more pronounced when the primary-to-overall schooling ratio and the indicator of law and order increase.

The existing two sets of literature previously described, that is, the one that seeks the relationship between finance and growth and the other that seeks the relationship between finance and growth, share a common feature: both rely on single-equation regression methods.

Structural models for general equilibrium frameworks show that growth and inequality are linked through financial development and that their relationship co-evolves over time possibly in a complicated way. Such canonical examples are illustrated by Greenwood and Jovanovic (1990), Gine and Townsend (2004), Townsend and Ueda (2006), and Jeong and Townsend (2007, 2008). This group of theoretical models postulate some constraints in the financial sector. Therefore, although financial development and economic growth are closely related, the distributional effects of these financial and real development are complicated. Inequality may rise during the initial stage of development, which may eventually decline as Kuznets postulated, although the underlying mechanisms are different between the two groups of literature.

The aforementioned theoretical works suggest the need for an empirical model, in which dynamic interactions among growth, inequality, and finance are allowed to be estimated in a system, to understand the relationship among them. The panel VAR model is useful in achieving this goal because it estimates the entire system of current and lagged interactions among the concerned variables. This way, the simultaneity and feedback responses across the variables can be captured. Based on the above motivation, we use the panel VAR model to seek the relationship between growth and inequality via the link of finance, which will bring a new set of evidence to the three strands of empirical literature of "growth and inequality," "finance and growth," and "finance and inequality."

The remainder of this paper consists as follows. Section II explains the data. Section III describes the panel VAR methodology and model specification. Section IV reports the estimation results from the baseline models using impulse response functions and presents a robustness analysis by varying identification assumptions, substituting the measures of financial deepening, and controlling other development

indicators. Section V shows the extended experiments. Finally, Section V concludes the paper.

II. Data

We use the real GDP per capita in constant 2005 US dollar from the World Development Indicator (WDI) for our income measure in logarithmic value (denoted by "Y").

The compatible measurement of the time-series of cross-country distributional indices is difficult because the "welfare variables" of which the background surveys measure inequality vary across countries. Welfare measures can be concepts of income or consumption variables. Among income variables, the range of income coverage differs. Occasionally, income may exclude or include tax, transfers, and monetary income. That is, the underlying contents of inequality can be different across countries. Thus, we attempt to measure the inequality indices consistently for a given country over time and focus on analyzing their changes.

Despite the above difficulties, the Standardized World Income Inequality Database (SWIID) provides a panel of distributional indices (as comparable as possible), such as Gini coefficient and top 1% income share, covering 174 countries for the 1960–2013 period. SWIID provides the Gini coefficients of market and disposable incomes. In this study, we focus on the distributional responses to financial or real shocks of the economy rather than the redistribution aspects. Thus, we use the Gini coefficient of market income from SWIID for our inequality index (denoted by "GINI").[1]

The most common variable for macroeconomic financial depth is the ratio of private credit to GDP (denoted by "CR"), which will be our benchmark measure of financial deepening. We also consider two other typical measures of financial deepening, namely, the ratios of liquid liability to GDP (denoted by "LL") and of stock market capitalization to GDP (denoted by "ST").[2] All three financial deepening measures are

[1] We thank Kwanho Shin for sharing the inequality data from SWIID, which were used by Park and Shin (2017). Hence, the comparison of our results with their regression analysis using the same data source will be meaningful.

[2] Data on ratios of liquid liability to GDP and stock market capitalization to GDP are used for the periods of 1961–2011 and 1989–2011, respectively.

TABLE 1
SUMMARY STATISTICS

Variable	#Obs.	Mean	Std. Dev.	Min.	Max.
Y	8,069	7.94	16.2	3.9	12.0
Gini (%)	4,505	38.2	10.9	15.4	80.4
CR (%)	7,096	37.0	35.4	0.2	31.1
LL (%)	5,852	47.4	38.6	0.25	399.1
ST (%)	1,972	48.1	57.2	0.01	569.5
OPEN (%)	7,670	77.7	49.6	0.31	562.1
GOV (%)	7,338	16.0	7.7	1.4	164.7
HTEX (%)	3,077	9.7	12.4	0.0	87.4

Note: Each variable indicates the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; CR: Private credit-to-GDP ratio; LL: Liquid liability-to-GDP ratio; ST: Stock market capitalization-to-GDP ratio; OPEN: Ratio of total trade (exports + imports) to GDP; GOV: Government expenditure share of GDP; and HTEX: Share of manufactured high-technology exports (products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery).

from the Global Financial Development Database collected by the World Bank.

In our robustness analysis, we consider each of the following development indicators as a control variable in our panel VAR estimation: (i) trade openness, measured by the ratio of total value of trade (exports + imports) to GDP (denoted by "OPEN"); (ii) government expenditure share of GDP (denoted by "GOV"); and (iii) share of manufactured high-technology exports (denoted by "HTEX").[3] These development indicators are obtained from the WDI database.[4]

Table 1 provides the summary statistics of the above variables used in this study.

[3] High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments and electrical machinery.

[4] The data on trade openness, government expenditure share of GDP, and share of manufactured high-technology exports are available for the periods of 1960–2010, 1960–2010, and 1988–2010, respectively.

III. Empirical Modeling of Panel VAR

A. Panel VAR Methodology

We examine the dynamic and interactive relationship among financial development, economic growth, and income inequality using panel VAR models. These models provide us with a useful empirical methodology to investigate the issue for the following reasons. First, dynamic effects can be inferred from VAR models. VAR models can capture the effects of the changes of income and inequality over time as influenced by the financial shock. Thus, we can characterize the relationships between finance and growth and between finance and inequality via dynamic responses. Second, as long as the identification permits, any structure of interactions among financial development, inequality, and economic growth can be allowed in the models. Previous studies of single-equation empirical models did not consider such interactions among the variables. For example, although financial development may affect inequality, changes in inequality may also affect the status of financial development. Furthermore, the effects from financial development to inequality and those from inequality to financial development do not need to be the same in VAR models. Similar arguments apply to the relationships between financial development and economic growth and between growth and inequality, which control the financial deepening effects. Third, VAR models are relatively free of ad hoc identifying assumptions; thus, data-oriented empirical results can be provided.

We develop a panel VAR model instead of constructing a VAR model for each country because for cross-country data, a VAR model for each country will suffer from the degree-of-freedom problem.

Assume that an economy, indexed by i ($i = 1, \ldots, N$), is described by the following structural-form equation:

$$G(L)y_t^i = d^i + e_t^i, \tag{1}$$

where $G(L)$ is a matrix polynomial in the lag operator L; y_t^i is an $m \times 1$ data vector of the variables of interests; d^i is an $m \times 1$ constant matrix, where m is the number of variables of the model; and e_t^i denotes a vector of structural disturbances. By assuming that structural disturbances are mutually uncorrelated, we denote the variance matrix of the disturbance vector var(e_t^i) by Λ, which is a diagonal matrix where

the diagonal elements of the matrix are the variances of the individual structural disturbances. The constant vector d^i is introduced to control the country-specific fixed effects.

We can convert the above structural equation into the following reduced-form panel VAR with the country-specific fixed effects, such that

$$y_t^i = c^i + B(L)y_{t-1}^i + u_t^i, \tag{2}$$

where c_t and c^i are $m \times 1$ constant matrices, $B(L)$ is a matrix polynomial in the lag operator L, and $\text{var}(u_t^i) = \sum$. We pool the cross-country data and estimate this panel VAR model.

Several approaches can be used to recover 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, as performed by Sims (1980). Our statistical inference is unaffected by the presence of non-stationarity because we follow a Bayesian inference (see Sims (1988) and Sims and Uhlig (1991)).[5]

B. Empirical Model Specification

We consider a panel VAR model with three log variables, namely, real GDP per capita, Gini coefficient of market income, and private credit-to-GDP ratio, as our benchmark model in identifying the relationship among finance, growth, and inequality. That is, the data vector of the panel VAR y_t^i is [Y, GINI, CR], where Y is the log of real GDP per capita, GINI is the Gini coefficient of market income, and CR is the domestic private credit-to-GDP ratio. For this model, annual data for the period of 1960–2012 is used.

We assume a recursive structure on the contemporaneous relationship among the three variables for our panel VAR model. The order of the benchmark model from the most contemporaneously exogenous is [Y, GINI, CR]. Financial variable CR is likely to respond contemporaneously to real variables, such as Y and GINI; however, real variables are

[5] Specifically, we generate the standard error bands based on a Bayesian method, as described in the RATS Manual.

likely to respond sluggishly to financial variables. Therefore, we assume that Y and GINI are contemporaneously exogenous to CR. Such an assumption is used in past studies (Kim 1999; Sims and Zha 2006).

The order between Y and GINI is not evident. However, innovations in Y and in GINI have extremely low correlation in all the considered models in this study. Therefore, order between Y and GINI does not change the results considerably. The following argument provides a rationale for this robustness result. Despite the presence of correlation between income inequality and economic growth over time, they are not likely to affect each other immediately because the linking channels between growth and inequality involve the dynamic dimensions such as savings or investment decisions, the medium- or long-term responses of institutional changes, and political economic factors.

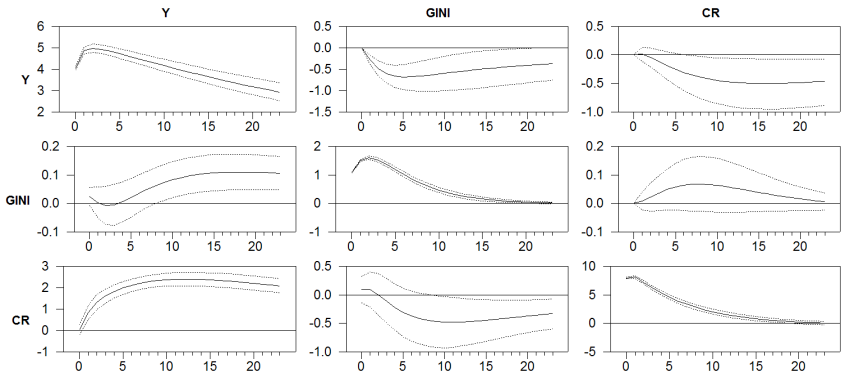
In this study, we explore the robustness of our results by varying this identification assumption on ordering, showing that the identifying assumption on the order of the variables does not affect the results considerably.

IV. Estimation Results

A. Benchmark Model Estimation Results

Figure 1 shows the impulse responses over 24 years, with 95% probability bands for the benchmark panel VAR model. The order of the variables of the benchmark model from the most contemporaneously exogenous variable is [Y, GINI, CR]. Figure 1 consists of 3×3 matrix of impulse response functions. The variable name for each column at the top indicates each shock, and that for each row at the left indicates the response variable. For example, the impulse response function at CR column and GINI row shows the response path of GINI to the one standard deviation increase of the CR shock. The rest of the impulse response figures are also organized as such.

In response to CR shocks, CR sharply increases but decreases over time and goes back to the initial level in about 24 years. In response to such a CR shock, GINI increases persistently but with a wide probability band. With the same CR shock, real GDP per capita decreases persistently and significantly (the decline after 10 years is different from zero with more than 95% probability). These results suggest that financial deepening measured by the private credit-to-GDP ratio has a



Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.
2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; and CR: Private credit-to-GDP ratio.
3. Dotted lines denote 90% probability bands.

FIGURE 1
IMPULSE RESPONSES OF THE BENCHMARK MODEL

significant *negative* effect on economic growth, which seems unclear. Financial deepening does not improve but weakly increases inequality.

In response to an inequality shock, GINI increases sharply on impact, further increases for the next few years, and then decreases back to the initial level in 24 years. In response to such inequality shock, both CR and Y decrease significantly. The decrease in CR is different from zero with 95% probability after 10 years. The decrease in Y for three to thirteen years after the shocks is also different from zero with 95% probability. These results suggest that an increase in income inequality has a negative effect on economic growth and financial development, which is consistent with the results of the conventional literature rather than the new literature following Forbes (2000).

In response to an income shock, income increases initially, further increases for the next few years, decreases over time, and remains larger than the half of the peak responses after 24 years. That is, the income shock is more persistent than the CR or inequality shocks. In response to such income shock, GINI increases persistently, although a short span of insignificant decrease in inequality is observed. The increase in GINI is different from zero after 10 years with 95% probability.

CR also increases persistently. The increase in CR is different from zero only after a year with 95% probability, and the level of CR remains near the peak after 24 years. These results suggest that economic growth positively affects financial deepening but negatively affects income inequality. The negative effect of income shock on inequality suggests that the transitory growth comes from the sources that tend to increase in inequality. For example, the short-term positive investment shocks increase income but may worsen inequality, along with the expansion of credit demand.

In view of the literature on the empirical relationship between growth and inequality via the channel of finance, the above results suggest that financial deepening measured by aggregate private credit (normalized by GDP) contributes neither to promoting growth nor to reducing inequality, considering the interactive dynamics among the three variables. At surface level, this finding seems to be more consistent with the new literature concerning the relationship between finance and growth, that is, the "too-much-finance" literature.

However, at the same time, financial deepening responds positively to the income shock, and this effect is extremely strong, as observed in the Y-column–CR-row impulse response function. That is, the association between income and financial deepening is positive. This asymmetry between the CR–Y and Y–CR responses suggests that the relation between CR and Y can change depending on the original source of shocks. The empirical studies that have discovered the positive and negative correlation between financial depth and income level might be based on the association on income and financial shocks, respectively. That is, such findings from both groups of literature may be obtained from the single-equation regression approach. Our panel VAR model reveals such possibility.

The nature of innovation in VAR depends on measured variables. If we measure the financial depth by the private credit-to-GDP ratio and the measured "private credit" reflects the demand side rather than the supply side of the financial sector, then our finding of the asymmetry between the CR–Y and Y–CR responses is reasonable. Moreover, the demand for private credit increases with the positive income shock. Furthermore, if the disturbance component of the private credit-to-GDP ratio reflecting the innovation or shock of the variable may reflect the business cycle of the economy, then the "financial shock" measured by the GDP-normalized private credit may generate the decline of income.

The asymmetric responses between a pair of variables from the panel VAR model seem to reveal a deep level of understanding on the genuine relationship among the variables of interest when dynamic interactions exist among them.

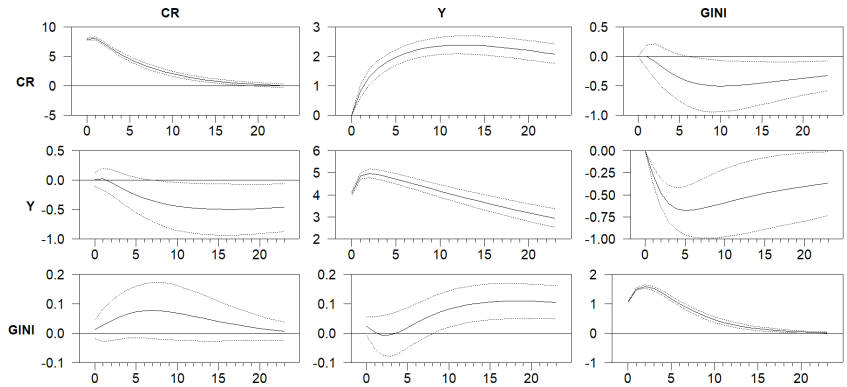
We found that the GINI response to CR shock is weakly positive and that the CR response to GINI shock is negative. This finding may suggest that the negative correlation between financial deepening and inequality from the previous regression analysis is based on inequality shock rather than financial shock. By contrast, the positive correlation between financial deepening and inequality is due to financial shock. Given the genuine nonlinearity of inequality dynamics in response to either real or financial development, drawing definite inferences from these asymmetric responses is difficult. Canonical theories in the literature, such as that of Greenwood and Jovanovic (1990), clarify that inequality may first rise and then fall during the co-evolution of financial and real development.[6] Nevertheless, we can suggest that the causal direction may change depending on the sources of shock. The negative correlation between finance and inequality seems to be based on inequality shock not on financial shock. Then, perhaps the correct causal direction from finance to inequality is weakly positive. Whether this finding is counterintuitive from the theoretical perspective depends on whether the GDP-normalized private credit is a right measure of finance being consistent with the theories on finance and inequality. Our panel VAR model does not address this issue.

In the following subsections, we check if the previous findings are robust (i) to the identification assumption on the order of contemporaneously exogenous variables, (ii) to the measurement of aggregate financial development, and (iii) to the controls of other development indicators.

B. Alternative Identifying Assumptions

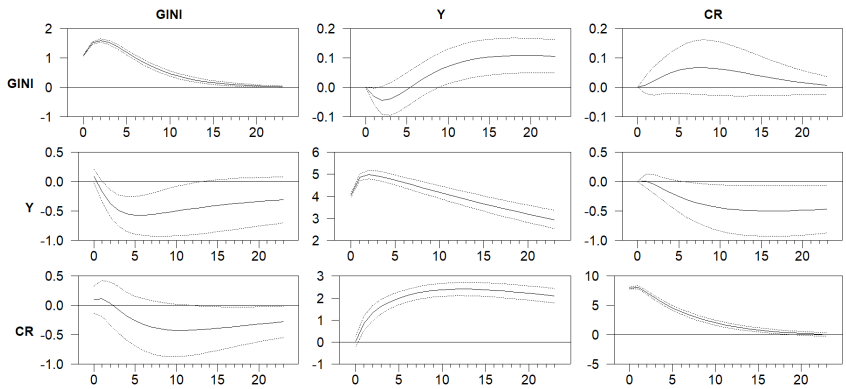
Here, we consider the alternative identifying assumptions. We experiment on the various combinations of ordering assumption and found that the results of the benchmark model remain similar. The order of the benchmark model is [Y, GINI, CR], where Y and GINI as

[6] Jeong (2008) and Jeong and Townsend (2008) showed such nonlinear dynamics of inequality using micro financial data from Thailand.



Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.
2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; and CR: Private credit-to-GDP ratio.
3. Dotted lines denote 90% probability bands.

FIGURE 2
IMPULSE RESPONSES FROM ALTERNATIVE ORDER OF [CR, Y, GINI]



Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.
2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; and CR: Private credit-to-GDP ratio.
3. Dotted lines denote 90% probability bands.

FIGURE 3
IMPULSE RESPONSES FROM ALTERNATIVE ORDER OF [GINI, Y, CR]

contemporaneously exogenous to CR. This study primarily aims to explore the relationships between finance and growth and between finance and inequality. Thus, the most critical order variation is to assume CR as contemporaneously exogenous to Y and GINI, that is, [CR, Y, GINI], to check the robustness under the opposite assumption on contemporaneous relation. We also consider the model of [GINI, Y, CR], where GINI is assumed to be contemporaneously exogenous to Y, which is different from the benchmark model.

Figures 2 and 3 show the impulse responses for the models of [CR, Y, GINI] and [GINI, Y, CR], respectively. The results of these models are similar to those of the benchmark model.

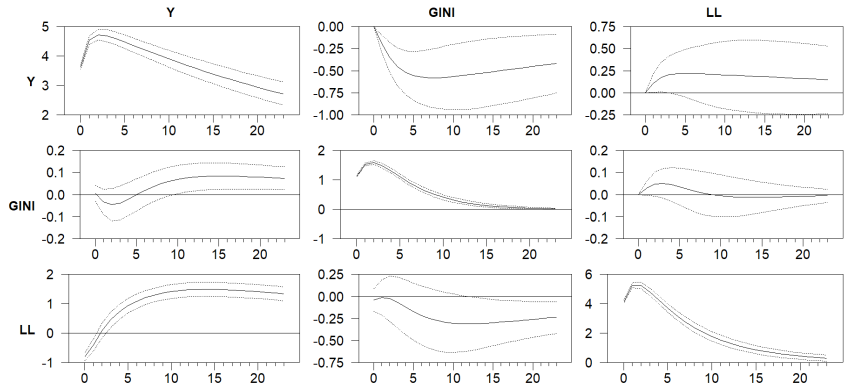
C. Alternative Measures of Aggregate Financial Deepening

Two other typical measures of aggregate financial deepening are ratios of liquid liability to GDP (LL) and stock market capitalization to GDP (ST).[7] Figures 4 and 5 show the impulse responses, replacing the private credit-to-GDP ratio with LL and ST variables as the financial depth measure, respectively. Figure 4 suggests that the impulse responses using the liquid liability-to-GDP ratio as a financial depth measure are virtually the same with those of the benchmark model; however, the LL shock does not reduce the income as the CR shock did.

The impulse responses look considerably different from those of the benchmark model when the stock market capitalization-to-GDP ratio is used as a financial depth measure. Figure 5 shows that the increase in the ST shock significantly increases income, unlike the CR shock. The initial rise of inequality from the ST shock becomes more pronounced than that from the CR shock. Conversely, the increase of financial depth measured by ST from the income shock is more pronounced but less sustaining compared with the CR case, although the positive association between financial depth and growth from the income shock is common between the ST and CR variables. Furthermore, the decrease in financial depth from the inequality shock, which occurs in the case of using CR variable, disappears when using the ST variable.

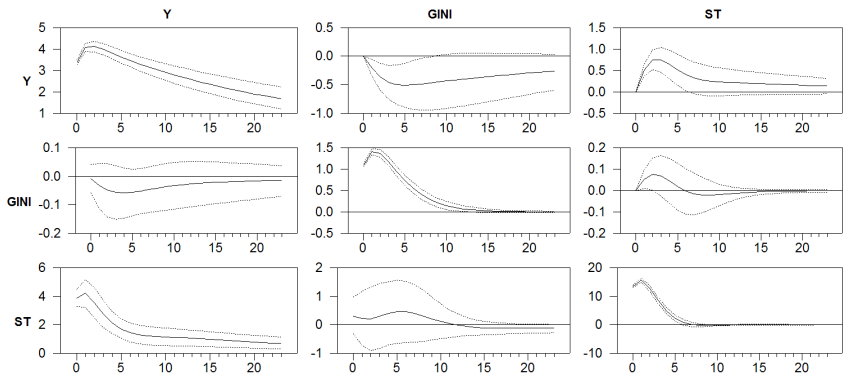
The most striking difference between CR and ST variables is that the ST shock promotes growth. This difference indicates that the innovation

[7] Data on the ratios of liquid liability to GDP and stock market capitalization to GDP are used for the periods of 1961–2011 and 1989–2011, respectively.



Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.
2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; and LL: Liquid liability-to-GDP ratio.
3. Dotted lines denote 90% probability bands.

FIGURE 4
IMPULSE RESPONSES USING LL



Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.
2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; and ST: Stock market capitalization-to-GDP ratio.
3. Dotted lines denote 90% probability bands.

FIGURE 5
IMPULSE RESPONSES USING ST

of ST variable may reflect the supply-side aspects of the economy, whereas the CR variable captures the demand-side aspects. This interpretation seems plausible because the stock market capitalization reflects the real valuation of the listed firms. Furthermore, this finding is consistent with that of Reisen and Soto (2001), who provided evidence that the foreign direct investment and portfolio equity investment have positive effects on growth, whereas the short- and long-term bank lendings affect growth negatively for developing countries. The importance of this issue for financial globalization was also addressed by Kose *et al.* (2009).

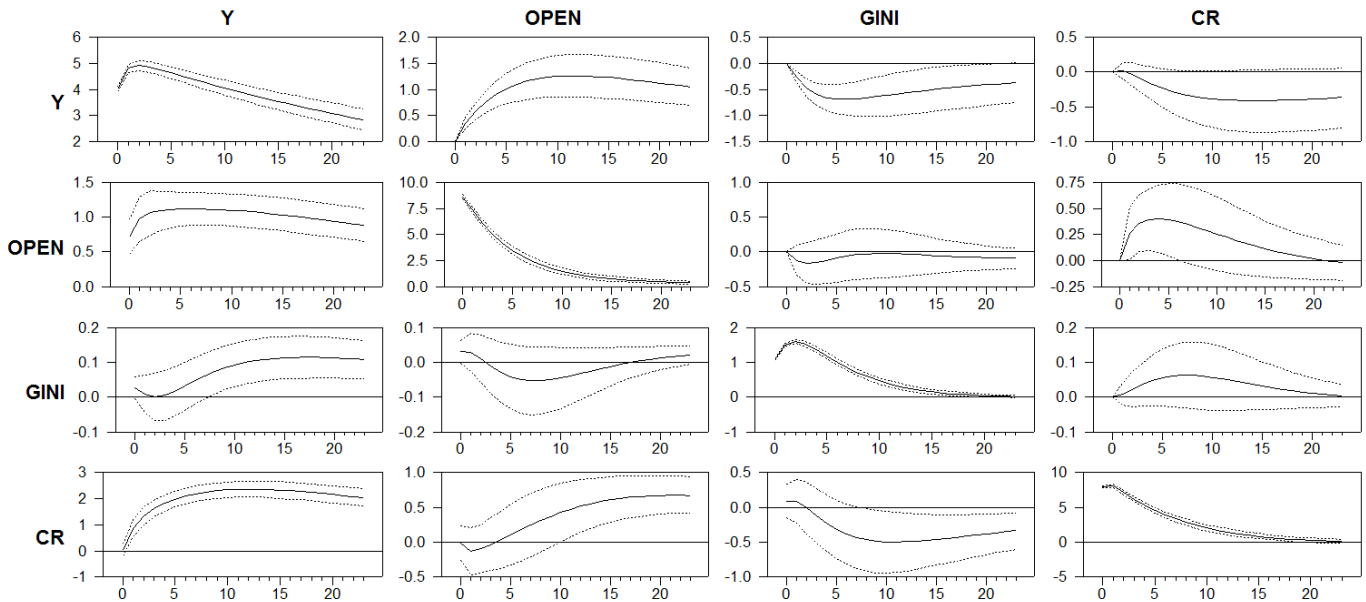
Despite the above differences between the CR and ST variables, the negative impact of inequality on growth remains robust to the selection of financial depth measure. This robust feature of the relationship between inequality and growth, which controls various financial aspects and allows dynamic interactions, delivers an important message to the existing literature on growth and inequality.

D. Controlling Additional Development Indicators

As previously mentioned, the effect of finance on growth and inequality may change depending on the level and channel of development; thus, the dynamic interactions among finance, growth, and inequality may change, including the key development indicators. Park and Shin (2017) suggested that the trade openness measured by OPEN, GOV, and HTEX are important control variables in their regression analysis in seeking the relationship among finance, growth, and inequality because the relationship between growth and inequality may change.

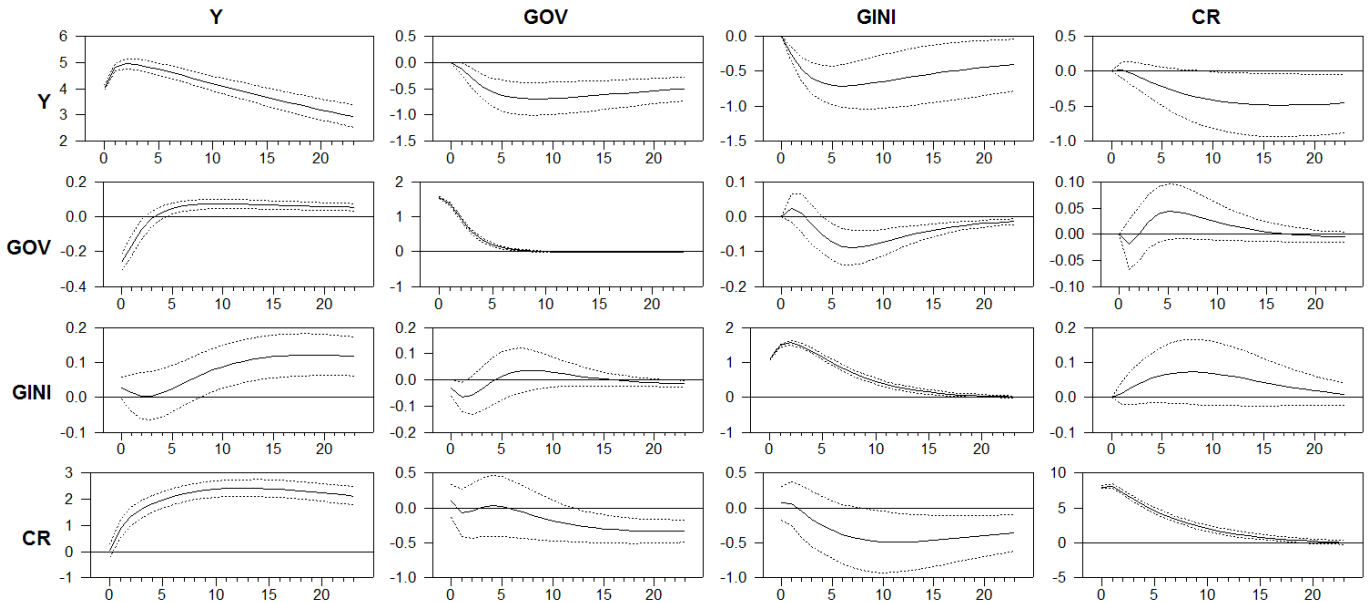
Here, we extend the panel VAR model by adding each of these development indicators to the benchmark model. We assume that the added variable is contemporaneously exogenous to GINI and CR and that Y is contemporaneously exogenous to the new variable. Under these identifying assumptions, the newly added variable is allowed to affect GINI contemporaneously, which can be regarded as a reasonable feature because the added variable is a potentially important variable to explain GINI. For example, the promotion of the share of manufactured high-technology exports may increase the skill premium, thereby increasing inequality, although the other way around is not likely a priori.

Figures 6 to 8 show the impulse responses of the extended models



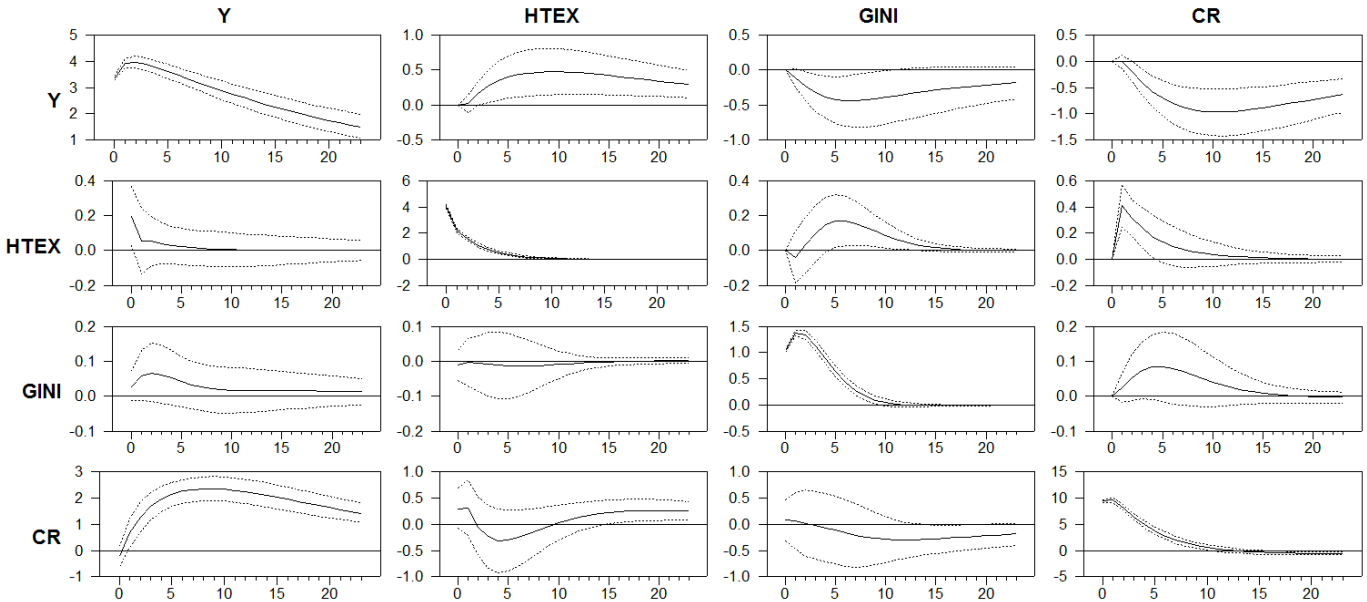
Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.
2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; CR: Private credit-to-GDP ratio; and OPEN: Ratio of total trade (exports + imports) to GDP.
3. Dotted lines denote 90% probability bands.

FIGURE 6
IMPULSE RESPONSES CONTROLLING FOR TRADE OPENNESS VARIABLE OPEN



Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.
2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; CR: Private credit-to-GDP ratio; and GOV: Government expenditure share of GDP.
3. Dotted lines denote 90% probability bands.

FIGURE 7
IMPULSE RESPONSES CONTROLLING FOR GOVERNMENT EXPENDITURE GOV



Note: 1. Each column variable at the top indicates the shock variable. Each row variable at the left indicates the response variable.

2. Each variable denotes the following data: Y: Log GDP per capita in constant 2005 US dollar; Gini: Gini coefficient; CR: Private credit-to-GDP ratio; HTEX: Share of manufactured high-technology export products (products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery).

3. Dotted lines denote 90% probability bands.

Figure 8

Impulse Responses Controlling for High-technology Export Variable HTEX

by adding OPEN, GOV, and HTEX, respectively. We gain additional understanding on the effects of these control variables on growth and inequality. For example, the OPEN column in Figure 6 shows that the increase in trade openness contributes to income growth and private credit expansion but has no significant effect on inequality. The GOV column in Figure 7 shows that the increase in government expenditure share significantly decreases income but has no significant effect on inequality and private credit. The HTEX column in Figure 8 suggests that the increase in the share of manufactured high-technology exports promotes growth but has no significant effect on inequality and private credit. The lack of influences of the shocks from openness and high-technology exports on inequality may be different from the literature on trade and inequality, which typically postulates the negative impact of trade on inequality. Nevertheless, we do not find significant effect from our panel VAR estimation.

Although we gain additional interesting findings as above, the impulse responses among Y, GINI, and CR are virtually unchanged. Thus, even after controlling the development indicators, such as trade openness, government size, and high-technology export variables, our findings on the dynamic relationship among finance, growth, and inequality remain robust. Particularly, we consistently find the negative effect of inequality on growth.

V. Conclusion

This study analyzes the relationship among financial development, economic growth, and inequality using panel VAR models rather than single-equation regression models to allow the dynamic interactions among these variables. Our findings indicate that the relationships between finance and growth and between finance and inequality depend on the selection of the financial development measure. Financial deepening measured by private credit tends to decrease economic growth while it weakly increases inequality. Similar patterns are found from the liquid liability ratio. We confirm that these relationships are robust to the changes of identification assumption and to the inclusion of additional development indicators, such as trade openness, government size, and share of high-technology exports.

However, financial deepening measured by the stock market capitalization tends to increase economic growth, whereas its effect on

increasing inequality becomes more pronounced initially but phases out quickly. This contrast may arise because the private credit captures the demand-side effects, whereas the stock market capitalization reflects the supply-side effects.

Moreover, the increase in inequality is indeed harmful for economic growth, even after controlling all three financial development measures. Furthermore, inequality is harmful for financial development in terms of private credit and liquid liability.

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References

Alesina, Alberto and Dani Rodrik. "Distributive Politics and Economic Growth." *Quarterly Journal of Economics* 109 (No. 2 1994): 465-490.

Alesina, Alberto and Roberto Perotti. "Income Distribution, Political Instability, and Investment." *European Economic Review* 40 (No. 6 1996): 1203-1228.

Arcand, Jean Louis, Enrico Berkes, and Ugo Panizza. "Too much finance?" *Journal of Economic Growth* 20 (No. 2 2015): 105-148.

Banerjee, Abhijit and Esther Duflo. "Inequality and Growth: What Can the Data Say?" *Journal of Economic Growth* 8 (No. 3 2003): 267-299.

Barro, Robert J. "Inequality and Growth in a Panel of Countries." *Journal of Economic Growth* 5 (No. 1 2000): 5-32.

Beck, Thorstein, Asli Demirgüç-Kunt, and Ross Levine. "Finance, Inequality, and the Poor." *Journal of Economic Growth* 12 (No. 1 2007): 27-49.

Benabou, Ronald. Inequality and Growth. NBER Working Paper No. 5658, 1996.

_____. "Unequal Societies: Income Distribution and Social Contract." *American Economic Review* 90 (No. 1 2000): 96-129.

Benhabib, Jess and Mark Spiegel. Cross-country Growth Regressions. Mimeo, 1997.

Bourguignon, François. The Distributional Effects of Growth: Case Studies vs. Cross-country Regression. DELTA Working Paper No. 2002-23, 2002.

Cecchetti, Stephen G. and Enisse Kharroubi. Reassessing the Impact of Finance on Growth. BIS Working Paper No. 381, 2012.

_____. Why Does Financial Sector Growth Crowd out real Economic Growth? CEPR Discussion Paper No. DP10642, 2015.

Cline, William R. Too Much Finance, or Statistical Illusion? Peterson Institute for International Economics Policy Briefs. PB15-9, 2015.

Diamond, Douglas and Phillip Dybvig. "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political Economy* 91 (No. 3 1983): 401-419.

Deininger, K. and L. Squire. "A New Data Set Measuring Income Inequality." *World Bank Economic Review* 10 (No. 3 1996): 565-591.

Demirgüç-Kunt, Asli and Ross Levine. "Finance and Inequality: Theory and Evidence," *Annual Review of Financial Economics* 1 (No. 1 2009): 287-318.

Forbes, Kristine. "A Reassessment of the Relationship Between Inequality and Growth." *American Economic Review* 90 (No. 4 2000): 869-887.

Gine, Xavier and Robert M. Townsend. "Evaluation of Financial Liberalization: a General Equilibrium Model with Constrained Occupational Choice." *Journal of Development Economics* 74 (No. 2 2004): 269-307.

Greenwood, Jeremy and Boyan Jovanovic. "Financial Development, Growth, and the Distribution of Income." *Journal of Political Economy* 98 (No. 5 1990): 1076-1107.

Jeong, Hyeok. "Assessment of Relationship Between Growth and Inequality: Micro Evidence from Thailand." *Macroeconomic Dynamics* 12 (No. 52 2008): 155-197.

Jeong, Hyeok and Robert M. Townsend. "Sources of TFP Growth: Occupational Choice and Financial Deepening." *Economic Theory* 32 (No. 1 2007): 179-221.

_____. "Growth and Inequality: Model Evaluation Based on an Estimation-Calibration Strategy." *Macroeconomic Dynamics* 12 (No. S2 2008): 231-284.

Kim, Soyoung. "Do Monetary Policy Shocks matter in the G-7 Countries? Using Common Identifying Assumptions about Monetary Policy across Countries." *Journal of International Economics* 48 (No. 2 1999): 387-412.

King, Robert and Ross Levine. "Finance and Growth: Schumpeter Might

Be Right." *Quarterly Journal of Economics* 108 (No. 3 1993): 717-737.

Kose, Ayhan, Eswar Prasad, Kenneth Rogoff, and Shang-Jin Wei. Financial Globalization: A Reappraisal. IMF Staff Papers, Palgrave Macmillan Journals 56 (No. 1 2009): 8-62.

Kuznets, Simon. "Economic Growth and Income Inequality." *American Economic Review* 45 (No. 1 1955): 1-28.

Levine, Ross. "Finance and Growth: Theory and Evidence." In P. Aghion and S. Durlauf (eds.), *Handbook of Economic Growth.* Chapter 12, Vol. 1A, North Holland, Netherland: Elsvier, pp. 865-934, 2005.

Park, Donghyun and Kwanho Shin. "Economic Growth, Financial Development, and Income Inequality." Emerging Markets Finance and Trade, Forthcoming, 2017.

Reisen, Helmut and Marcelo Soto. "Which Types of Capital Inflows Foster Developing-country Growth?" *International Finance* 4 (No. 1 2001): 1-14.

Sims, Christopher A. "Macroeconomics and Reality." *Econometrica* 48 (No. 1 1980): 1-48.

_____. "Bayesian Skepticism on Unit Root Econometrics." *Journal of Economic Dynamics and Control* 12 (No. 2-3 1988): 463-474.

Sims, Christopher A. and Herald Uhlig. "Understanding Unit Rooters: A Helicopter Tour." *Econometrica* 59 (No. 6 1991): 1591-1599.

Sims, Christopher A. and Tao Zha. "Does Monetary Policy Generate Recessions?" *Macroeconomic Dynamics* 10 (No. 2 2006): 231-272.

Solt, Frederick. "The Standardized World Income Inequality Database," Working Paper. SWIID Version 5.0, 2014.

Townsend, Robert M. and Kenichi Ueda. "Transitional Growth with Increasing Inequality and Financial Deepening." *Review of Economic Studies* 73 (No. 1 2006): 251-293.