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The KDI Journal of Economic Policy (KDI JEP) is a professional journal published on a quarterly basis. The Journal publishes papers on the academic and policy issues related to the development of Korea's economy. The KDI Journal of Economic Policy welcomes innovative and insightful academic papers on all areas of economics with an emphasis on empirical analysis that contain solid policy implications. KDI JEP is published in English starting in 2015, volume 37 number 1.

The Journal aims to disseminate research outcomes and policy recommendations not only to experts at academia and research institutes but also to policy-makers and the general public. First published in March 1979, the original objective was to circulate ongoing- and past researches conducted in KDI, a leading economic think-tank of South Korea. Starting in August, 2001, the Journal has accepted manuscripts from outside in order to provide the readers more diverse perspectives on Korea's policy initiatives. The Journal now actively seeks and welcomes submissions by researchers at home and from abroad who have genuine interests in the Korean economy.

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Articles

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China's Slowdown†

By BARRY EICHENGREEN*

This paper evaluates explanations for China's growth slowdown. The natural tendency for rapidly growing economies to slow down is a major factor, along with problems bequeathed by unbalanced growth, including a declining ICOR, slowing total factor productivity growth, and rising indebtedness. A number of other mechanisms are of lesser importance: demographics, President Xi's centralization of political power and anti-corruption campaign, and U.S. export controls. Sustaining growth in the longer term will require China to step away from investment, debt and export-fueled growth in favor of a balanced growth model with household consumption playing a larger role. Doing so will require hardening of the budget constraints of regional and local governments and restructuring of the nonperforming debts of property and construction companies.

Key Word: China, Growth Slowdowns, Economic Growth, Debt
JEL Code: E02, O10, O11

I. Introduction

The growth slowdown in China is indisputable. As shown in Figure 1, the three-year nonoverlapping GDP growth rate slowed from 12.8 percent in 2005-07 to 9.9 percent in 2008-10, 8.4 percent in 2011-13, 7.1 percent in 2014-16, 6.6 percent in 2017-19, and 4.5 percent in the pandemic-punctuated years 2020-22.[1] This sequence gives the unmistakable impression of an underlying trend. It also raises at least three questions. First, what are the factors responsible for this trend of slowing growth? Second, will the trend continue? Third, what are the implications for the rest of the world?

This paper will have most to say about the first of these questions, as there is a large and contentious body of work focusing on the past and current performance

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[1]All figures are from the IMF's World Economic Outlook database.

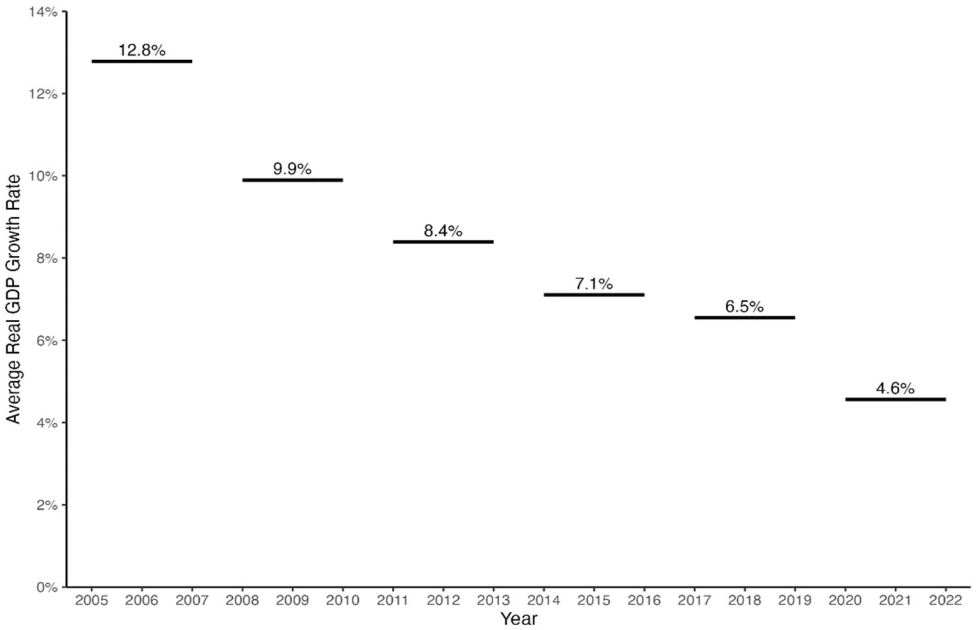

FIGURE 1. THREE-YEAR AVERAGE GDP GROWTH RATE

Source: IMF World Outlook.

of the Chinese economy. Attempts to answer the second and third questions, which concern the future, are by definition more speculative.

On the causes of the slowdown, the paper will explore seven hypotheses. First, China's slowdown is heavily driven by its demography, and specifically by a labor force that effectively stopped growing in 2015. Second, the slowdown in China is analogous to those of other formerly fast-growing economies, in East Asia and elsewhere, which occurred once the easy returns on investments and technology transfers were reaped and the country reached middle-income status. Third, Chinese economic growth has slowed as a result of diminishing returns toa growth model that emphasizes investment, exports and debt, and due to the reluctance of the government and other vested interests to move away from this tried-and-true economic strategy. Fourth, corporate investments, household spending and entrepreneurship have been depressed by the uncertainty associated with the centralization of political power in the hands of the president and the politburo and by their crackdown on dissent. Fifth, U.S. export controls, which limit China's access to state-of-the-art semiconductors with national security and artificial intelligence applications, have slowed and will continue to slow the growth of output and productivity in China's increasingly important high-tech sector. Sixth, the central government has grown increasingly reluctant to use its macroeconomic policy instruments, its fiscal levers in particular, in order to sustain a high level of growth, reflecting concern over high and rising levels of debt. Finally, heavy household, corporate and government debts have given rise to distortions and have diverted resources away from productive uses while also creating the risk of a costly and disruptive financial crisis.

As for whether this trend of slowing growth will continue, the answer, inevitably, is maybe. Forecasting growth requires one initially to forecast other domestic and international economic and political variables, the evolution of which is highly uncertain. If one believes that China's growth slowdown is heavily driven by its demography, for example, then the answer turns on the success or failure of the authorities' efforts to raise the birth rate, which remains uncertain. If one believes that the main culprit is a growth model that has outlived its usefulness, then the answer depends on whether or not officials in high circles acknowledge this fact and move away from that model; just because they have been reluctant to do so in the past is no guarantee that they won't do so in the future. If one thinks that political centralization and repression have depressed spending and entrepreneurship, then it is important to acknowledge uncertainty about whether this centralizing trend will continue; if one's belief is that U.S.-China tensions and U.S. export controls are holding back China's high-tech sector, then one needs a forecast of whether those tensions will continue to intensify or, instead, diminish.

On the third question – implications for other economies – the answer depends on the specific economy considering that slower growth in China will impact its neighbors and competitors through multiple channels of differing levels of importance depending on the country. Slower growth will mean less intense export competition from Chinese firms and less demand for imports from Chinese consumers, meaning that instances of spillover will vary depending on an economy's net trade balance with the country – recognizing also that rebalancing in China, if it accompanies the growth slowdown, could alter the balance of bilateral trade. Slower growth will mean a less voracious appetite for energy and raw materials, which will benefit other energy- and raw-material importing countries and hurt the corresponding exporters. Slower growth of China's high-tech sector, if this results from U.S. export controls, will work to the benefit of other high-tech economies in the region. However, insofar as slower growth of China's high tech sector stems from U.S. prohibitions on the transfer of advanced manufacturing equipment, this will work to the disadvantage of other countries whose firms operate manufacturing facilities in China. Economists have deployed partial- and general-equilibrium models in an effort to pin down these effects. All that can be said with confidence, however, is that the external implications of China's slowdown will vary by case.

II. Demography

Kotschy and Bloom (2023) is a survey of channels through which demography affects economic growth. As the authors observe, although earlier studies showed conclusively that a falling youth share of the population creates the opportunity for a demographic dividend (it is associated with faster growth), there is no consensus with regard to the implications of a rising old-age population share. Whereas some studies suggest that a rising old-age share will slow growth by lowering the ratio of labor to capital and depressing rates of return on investment (Jones, 2022), others suggest that it will encourage capital-labor substitution and encourage growth (Cutler *et al*., 1990). Most recent works (e.g., Aksoy *et al.*, 2019) evidently conclude

in favor of a negative impact on balance.

The magnitude of this effect will depend, however, not just on the share of a country's population above a given age threshold but on how many individuals above that threshold can remain productive members of the labor force. China's population may be ageing, but the health and longevity of the elderly is improving, enabling older workers to stay in the labor force longer. Life expectancy in China has risen from 66 years in 1979, when the period of reform and rapid economic growth commenced, to 77 years today; United Nations projections see it as increasing further, to 82 years, by 2050 (Figure 2). It is widely anticipated (see, e.g., Reuters, 2023a) that China will raise its retirement age, which currently stands at 60 for men, 55 for white-collar women, and 50 for women working in factories. Looking at a cross-section of countries, Kotschy and Bloom conclude that introducing this additional effect into models of the impact of ageing on growth reduces the estimated impact of a given change in raw demographic structure by more than half.

Moreover, the magnitude of the demographic dividend will depend not simply on the share of the Chinese population that is of working age but also on participation rates. Ming's (2023) reconstruction of the latter suggests that at the same time the share of China's population that was of working agerose from 60 percent in 1982 to 73 percent in 2015, labor force participation dropped from 85 percent to 70 percent. This decline reflected increasingly stringent enforcement of the aforementioned mandatory retirement provisions, but also increases in secondary and tertiary educational enrollment and rising child care costs, which kept women out of the labor force. On balance, these calculations suggest a minimal change in the share

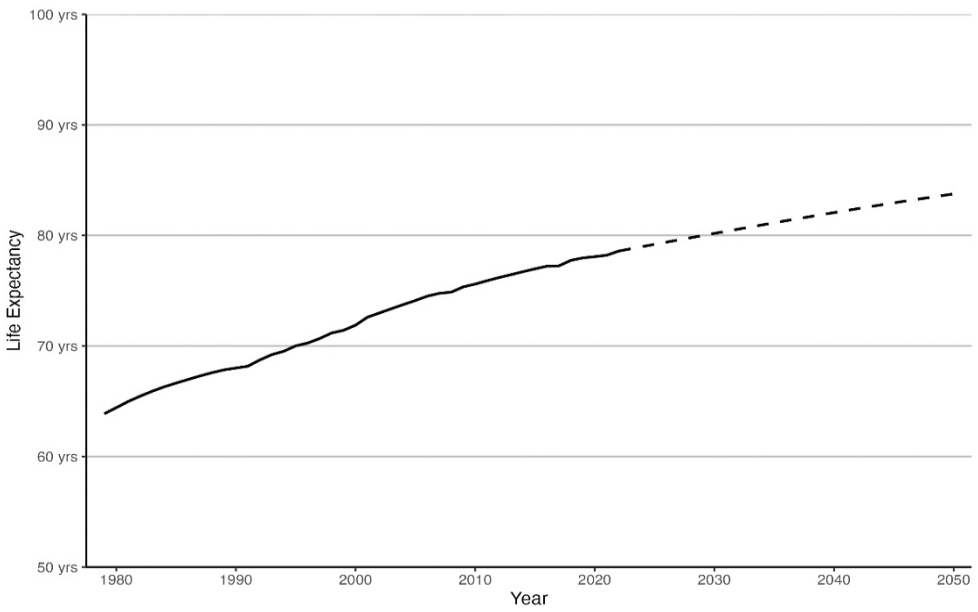

FIGURE 2. MEDIAN LIFE EXPECTANCY AT BIRTH

Note: Median life expectancy at birth, both sexes. Dotted line represents UN projections.

Source: United Nations, *World Population Prospects*.

of labor-force participants in the population over this period. This negative finding is reinforced by a regression analysis which shows little evidence of a relationship between the working-age share of the population and economic growth across Chinese prefectures and over time.

Youth unemployment points in the same direction – that sheer size of the labor force and share of the population in their prime working-age years matter less when a non-negligible share of that labor force is unemployed. China has stopped publishing youth unemployment statistics, but as of June of 2023, the urban youth unemployment rate was 21 percent (Figure 3). A number of studies have emphasized China's rapid accumulation of human capital, as reflected in university enrollment and graduation, as a factor offsetting the declining size of the labor force (see Peschel and Liu (2022) for discussion). However, the country's high urban youth unemployment rate is indicative of a mismatch between skills supplied and demanded, reflecting how China boosted the share of university-educated labor-force entrants while simultaneously clamping down on the service sector, their logical destination, and instead subsidizing construction (Steil and Harding, 2023). On balance, this analysis leads one to downplay the hypothesis that demographic factors are driving the growth slowdown.

Looking forward, youth unemployment can be reduced by educational reforms that better match the skills acquired by labor-force entrants to those desired by firms. Labor force participation by women can be encouraged through the more generous provision of child-care services, and the continued labor force participation of older workers can be promoted by the wider provision of health services and by an increase in the retirement age.

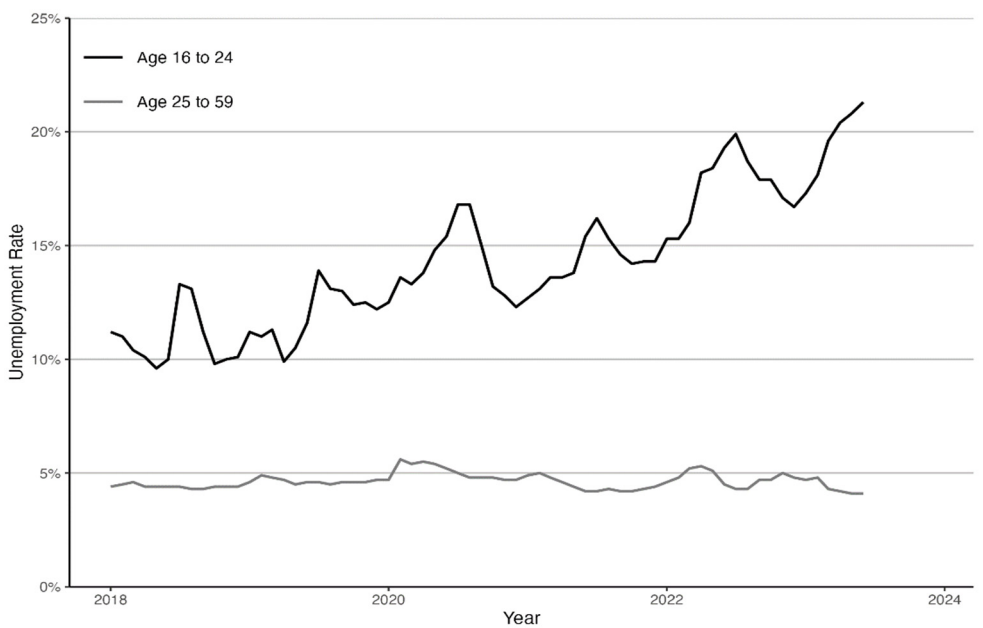

FIGURE 3. URBAN UNEMPLOYMENT RATES

Source: National Bureau of Statistics.

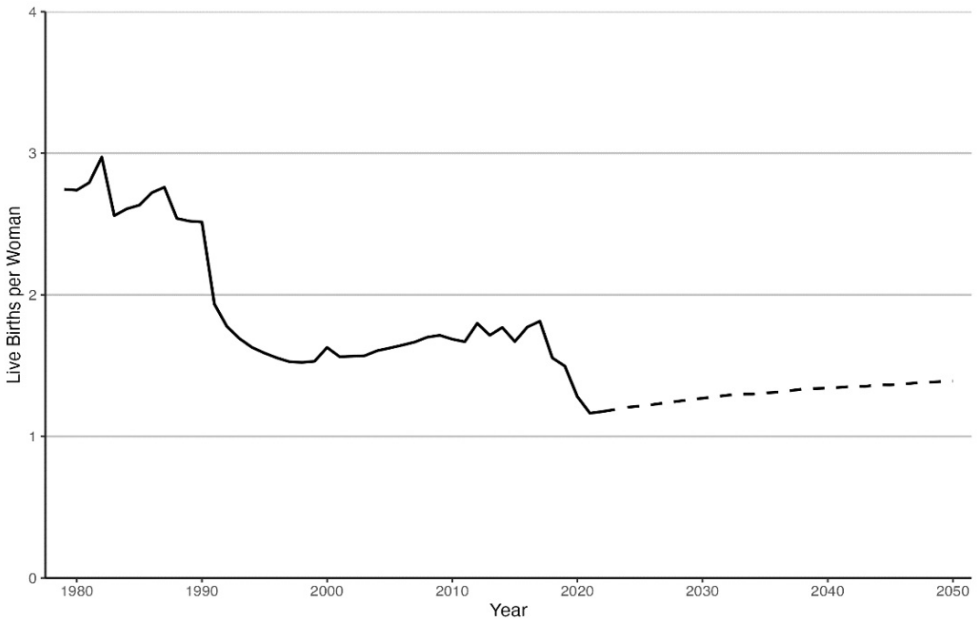

FIGURE 4. TOTAL FERTILITY

Note: Total fertility, both sexes. Dotted line represents UN projections.

Source: United Nations, *World Population Prospects*.

Over a longer horizon, Chinese policymakers are seeking to limit demographic drag by increasing the fertility rate. This started with the relaxation of the one-child policy and continued with efforts to enhance child-care availability, but early returns have disappointed (Figure 4). According to the latest data, China's fertility rate remains below even those of Italy and Japan (Fuxian, 2023). Liu (2023) suggests that the reluctance of Chinese women to marry and bear children reflects the disproportionate burden on wives in providing childcare and household services, together with the career costs borne by mothers when they interrupt their labor force participation (as in Goldin, 2021). This in turn suggests that the longer-run objective of increasing the fertility rate will be achieved only in conjunction with measures to address social and gender inequalities. These last points should resonate with South Korean readers.[2] Unfortunately, China appears to be moving in the opposite direction, with the current government's reassertion of "traditional virtues of the Chinese nation" (Osnos, 2023). Revealingly, for the first time in several decades, all of the members of the politburo are male.

III. Natural Slowdown

A second hypothesis is that rapidly growing catch-up economies have a natural

[2]South Korea, it should be noted, has and will continue to have an even lower total fertility rate than China, according to United Nations projections.

tendency to slow down. Initially, rapid growth can be sustained by even modest investment rates that build up the capital stock from low levels. Output per worker can be increased by transferring labor from agriculture, initially the dominant source of employment, to manufacturing, where productivity is higher, and by exporting the output of industry when there is a shortfall of domestic demand. Productivity can be upgraded by licensing foreign technologies, engaging in reverse engineering, and encouraging inward foreign investment.

Over time, however, these easily accessed inputs are progressively exhausted. They must be replaced by indigenous sources of output and productivity growth. Capital/output ratios rise, raising the incremental capital/output rate (ICOR). The pool of underemployed agricultural labor is drained. Exporting becomes more difficult, as an initially small player in world markets grows larger and experiences protectionist pushback from its trade partners. The share of the labor force in manufacturing peaks at around 25 percent, after which employment shifts toward the service sector, where levels and growth rates of productivity are lower. As the economy approaches the technological frontier, it must develop new technologies at home rather than importing them from abroad. With the diversification of social goals, more savings are devoted to environmental cleanup, health care, old-age pensions and other transfer payments, leaving less for capacity expansion in industry.

These dynamics are evident in China. The share of employment in agriculture has fallen from 60 percent in 1991 to less than 25 percent today. Over the last decade, the share of the workforce employed in the industrial sector has begun to fall, while that employed in services has risen strongly, from 36 percent in 2012 to 47 percent in 2022. Clark and Dawson (2022) estimate that China's ICOR has increased from 4 at the turn of the century to more than 8 today (Figure 5). For China, having grown

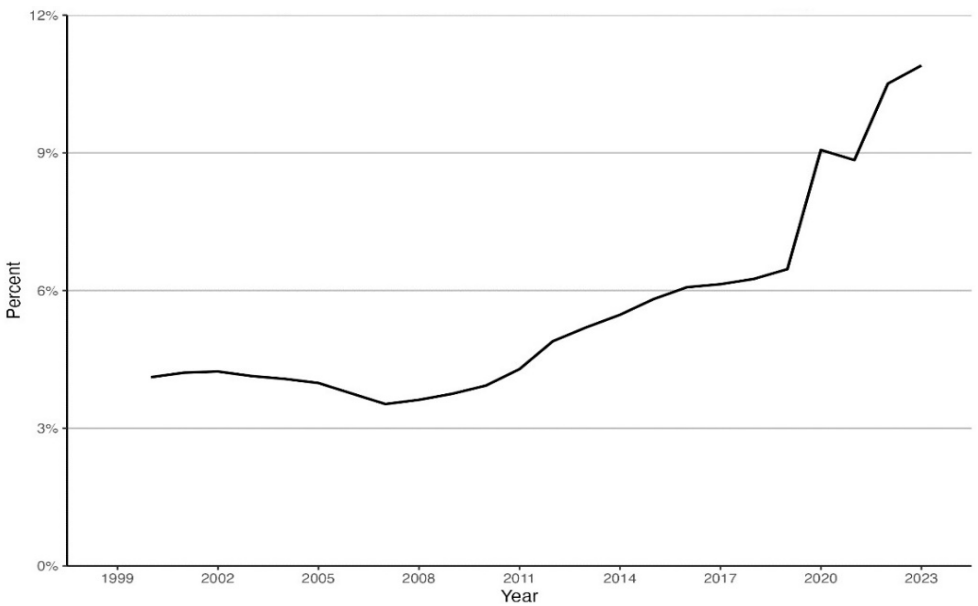

FIGURE 5. 5-YEAR ROLLING AVERAGE OF INCREMENTAL INVESTMENT TO OUTPUT RATIO

Source: IMF World Economic Outlook.

into a large supplier in world markets, its exports are more likely to excite protectionist sensitivities.

Eichengreen, Park, and Shin (2012; 2014) suggest that these structural features have led to slowdowns in aggregate GDP growth, in China and more generally. Their model predicted a slowdown in the aggregate growth rate in China around 2015, which is not inconsistent with the facts.[3] However, the average deceleration of the growth rate in their sample of slowdown episodes is 3.5 percentage points. China's growth rate has slowed (on a three-year moving-average basis) by 8.3 percentage points since the apex of high growth in 2005-07. This suggests that natural slowdown is not the entire story.

IV. Unbalanced Growth

A third hypothesis is that GDP growth has slowed because the economy is unbalanced, owing to continued pursuit of a growth model no longer suited to the country's circumstances. Chinese authorities have long prioritized investment over consumption. Private consumption remains little more than a third of GDP, while savings and investment rates approach 50 percent of national income, unprecedented for a country of China's (or any country's) size.[4] High investment delivered fast growth when infrastructure was underdeveloped and the capital stock was small but the country has since invested extensively in infrastructure, and the return on investment, as measured by the ICOR, has doubled over the last two decades, as noted above.

However, allowing investment to decline would cause growth to slow and the economy to undershoot its growth targets, absent measures capable of boosting household consumption. Not wishing to see its growth targets missed, the politburo continues to encourage investment, using the central government's fiscal resources and policy banks to provide the necessary finance. Increasingly, investment is undertaken by local and regional governments and their local government financial vehicles (LGFVs).[5] A third of LGFVs failed to generate positive cash flow in 2022, indicative of the low returns on these investments.[6]

The government has proposed to address these imbalances through what has been termed a "dual circulation strategy," introduced in May of 2020; one element involves increasing domestic consumption while the other entails continuing to grow exports. However, increasing household consumption requires raising household incomes, which are an unusually low 60 percent of GDP. Raising household incomes implies granting higher wages. Higher wages mean higher costs of production and declining international competitiveness, ceteris paribus, defeating the other element of the strategy. Not willing to accept the slower growth that will come with declining

[3]There is a related literature on the "middle-income trap" (World Bank, 2007), but this concerns the possibility that income growth in late-developing countries may slow relative to that in advanced economies such that relative incomes fail to converge, not with how growth rates in late-developing countries themselves vary over time. This is linked to the distinction between "sigma" and "beta" convergence (see Barro and Sala-i-Martin, 1995).

[4]Gross national savings rates actually peaked at 52 percent of GDP in 2008. The savings rate was still 44 percent in 2019, the last semi-normal pre-COVID year.

[5]Local and regional governments receive transfers from Beijing, while LTFVs receive transfers from local and regional governments. LTFVs are discussed later in the paper in the context of China's debt problem.

[6]See Reuters (2023b) for additional data points.

international competitiveness, Chinese officials have been reluctant to operationalize their dual circulation strategy.

In 2021, the government then followed with a "common prosperity strategy" that foresaw transferring income, through the fiscal system, from the wealthy, whose marginal propensity to consume is low, to working-class households, whose propensity to consume is higher. The intention was to boost household consumption without damaging export competitiveness. However, while that year and the subsequent period saw harsher policies toward the wealthy, it how much of this reflected the desire for "common prosperity" as opposed to insistence on stricter political control remains unclear. More broadly there is the worry that garnishing corporate profits and high incomes will discourage investment and entrepreneurship. The government has again been reluctant to implement the strategy for fear of damaging the vitality of the economy (Pettis, 2021).

The implication is that in order to sustain a higher growth rate in the long run, China must accept a sharper growth slowdown in the short run. If one thinks that vested interests in Beijing, in local and regional governments, and in high-investment sectors of the economy will be reluctant to accept this, then one is likely to arrive at a relatively pessimistic forecast of future Chinese growth. Another implication is that prudence is necessary when interpreting Chinese growth statistics. Construction of unoccupied apartment blocks and empty airports shows up as GDP growth but has little economic value. This leads authors such as Pettis (2019) to question the meaning of such statistics and to distinguish between the quality and quantity of Chinese growth.

V. Rule of Law

Some observers point to the increasingly repressive policies of the central government under President Xi as discouraging investment and growth. Posen (2023) points to a general tendency for authoritarian governments to crack down on private enterprises as they become larger and more powerful. He argues that the resulting uncertainty discourages investment and causes households to defer spending on durable goods, suggesting that there is evidence of both tendencies in China. Households fearful of losing access to their assets are prioritizing liquidity over spending, thereby aggravating preexisting conditions of excessive saving and inadequate consumption.[7] Osnos (2023) suggests that political uncertainty and repression in China discourage entrepreneurship while encouraging emigration of the most skilled and educated workers. Posen suggests further that harsh COVID-19 lockdowns catalyzed these fears of arbitrary future action by authorities.

These warnings are not without merit, but quantifying their impact is challenging given the ambiguity of the arguments and the mixed nature of the evidence. It could be that these authors are arguing that authoritarian governance, in China and in general, is detrimental to growth. Nonetheless, evidence to this effect is not consistent. In an influential study, Barro (1996), using cross-country regressions,

[7]IMF (2022), p.5 confirms a further rise in household savings since 2019, though how much of this is attributable to the COVID-19-related lockdowns as opposed to general political uncertainty is unclear.

found that the effect of democracy on economic growth is negative once one controls for rule of law, market freedom, government consumption and human capital. Gerring *et al*. (2012) reinforce his conclusion, whereas Acemoglu *et al*. (2019) provide evidence from a dynamic panel model focusing on changes in political regimes that democracy has a positive effect on GDP per capita. Such results are clearly sensitive to the methodology used.

Alternatively, the position can be interpreted as arguing that weak rule of law, implying uncertainty about property rights, is bad for growth. However, as emphasized by Haggard and Tiede (2010), rule of law can affect economic growth through multiple channels, i.e., through security of property and enforcement of contracts, through checks on the government, and through checks on corruption. China's current government has launched a high-profile anti-corruption campaign, something that most economists argue should be positive for growth.[8] At the same time, however, checks on government (given political centralization) and security of property (as in the case of Jack Ma) have weakened, with the opposite effect.[9]

VI. U.S. Export Controls

The US federal government operates a system of export controls designed to limit China's access to U.S. designed and produced dual-use technologies with both civilian and military uses, notably high-end semiconductors with applications in weapons systems and artificial intelligence (AI). American controls are now applied extraterritorially – that is, Washington, D.C. seeks to limit the export of items produced in other countries containing U.S.-produced inputs, such as the advanced photolithography machines produced by the Dutch company ASML (Bown, 2020). U.S. export restrictions have been applied since 2018. The question is whether they have contributed materially to the slowdown in China and whether they will do so in the future.

Current authority for the president to control dual-use exports for national security and foreign policy reasons was established by the Export Control Reform of 2018.[10] In addition, the U.S. government maintains an "entity list" of firms, such as Huawei, with which U.S. trade is restricted. However, while the Department of Commerce compiles an extensive list of dual-use technologies potentially subject to control (covering some 18 percent of total U.S. exports to China), it requires licenses or prohibits export for only a small fraction of the enumerated items. These exceptions raise questions about the comprehensiveness and hence the impact of U.S. controls. Thus, Huawei was initially able to continue acquiring unrestricted technology exports, including 4G, 6G, cloud and undersea cable technologies (Congressional

[8]Li, Roland, and Xie (2022) argue, however, that local corruption actually has a positive impact on productivity in China, absent reliable contract enforcement and other conventional aspects of rule of law.

[9]Haggard and Tiede's empirical analysis finds that control of corruption has a more robust impact on growth than security of property rights and checks on government. In contrast to Li *et al.* (2022), they point to a negative impact of corruption on growth.

[10]This type of authority existed before World War II and under the Export Control Acts of 1949 and Export Administration Acts of 1970 and 1979, which were aimed at the Soviet Union. These provisions were allowed to expire in 1990 with the end of the Cold War, although limited presidential powers remained under an executive order issued by President George H.W. Bush.

Research Service, 2022). The Chinese foundry Semiconductor Manufacturing International Corporation (SMIC) was similarly able to import U.S. manufacturing equipment and designs for chips of at least 14 nanometers (only chips with resolutions of 10 nanometers and less were restricted).[11] Chinese firms' foreign subsidiaries were able to purchase chips that their parents were barred from buying. These entities were also able to obtain advanced semiconductors from third parties such as the Taiwanese company TSMC and the South Korean chipmakers Samsung and SK Hynix, which also secured indefinite waivers to install otherwise restricted equipment in their factories in China.

Estimating the impact on the Chinese economy is difficult given the absence of input-output tables at the necessary level of disaggregation. Estimates depend also on what one assumes with regard to the scope of evasion and the ability of Chinese producers to develop substitutes for restricted exports. The ability of SMIC unexpectedly to provide Huawei with advanced microprocessors for its latest-generation smartphone suggests that this last response should not be underestimated. Semiconductor manufacturing and related industries may account for only some 7 percent of Chinese GDP, but in addition to estimating the impact on China's high-tech sector per se, one must also form an estimate of the impact of tech-sector outputs such as AI on the productivity of other industries.

One study has taken on this challenge. Assuming a 21 percent reduction in China's semiconductor supply, Oxford Economics (2023) estimates a drag on growth of five basis points (five one-hundredths of a percent) in 2023, rising to a cumulative medium-term 0.8 percent decline in the level of GDP by 2026. The larger medium-term effect reflects the impact over time on downstream semiconductor-using sectors. This is considerably lower than Oxford's estimate of the impact on Chinese GDP of the COVID-19 lockdowns and of the correction in the property market.[12] The implication is that U.S. export controls have not contributed materially to the Chinese growth slowdown to date.

Chorzempa (2023) considers the impact of these U.S. export restrictions on the neighboring South Korean semiconductor industry. He estimates that Samsung and SK Hynix benefit significantly in the short run from the decline in Chinese competition in their memory chip business, but he also observes that while Samsung and SK Hynix received waivers from U.S. export controls, as noted above, the two companies are not exempt from bans on exporting semiconductor-related manufacturing equipment, including to their own production facilities in China. Samsung produces 40 percent of its NAND chips in China, while SK manufactures 20 percent of its NAND chips and 40 percent of its DRAM chips there. The inability to export manufacturing equipment will prevent the two companies from upgrading their facilities, eventually rendering those fabs uncompetitive and requiring earlier investments to be written off.[13] Thus, the impact on South Korean high-tech firms,

[11]In July of 2022, this ban was extended to chips with resolutions of 14 nanometers.

[12]Using an input-output model, Park and Liu (2023) find a negative impact on the semiconductor, machinery manufacturing and construction sectors in China. However, the authors analyze the impact under the assumption of a 50 percent reduction in U.S. semiconductor exports to China. They do not consider also the application of similar restrictions by other countries.

[13]In addition, companies may not be eligible for tax incentives for investments in the U.S. under the CHIPS Act if they continue investing in China.

while positive in the short run, is apt to be negative in the longer run.

VII. Fiscal Policy

Some attribute the growth slowdown in China to the reluctance of policymakers to apply fiscal stimulus measures more aggressively in the face of weak demand. This stands in contrast to the policy responses to previous crises. In response to the global financial crisis, the government announced a massive RMB 4 trillion stimulus, approximately 13 percent of 2009 GDP.[14] In 2015-17, in response to a stock market crash and capital outflows, it increased the augmented fiscal deficit and borrowing by government policy banks by an annual average of 7 percent of GDP over three years.

Attitudes toward the use of fiscal policy had evidently changed by 2020-21, when in response to the COVID pandemic the government provided a smaller stimulus of approximately 5% of GDP; this was only a fraction of that applied by the U.S., UK, and Japan, and even by other middle-income countries such as Brazil. The central government's response to disappointing growth in 2023 was even more tentative. In October, officials approved the sale of an additional RMB 1 trillion of central government bonds to finance local government flood and other disaster-related relief. This raised the budget deficit for the year by 0.8 percent of GDP, small by the standards of other countries facing a situation of weak private demand and small by the standards of China's own past.[15]

This more conservative approach to fiscal policy presumably reflects higher levels of central government and LGFV debt accumulated in the interim (more on which below). The question here, however, is not why, but with what effects? Focusing on advanced countries, Rachel and Summers (2019) argue that an expansionary fiscal policy was essential in the run-up to the COVID-19 pandemic to prevent the economy from falling into an extended period of slow or no growth. They estimate that the neutral real interest rate fell by 300 basis points over the preceding 20 years. In the absence of supportive fiscal policies, it would have been as much as 200 basis points below zero, consigning these economies to stagnation.

Is China now in this position? Guofeng and Rees (2021) estimate a neutral real rate for China, also finding a downward trend over the last 20 years, but their estimates place the neutral rate throughout this period above 2 percent. Thus, China does not appear to have suffered from a persistent problem of deficient private demand over this period.

Is it plausible that the situation changed dramatically after 2019, when Guofeng and Rees's sample period ends? Rachel and Summers observe that the neutral rate is

[14] Roughly a third was its own spending, two thirds debt-financed spending by LGFVs and state-owned enterprises.

[15] In addition to the fiscal impulse being weaker, Posen (2023) suggests that the fiscal multiplier is now smaller, as households facing heightened policy and political uncertainty grow more reluctant to spend. Along with this action on the fiscal front, there was some supportive use of monetary policies: the People's Bank of China cut its one-year loan prime rate twice over the first three quarters of the year. Again, however, the cuts were small, and the central bank left longer-term rates unchanged. Commentators dismissed the cuts as "underwhelming" (Tan, 2023) and explained this in terms of the need to support a weak exchange rate in the face of high central bank policy rates in, inter alia, the United States.

determined by slowly moving variables such as potential output growth, demographics and income distribution. For China, Guofeng and Rees similarly point to the roles of potential output growth, demographics, financial development, and shifts in savings preferences as incomes have risen. Their estimates of past movements in the neutral rate, incorporating these determinants, show these too to be slowly moving. This implies that not a lot has changed since 2019 and that deficient public spending is unlikely to be behind the slowing rate of Chinese growth.

VIII. Debt

Another widely cited culprit with regard to the Chinese growth slowdown is high debt. Figure 6 shows the debt/GDP ratio as calculated from the IMF's Global Debt Monitor, distinguishing public, household, and nonfinancial corporate debt. The sum, which approached 300 percent in 2023, rivals that of the most heavily indebted advanced economies and exceeds the debt ratios of other emerging markets.

Heavy indebtedness is an intrinsic feature of Chinese political economy and of the growth model pursued thus far. First, the central government's political legitimacy rests on success at delivering "common prosperity," which among other things entails hitting its targets for GDP growth. Until recently, central government authorities have therefore responded with fiscal stimulus measures, financed by debt issuance, whenever growth shows signs of falling short of target, as in 2008-09, 2015-16 and 2020 (see above).

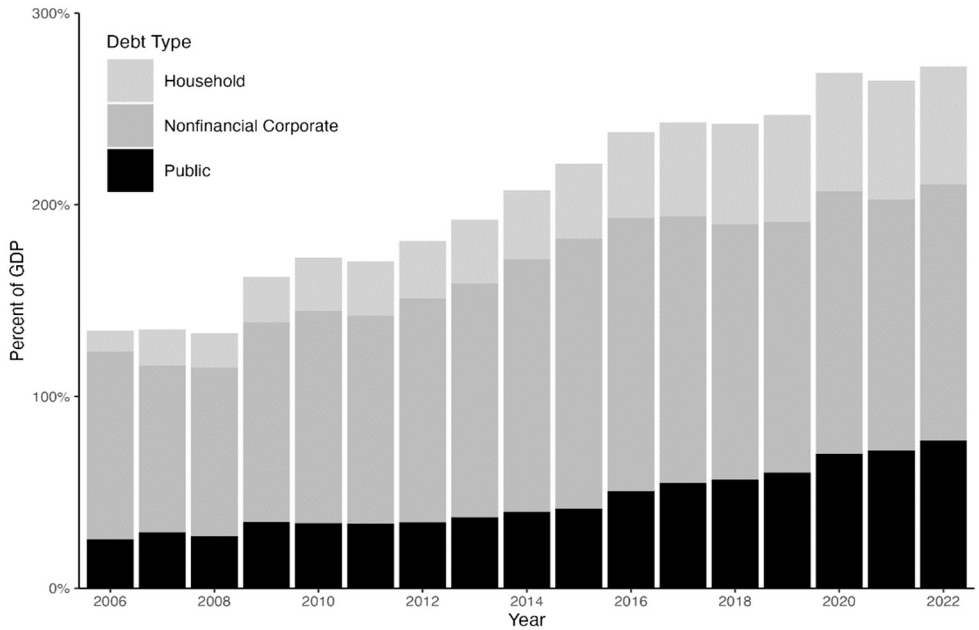

FIGURE 6. DEBT TO GDP RATIO

Source: IMF Debt Monitor.

Second, local government officials have powerful incentives to borrow, through their LGFVs, in order to build roads, railways, power plants and housing but also to invest in enterprises in manufacturing and other sectors, so as to provide employment for their constituents and sinecures for themselves. Historically, local governments and their financing vehicles have had soft budget constraints. They have received transfers from the central government and forbearance from its policy banks when experiencing debt distress.[16] Transfers are motivated by fears of contagion; as one observer put it, "If one local government defaults…it would bring about a systemic crisis and trigger a market sell-off of the debts of various local governments, and even the central government's. Local government debts," the implication follows, "are also debts of the central government."[17]

Third, property investment is an intrinsic feature of the Chinese economy, given the perceived safety of investments in property relative to other assets.[18] China's large property-development companies, forced to build ahead of demand, borrowed in order to finance construction. Real-estate developers, like local governments (the two sometimes being one and the same), enjoyed generous access to debt finance from banks and trust companies, given that the property sector was an important component of the Chinese economy and a critical contributor to GDP growth.[19] Households generously funded these trust companies, which promised high rates of return, in the belief that the shadow banks in question enjoyed implicit guarantees from the government. Developers also borrowed abroad, foreign lenders tending to extrapolate past increases in property prices and believing that government would step if the trust companies experienced financial distress.

In 2020, however, officials grew concerned about a property bubble, and they curtailed the sector's credit access. In the subsequent three years, more than 50 Chinese developers, short of cash, defaulted or failed to make timely debt payments. The problems of Evergrande and Country Garden spooked home buyers, who questioned whether the companies would deliver the promised apartments, causing home sales and prices to fall, which further worsened the financial position of the developers. They also worsened the problems of local governments, which depended on land sales for current revenues.

Debt of the real-estate/construction sector has received the most attention, for good reason, but other heavily indebted corporate sectors include transportation, retail, leisure, consumer goods and pharmaceuticals. Like property developers, enterprises in these sectors, many of which are linked to local governments, were

[16]As noted in Section 7, fiscal stimulus in 2023 was adopted in part to aid local governments struggling with debt. In contrast to earlier periods, however, steps were also taken to rein in moral hazard. Local governments in 12 high-debt regions were not permitted to undertake new projects without permission from the central government and were not permitted to take on new railway and power-plant projects under any circumstances. The central government also issued an order specifying that debt of LGFVs should not grow faster than the average loan growth rates of the corporate sector in the province where LGFVs are located.

[17]The quote is attributable to Xu Gao, chief economist at Bank of China International, cited in Lee (2023).

[18]Relatedly, it is sometimes argued that China's current generation sees itself as a "real estate generation," given that it was the first generation to take advantage the housing privatization that began after 1998 (Huifeng and Cai, 2023). If the savings and spending decisions of future generations are then less "real-estate centric," then this problem of excessive focus on the construction sector may solve itself.

[19]Official statistics suggest that real estate and construction constituted 14 percent of GDP in 2020, up from 10 percent in 1995. Rogoff and Yang (2020) estimate that the real estate sector is responsible for fully 29 percent of Chinese GDP, taking into account higher order upstream and downstream linkages. This is more than twice the comparable level for South Korea.

encouraged to borrow to help the authorities achieve their announced growth targets, until starting in 2020 when the central government sought to reduce financial risk by cracking down on speculative activity (S&P Global, 2021).

The channels through which heavy indebtedness and debt distress negatively impact economic growth are familiar from earlier research. Heavy government debt discourages capital accumulation if investors lower their expectations of returns in anticipation of higher and more distortionary taxes to meet debt service obligations in the future. Indebted governments with less fiscal space will be more reluctant to engage in expansionary fiscal policies in downturns, as seen in the Chinese case, and to undertake productivity-enhancing investments. The perceived need to recapitalize the debts of distressed corporates, LGFVs and local governments may then reduce the fiscal space still further. Heavily indebted households may be reluctant to spend, preferring to pay down existing obligations and strengthen their balance sheets. Heavily indebted corporates struggling to meet their interest obligations will similarly be in a poor position to undertake productivity-enhancing investments. Banks evergreening their loans to corporations with distressed debts will lack the resources to lend to more productive entrants, while the failure of loss-making firms to exit will discourage entry by those new competitors, as in the case of Japan's zombie banks and firms (Caballero, Hoshi, and Kashyap, 2008).

Earlier research also points to policies intended to minimize these negative impacts. A central government running deficits in bad times should run surpluses in good times. Reducing vertical fiscal imbalances and hardening the budget constraints of regional and local administrations will limit the likelihood that the central authorities will be forced to assume the debts of lower levels of government. Regulators should discourage financial intermediaries from evergreening their loans to insolvent corporations and LGFVs, while the debts of the latter should be restructured sooner rather than later.

The problem at hand is that these interventions imply slower growth in the short run. Corporations and local governments with harder budget constraints will spend less. Restructuring their debts will impose losses on investors, who will feel negative wealth effects, and on banks, which will suffer balance-sheet losses. Property prices will fall, and confidence may be further eroded.

This, then, is a general instance of the more general phenomenon of unbalanced growth described in Section 4, a model that is not feasible indefinitely. The longer authorities stick with it, the greater the vulnerabilities and headwinds for future growth – and the heavier the debt bequeathed to the future. However, moving away from that model implies slower growth now. Again, the implication is that to sustain a higher growth rate in the long run, China needs to accept a sharper growth slowdown in the short run.

IX. Crisis Risk

Conventional wisdom has it that China remains enough of a controlled economy and that the central government retains sufficient fiscal space such that a financial crisis capable of throwing growth seriously off course is a low-probability event.

Still, some such as Ip (2023) have sought to make the case that crisis risk is real. His argument starts with the fact that the liabilities of local governments and their LGFVs exceed 45 percent of GDP.[20] It then proceeds to the observation that 80 percent of LGFV debt is held by banks, while much of the rest is held by trust companies.[21] The IMF estimates that the cost of restructuring financially nonviable LGFV debt could approach $1 trillion. If the entirety of this cost is borne by banks, restructuring charges would reduce bank capital relative to assets by 3.5 percentage points.[22]

Bank capital ratios, at slightly more than 10 percent of assets, are already low by international standards. Consequently, news of this further damage to bank balance sheets could precipitate a crisis of confidence and unleash depositor runs, starting with local banks, which are least well capitalized, in provinces suffering from the largest declines in property prices, and then spreading from there to other banks, including big, systemically important banks. The central government would be forced to step in, recapitalizing the banks in order to restore confidence,[23] but the government would then enter a "diabolic loop" (Brunnermeier and Reis, 2023), as recapitalization costs add to an already heavy government debt. Questioning the government's ability to service that debt without help from a monetary authority, investors would shed government bonds. The central bank would be forced to buy them to stabilize the market, fueling inflation. Either way – via a banking panic or through an inflationary crisis – growth would suffer.

Spelling out this scenario has the advantage of exposing its plausibility, or lack thereof. Central government debt in China is 77 percent of GDP. Adding $1 trillion of bank recapitalization costs would raise this to approximately 83 percent. It is questionable whether a change of this magnitude, on its own, would undermine confidence in the central government's debt. $1 trillion may be a large number, but it is less than 6 percent of Chinese GDP, as noted. To put this in perspective, recall that the cost of resolving the banking crisis in South Korea between 1998 and 2002 cost $160 trillion won, or 30 percent of 2002 GDP (Kim, 2006). Evidently, China's banking problems do not begin to approach historic Korean levels.[24]

Thus, the conventional wisdom that China possesses the instruments and fiscal space needed to resolve its debt and banking problems and to avert any incipient crisis remains accurate for the moment. Nonetheless, the central government is running substantial budget deficits which, if allowed to continue, will erode that fiscal space. The longer nonperforming loans to LGFVs remain unaddressed, the more costly they will be to resolve. The conventional wisdom may not remain conventional indefinitely.

[20]This estimate is from the IMF (2023).

[21]Ip doesn't mention the claims of banks and trust companies on troubled property-development companies, but these issues point in the same direction.

[22]The IMF describes a case where banks bear half of the cost of restructuring that debt. Here, for simplicity I describe a case where banks bear the entire cost of restructuring the local government debt on their balance sheets.

[23] This would follow the precedent of the 1990s, when a banking crisis was resolved by transferring nonperforming assets to government owned and operated asset management companies.

[24]That said, the Korean government's debt was much lower as a share of GDP, giving it fiscal space adequate for absorbing those costs.

X. Conclusion

In *The Interpretation of Dreams* (1900), Sigmund Freud referred to the concept of an overdetermined system, where a single occurrence has multiple causes. China's growth slowdown is plausibly interpreted analogously as having multiple causes, ranging from unfavorable demographics, the exhaustion of high growth potential, and the diminishing effectiveness of unbalanced growth on the one hand, to U.S. export prohibitions, centralization of domestic political control, and heavy debt on the other. As with any overdetermined system, it is challenging to pin down the relative importance of different factors. Almost certainly, the natural tendency for rapidly growing economies to slow down is a major factor, although this tendency alone cannot explain the magnitude of the deceleration in China over the last 15 years. The problems bequeathed by unbalanced growth, including a declining ICOR, slowing total factor productivity growth and rising indebtedness, almost certainly constitute collectively a second major factor. In contrast, a number of other mechanisms indicated by observers are likely to be less important, such as demographics, due to offsetting changes from labor force participation and unemployment. President Xi's centralization of political power and anti-corruption campaign also falls into this category, insofar as the different elements work in different directions, as do U.S. export controls, which are less than comprehensive and will encourage innovation by China to neutralize their effects.

Looking to the future, how growth evolves will depend on policy choices that are difficult to predict. What is clear is that there is a tradeoff between the short and longer runs. Sustaining growth over the longer term will require steps away from investment, debt and export-fueled growth in favor of a balanced growth model with a larger role for household consumption. Doing this will require hardening the budget constraints of regional and local governments and LGFVs and will mean the restructuring of the nonperforming debts of property and construction companies. Healthy growth can be maintained on this basis, although not necessarily growth at China's earlier, impressive rates, given China's demographics, inherited debts, and other headwinds. However, these same steps supporting growth in the longer run will make for slower growth in the short run, as the higher wages needed to support household consumption will undermine export competitiveness, regional and local governments will spend less, and debt restructuring will roil financial markets.

If they are secure in their position, as they appear to be, Chinese leaders can play the long game. Their discount rates being low, they can regard short-term costs as an acceptable price to pay for healthy growth in the medium to long run. At the same time, Chinese leaders, like leaders everywhere, can be set in their ways; they show an understandable reluctance to abandon a tried and true growth model that has served them well. Whether they will choose to restructure and reform the economy is thus anyone's guess.

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Assessing the Contributions of Non-bank Financial Institutions (NBFI) and ELS Issuance to Systemic Risk in Korea†

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Since the Global Financial Crisis of 2008-2009, the importance of non-bank financial institutions in macroprudential management has increased significantly. Consequently, major countries and international financial institutions have been actively discussing and implementing macroprudential supervision and regulation for non-bank financial institutions (NBFI). In this context, this paper analyzes the systemic risk of both banks and non-bank sectors (securities firms and insurance companies) in South Korea over different time periods. Using the widely recognized ΔCoVaR methodology for measuring systemic risk, the analysis reveals that systemic risk increased substantially across all three sectors (banks, securities firms, and insurance companies) during the Global Financial Crisis, the European Sovereign Debt Crisis, and the COVID-19 pandemic. Although the banking sector exhibited relatively high systemic risk compared to the securities and insurance sectors, the relative differences in systemic risk varied across the different crisis periods. Notably, during the margin call crisis in March of 2020, the gap in systemic risk between the banking and securities sectors decreased significantly compared to that during both the Global Financial Crisis and the European Sovereign Debt Crisis, indicating that securities firms had a more substantial impact on risk in the overall financial system during this period. Furthermore, I analyze the impact of the issuance of equity-linked securities (ELS) by financial institutions on systemic risk, as measured by ΔCoVaR, finding that an increase in the outstanding balance of ELS issuance by financial institutions had an impact on increasing ΔCoVaR during the three crisis periods. These findings underscore the growing importance of non-bank financial institutions in relation to South Korea's macroprudential management and supervision. To address this evolving landscape, enhanced monitoring and regulatory measures focusing on non-bank systemic risk are essential components of maintaining financial stability in the country.

Key Word: NBFI, Systemic Risk, Macroprudential Policies, Financial Stability, Equity-linked Seurities
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I. Introduction

Since the Global Financial Crisis, both the role and the share of non-bank financial institutions in the global financial market have significantly increased. As of the end of 2021, non-bank financial institutions accounted for 49.2% of the global financial market, marking an increase of 6.4 percentage points from 42.8% in 2011 (FSB, 2022). Furthermore, due to factors such as strengthened regulations that affect banks (including Basel III), prolonged periods of low-interest-rate monetary policies, and the growth of insurance and pension funds, non-bank financial institutions have been providing various forms of credit to both corporations and households. In response to this trend, major countries and international organizations such as governments, the BIS, and the IMF have actively engaged in discussions regarding the macroprudential supervision and regulation of non-bank financial intermediation. They have also worked on improving and introducing relevant regulatory frameworks. A notable example is the establishment of the Financial Stability Board (FSB) by G20 leaders in April of 2009, which tasked the FSB with developing regulatory measures for shadow banking, later renamed non-bank financial intermediation in November of 2011.

In South Korea, the importance of non-bank financial institutions has also increased since the Global Financial Crisis. The proportion of total assets held by non-bank financial institutions has consistently risen compared to that in the banking sector since the Global Financial Crisis. As of the end of 2020, non-bank financial institutions held approximately 90.4% of all assets compared to the banking sector. This marked an increase of approximately 28.4 percentage points from the end of 2010, when the proportion stood at 72.0% (Bank of Korea, 2022).

Furthermore, the scale of non-bank financial institutions has expanded significantly. By the end of 2021, the size of all non-bank intermediaries had increased by approximately two to four times compared to 2008. Specifically, the total assets of the securities industry grew from $80 billion in 2008 to around $350 billion by 2021, representing a substantial increase of approximately 4.4 times.

As a result, South Korea has introduced various measures to strengthen the macroprudential supervision of non-bank financial institutions such as securities firms and insurance companies. However, discussions focusing on the extent and means of enhancing macroprudential supervision for these non-bank financial institutions are ongoing. One key discussion point is whether the systemically important financial institution (SIFI) designation and the enhanced management framework, which were introduced for banks and bank holding companies, should also be applied to large securities firms and insurance companies. Additionally, while banks have experienced enhanced regulatory requirements, such as additional capital requirements and liquidity management through the implementation of Basel III, discussions on the topic of introducing similar levels of prudential regulation for securities firms and insurance companies are still ongoing.

Meanwhile, the COVID-19 Crisis has once again highlighted the importance of strengthening macroprudential regulations as they pertain to non-bank financial institutions. As the COVID-19 pandemic began in February of 2020 and various countries implemented lockdown measures, there was an increased demand for safe-

haven assets among global investors. Particularly, as the crisis deepened in March of 2020, there was a surge in demand for cash-like assets, leading to the "Dash for Cash" phenomenon. This, in turn, resulted in selling pressure on safe-haven assets, including U.S. Treasuries. Consequently, yields on government bonds in major countries experienced rapid increases over a short period. For example, with regard to U.S. Treasuries, the yield on the ten-year maturity bond increased by 50 basis points in just 12 days from March 11th to the 23rd.

In South Korea, there were financial market disruptions during the early stages of the COVID-19 Crisis. Like several other countries, South Korea experienced financial market turmoil, but due to different mechanisms. In March of 2020, securities firms faced margin calls triggered by the price drop of foreign assets underlying previously issued derivative-linked securities. They were required to provide additional collateral. As a result, these securities firms needed foreign currency funds, leading to a rapid surge in exchange rates and commercial paper (CP) rates over a short period.

In response to these challenges, the South Korean government and the Bank of Korea provided foreign currency liquidity to non-bank financial institutions through repurchase agreements (RPs). Additionally, the government established the Foreign Exchange Soundness Council, improved the monitoring system for foreign currency liquidity at non-bank financial institutions, enhanced the foreign currency liquidity supply system, and encouraged diversification of investments in the hedging assets of securities firms issuing derivative-linked securities. These measures aimed to strengthen the macroprudential regulation and management for non-bank financial institutions in South Korea during the COVID-19 Crisis.

Due to the increased importance of macroprudential regulation for non-bank financial institutions and the changing domestic and international regulatory landscape, this paper aims to analyze the changes in systemic risk over time and by industry sector in South Korea. It also examines the impact of the issuance of derivative-linked securities (ELS) on systemic risk. The goal is to derive policy implications pertaining to systemic risk as it affects non-bank financial institutions and macroprudential regulations of these institutions.

Specifically, I analyze the systemic risk of banks and non-bank financial institutions (securities firms and insurance companies) in South Korea by time and industry sector. Among various methods that can be used to measure systemic risk, I utilize the well-known ΔCoVaR metric. The analysis reveals that the level of systemic risk in all sectors, in this case banking, securities, and insurance, significantly increased during the Global Financial Crisis, the European Sovereign Debt Crisis, and the COVID-19 Crisis.

The estimated systemic risk based on ΔCoVaR for the banking sector was relatively high compared to that in the securities and insurance sectors. However, the inter-sectoral differences in systemic risk exhibited varying patterns depending on the crisis. Notably, during the margin call crisis in March of 2020, the difference in systemic risk between the banking and securities sectors decreased significantly compared to that during the Global Financial Crisis and the European Sovereign Debt Crisis. This suggests that the impact of the securities sector on the overall financial system risk during the margin call crisis was more substantial than during previous crises.

Furthermore, to understand the effects of the initial margin call crisis in securities firms' ELS and the development of the derivative-linked securities market on systemic risk, this study analyzed the effect of financial companies' ELS issuance on systemic risk using ΔCoVaR and MES. Initially, the ΔCoVaR and MES outcomes of financial companies were estimated, and a panel fixed-effects regression analysis was conducted to analyze the impact of ELS issuance on systemic risk. Through this analysis, it was found that the impact of the increase in the outstanding balance of financial companies' ELS issuance during three crisis periods and the Hong Kong Hang Seng Index's period of sharp decline led to an increase in systemic risk.

The structure of this paper is as follows. In Chapter II. I review existing research related to systemic risk measurements and macroprudential regulations as aspects of non-bank financial intermediation. Chapter III. provides an overview of the current status and policy trends in non-bank financial institutions. In Chapter IV, I briefly explain the systemic risk analysis method, ΔCoVaR, and its estimation techniques as used in this report. Chapter V presents the main empirical analysis results of this study, and finally, in Chapter VI, I conclude the report.

II. Literature Review

Since the Global Financial Crisis, various studies have attempted to measure systemic risk using different methodologies. Among the most actively utilized approaches for measuring systemic risk are those by Adrian and Brunnermeier (2016), who developed ΔCoVaR, and Acharya *et al*. (2017), who developed MES (marginal expected shortfall). These two methodologies are highly relevant due to their utilization of market data, but they have the drawback of limited insight into the transmission mechanisms within financial institutions or financial markets.

Contrary to market-based systemic risk measures such as ΔCoVaR and MES, balance-sheet-based systemic risk measures utilize data on financial institutions' assets, liabilities, and transactions. This approach has the advantage of being able to quantify the contagion mechanisms between financial institutions directly, though due to privacy concerns mandated by current laws and regulations, such data are confidential and available exclusively to regulatory bodies. Owing to these constraints, this study uses market-based systemic risk measures. Balance-sheet-based systemic risk measures are also generally associated with lower data frequency rates than market-based systemic risk measurement methods. In this paper, I estimate ΔCoVaR and MES using daily and weekly data. A survey study focusing on various systemic risk measurement methods was conducted by Suh (2018).

In research that utilizes ΔCoVaR, several noteworthy studies can be highlighted. Firstly, Kim and Kim (2010) conducted research on inter-industry contagion among commercial banks, mutual savings banks, and securities firms using the ΔCoVaR estimation technique. They particularly found that mutual savings banks exhibit greater exposure to systemic risk compared to other sectors.

Using ΔCoVaR, Kim and Lee (2017) analyzed the impact of changes in the proportion of non-deposit liabilities for large financial holding companies in South Korea and the United States before and after the Global Financial Crisis. Their

findings indicated that an increase in the proportion of non-deposit liabilities had a negative effect on systemic risk for large financial holding companies in the U.S. In contrast, for South Korea, it was observed that immediately after an increase in the proportion of non-deposit liabilities, there was a negative impact on systemic risk, but over time, the effect was positive. Consequently, they concluded that it is difficult to discuss the impact of non-deposit liabilities on systemic risk uniformly across different countries.

Jin and Lee (2021) estimated the impact of the credit cycle on systemic risk in the financial industry using ΔCoVaR and panel regression models. Their results confirmed that the credit cycle increases systemic risk, particularly highlighting the significant influence of non-financial corporate credit and household credit on the deterioration of systemic risk.

The discussion over whether securities firms and insurance companies are systemic financial institutions as important as banks is ongoing (Lee, 2020 and Kim, 2019). Lee (2020) argued that the systemic risk associated with securities firms has been steadily increasing but is not immediately worrisome. Kim (2019) contended that the nature of the insurance industry is changing, with exposure to systemic risk arising as the industry undertakes non-traditional insurance tasks, thereby increasing the magnitude of the risk as well. Regarding the measurement of systemic risk, Lee (2020) utilized indicators applied to banks, finding that the systemic risk for banks, securities, and insurance sectors was high in that order according to the mean of CoVaR as opposed to the outcome when using ΔCoVaR as introduced by Adrian and Brunnermeier (2016), though details about the estimation methods (i.e., VAR, quantile regression) were not provided.

Kim (2019), on the other hand, analyzed the systemic importance of securities and insurance companies by means of a concentration analysis, a principal component analysis, and with the Granger causality analysis method. In contrast, this paper used ΔCoVaR to compare and analyze systemic risk across different financial sectors, showing that the systemic risk of securities firms and insurance companies varies over time and that the gap with banks decreases during financial crises.

Previous research analyzing the impact of ELS issuance on financial stability or markets includes work by Yoon and Jung (2018) and by Lee (2017). Yoon and Jung (2018) used the Bank of Korea's Financial Stability Index (FSI), a weighted average of 20 indicators (such as bank delinquency rates, stock price, and foreign exchange volatility), to demonstrate that ELS issuance negatively affects financial stability. One limitation of their approach is that the FSI does not account for the contagion effect in systemic risk estimations. Lee (2017) estimated the impact of increased ELS on stock returns, government and corporate bond yields, and repurchase agreement (RP) sales balances, arguing that the financial risks associated with increased ELS are not alarming but have increased slightly. Lee (2017)'s study also did not use systemic risk indicators that reflect market contagion effects.

A range of earlier work has examined different aspects of systemic risk, but the present study is unique in the following ways. First, this study estimates the systemic risk of both banks and non-banks (securities firms and insurance companies) using the dynamic conditional correlation (DCC) model, with data available on a daily basis. Notably, the analysis period includes the margin call crisis of March of 2020. During the securities firms' margin call crisis in March of that year, collateral

requirements for securities firms increased significantly on a daily basis, causing turmoil in the South Korean financial markets. Therefore, this study examines daily changes in systemic risk, taking this period into account.

The second distinctive feature of this study is that it compares and analyzes the systemic risk of both banks and non-bank financial institutions. This allows for a discussion of the need to enhance systemic risk management and macroprudential policies, particularly for South Korea's non-banking sector. Based on the results of this study, discussions could include the introduction of Basel-style regulations for securities firms and considerations when applying the systemically important financial institution (SIFI) designation.

Lastly, this study includes a time-specific analysis using ΔCoVaR and MES to examine the impact of securities firms' ELS issuances on systemic risk, discovering that the magnitude of this impact increased during crises in the past, with variations observed during different crisis periods. Given the unique characteristics of South Korea's ELS market and its market size, this research utilized two representative systemic risk measurement methods, ΔCoVaR and MES, to analyze the effect of ELS issuances on the stability of South Korea's financial markets.

III. NBFI in Korea

A. *Overview of NBFI in Korea*

First, as with major countries worldwide, Korea has also seen an increase in the proportion of the non-bank financial intermediation (NBFI) sector within its

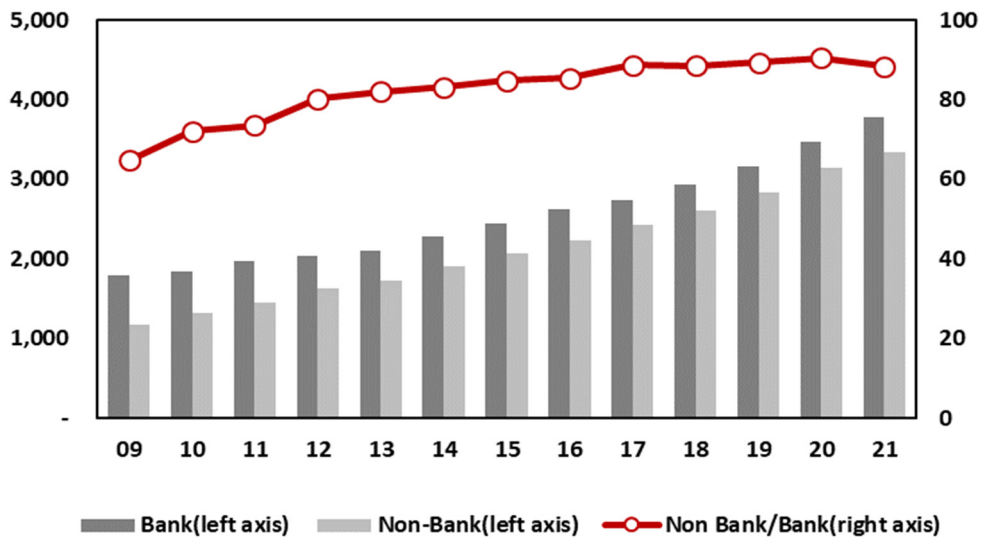

FIGURE 1. BANK AND NON-BANK'S TOTAL ASSET AND NON-BANK/BANK TOTAL ASSET RATIO

Note: Total assets for the Non-Bank category here refers to the sum of the total assets of insurance, credit unions, securities firms, specialized credit finance firms, and savings banks.

Source: Banking Statistics System of Financial Supervisory Service and Financial Stability Report of Bank of Korea.

financial markets since the Global Financial Crisis. This shift is evident when examining the size and proportion of NBFI's assets relative to banking assets. As of the end of 2020, the non-bank financial intermediation (NBFI) sector held approximately 90.4% of all assets, a notable increase of approximately 28.4 percentage points compared to the end of 2010, when this proportion stood at 72.0%.

As of the end of 2021, South Korea's non-bank financial intermediation (NBFI) sector reached $1.1 trillion in size. When categorized according to their economic function (EF) by the Financial Stability Board (FSB), the components of the narrow measure of NBFI, listed in descending order of their proportions, are shown in Table 1.

EF3, which includes securities firms engaged in credit intermediation within the direct finance market, accounts for 31.8% of the total. EF1, representing collective investment schemes with the potential for mass redemptions, makes up 31.1%. EF5, focusing on liquidity facilities involved in credit intermediation through securitization, constitutes 19.4%. EF2, encompassing lending institutions reliant on short-term funding, contributes 14.4%. EF4, comprising specialized bond guaranty insurers and similar entities involved in credit enhancement functions, represents 3.1% of the total.

When examining the scale and proportions by function over the years in Figure 2, it is evident that the rankings remain relatively stable. EF1 (collective investment schemes) and EF3 (securities firms) consistently account for approximately 20-30% each, collectively making up around 60-70%. Following these, EF2 (credit specialized finance companies), EF5 (liquidity facilities), and EF4 (guarantee institutions) take their positions in descending order.

The rankings based on size by year correspond to the rankings based on proportion. By the end of 2021, the size of all non-bank intermediaries had increased by approximately two to four times compared to 2008. Particularly, the assets of EF3 (securities firms) grew from $80 billion in 2008 to around $350 billion by 2021, an increase of approximately 4.4 times. This is mainly attributable to the introduction of the Comprehensive Financial Investment Business Entities system in 2013 and the Large-Scale IB system in 2016, which led to the expansion of asset sizes for securities firms.

Figure 3 shows the asset composition of banks, securities firms, and insurance companies. Banks have a large proportion of loans among their assets, while securities and insurance companies hold a substantial portion of securities. Such asset composition differences can lead to varying levels of systemic risk across

TABLE 1—SIZE, PERCENTAGE AND GROWTH OF NBFI BY ECONOMIC FUNCTIONS IN 2021

	USD trillions	% of total	% of GDP	2021 YoY growth, %	2016-20 growth, (%)
Total	1.10	100.0	63.3	9.9	8.3
EF1	0.30	31.3	19.8	19.0	7.8
EF2	0.20	14.4	9.1	6.8	7.2
EF3	0.30	31.8	20.1	4.5	10.2
EF4	0.00	3.1	2.0	8.8	12.8
EF5	0.20	19.4	12.3	8.0	6.4

Source: https://data.fsb.org/dashboard/Time%20Series%20View.

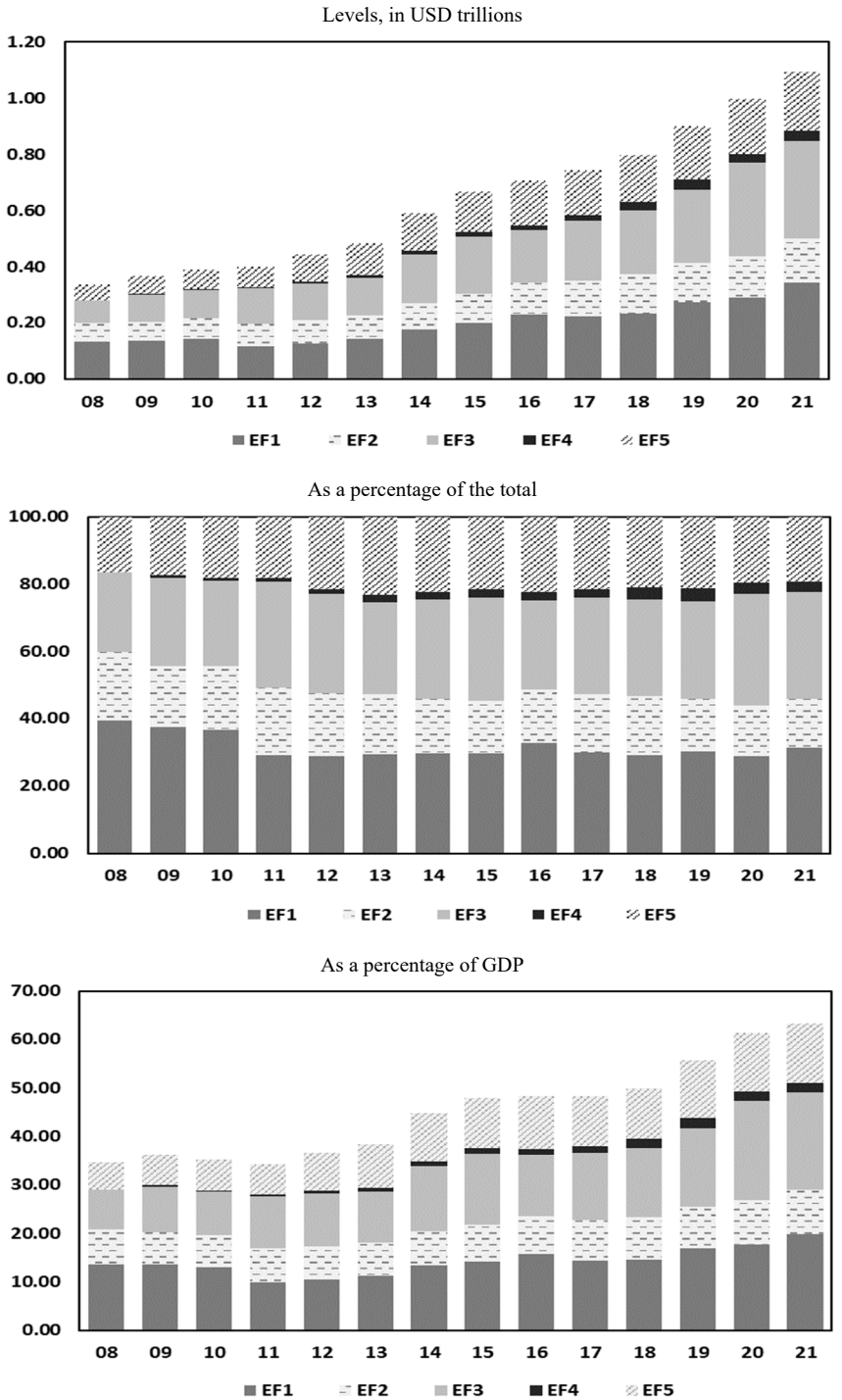

FIGURE 2. MAIN MONITORING AGGREGATES OF THE FSB'S GLOBAL MONITORING REPORT ON NBFI

Note: The definitions of Economic Functions are given in Table 1.

Source: FSB.

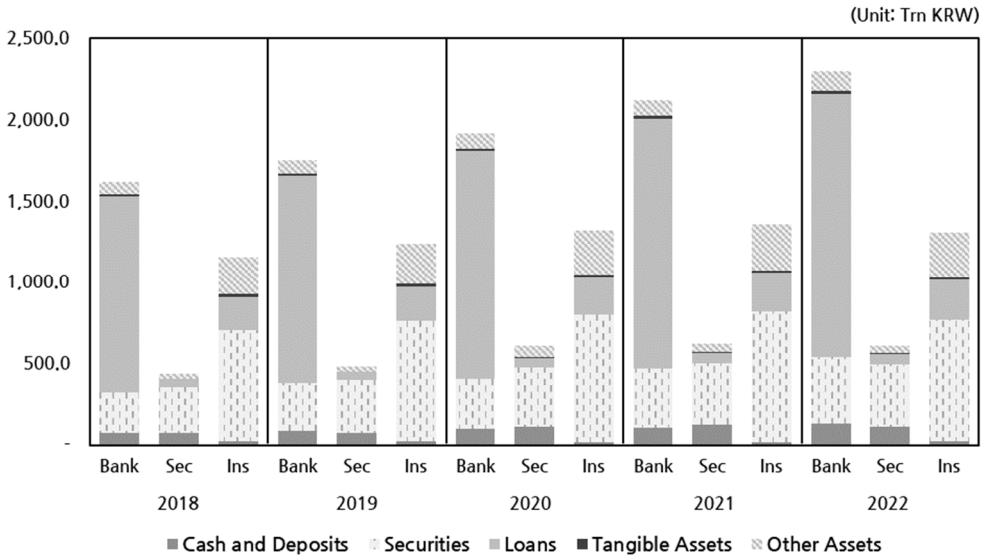

FIGURE 3. ASSET COMPOSITION OF BANKS, SECURITIES FIRMS AND INSURANCE COMPANIES

Notes: Other Assets of Security Firms include derivatives, CMA operating assets, lease assets, and other assets; Other Assets of Insurance Firms include non-operating assets and special account assets.

Source: Financial Supervisory Service Information.

these sectors. For instance, as evidenced by the margin call crisis in March of 2020, securities firms' self-hedging through the ownership of foreign index futures and credit card companies' bonds can affect systemic risk.

B. *March 2020 market turmoil and equity –linked securities (ELS)*

The COVID-19 Crisis marked the first event with the potential to threaten global financial stability since the 2008-09 Global Financial Crisis. Specifically, it exposed vulnerabilities in the non-bank financial intermediaries (NBFI) sector within the short-term financial markets, prompting unprecedented interventions by central banks and governments.

In particular, the surge in demand for cash in March of 2020, commonly referred to as the "Dash for Cash," resulted in turmoil across various financial markets, including stocks, bonds, and the foreign exchange market (see FSB, 2020). As the COVID-19 Crisis deepened in March of that year, there was a sharp increase in the demand for cash, a short-term highly liquid asset, which translated into selling pressure on major financial assets. On March 16th, 2020, the S&P 500 experienced a 12% decline, marking the largest single-day drop since 1987. Additionally, yields on government bonds of major economies experienced rapid increases. For instance, for U.S. Treasury bonds, the ten-year maturity yield surged by 50 basis points over 12 days (from March 11th to March 23rd).

For South Korea, the initial turmoil in global financial markets during the early stages of the COVID-19 Crisis had a direct impact on the derivatives and structured securities markets, indirectly leading to disruptions in South Korea's foreign

exchange and short-term financial markets. In March of 2020, securities firms faced margin calls due to the price declines of underlying assets in derivatives and structured securities issued abroad. The total net outflows from securities firms amounted to 1.3 trillion KRW from March 2nd to March 6th, with daily outflows subsequently ranging from 0.1 trillion KRW to 3 trillion KRW. As a result, a total of 10.1 trillion KRW was transferred to overseas exchanges to meet margin calls during March (see Figure 4).

In South Korea, the persistent low-interest-rate environment following the Global Financial Crisis led to continuous growth in the structured securities market, offering investors higher yields than traditional deposit accounts while maintaining a relatively low risk of principal loss. The market expanded from 26.9 trillion KRW at the end of 2008 to 111.7 trillion KRW at the end of 2018 but then decreased to 89.0 trillion KRW by the end of 2020.

Among the prominent types of structured securities in South Korea are equity-linked securities (ELS). The ELS type typically provides investors with a structure that guarantees a fixed return, often around 5.4% per year, as long as the underlying assets (such as the Hong Kong Hang Seng Index or Euro Stock) do not fall below a certain predefined level, set at around 85%, every six months.

This structure has been attractive to investors seeking relatively stable returns while minimizing the risk of significant capital loss, and it played a role in the growth and popularity of structured securities in South Korea during the low-interest-rate era.

Securities firms that issue equity-linked securities (ELS) use the funds received from investors to purchase or sell underlying assets and bonds, ultimately delivering returns to investors based on pre-established agreements. Through this process, the issuer engages in hedging to manage their exposure arising from the positions established within the products they have sold. The magnitude and direction of hedging transactions depend on the price and volatility of the underlying assets, which are determined based on sensitivity measures stemming from no-arbitrage-based derivative product pricing models (Bakshi and Kapadia, 2003).

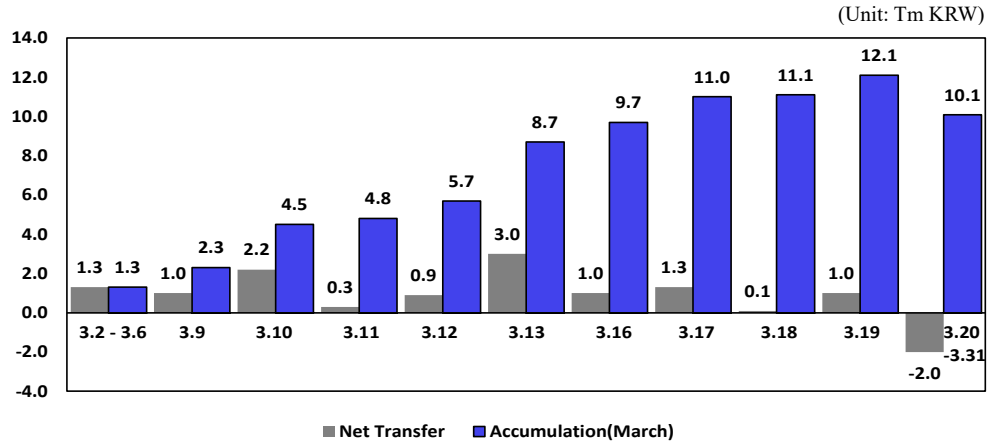

FIGURE 4. TREND OF SECURITIES FIRMS' NET TRANSFER DURING MACH 2020

Source: *MoneyToday*, "The day one year ago when securities firms shook, the system teetered," April 3, 2021.

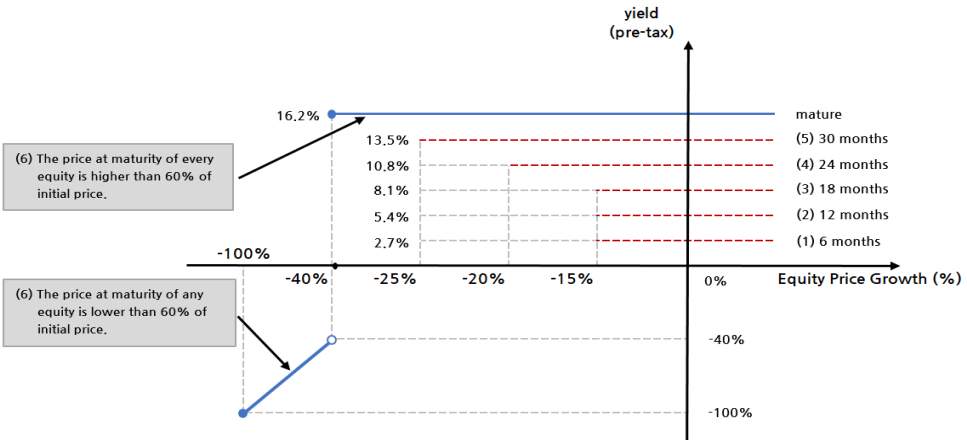

FIGURE 5. EXAMPLE OF STEP-DOWN AND AUTO-CALLABLE TYPE ELS PROFIT AND LOSS STRUCTURES

Source: Prepared by the author.

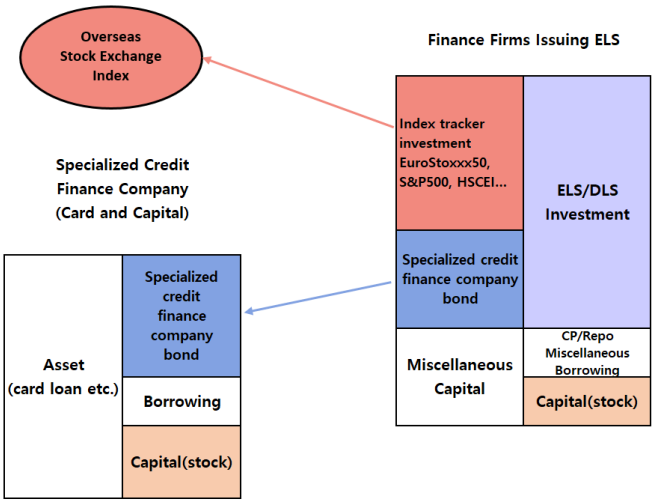

FIGURE 6. ELS HEDGING STRATEGY

Source: Prepared by author.

The mechanism through which the issuance of ELS by securities firms can trigger market turmoil lies in the behavior of hedging against the potential loss risks associated with ELS issuance. When securities firms issuing ELS opt for self-hedging by investing in stock index futures, they may need domestic or foreign currency funds to meet any margin calls that may arise. Consequently, the financial institution may attempt to sell assets such as bonds or borrow on the short-term money market to meet these additional margin calls.

For instance, for financial institutions that issue ELS, as depicted in Figure 5, there is a high likelihood that they will adopt long positions in the underlying asset futures to guarantee a certain annual interest rate (total return increases over time)

Type	Trillion won	% of Total
Corporate Bond	147.1	76.2
Borrowings	29.9	15.5
Foreign Currency Borrowings	2.4	1.3
ABS	12.8	6.6
etc.	0.7	0.4
Total	192.9	100.0

Type	Trillion won	% of Total
Securities Firms	52.7	37.4
Asset Management	27.8	19.7
Pension Fund	24.5	17.4
Insurances	12.3	8.7
Banks	17.5	12.4
Etc.	6.3	4.4

FIGURE 7. FUNDING STRUCTURE OF SPECIALIZED CREDIT FINANCING COMPANIES AND THE POSSESSION OF THOSE BONDS

Source: The Financial Services Commission (2018).

to investors until maturity. Consequently, if the price of the underlying asset drops significantly over a short period, financial companies that have chosen self-hedging as a strategy may incur losses from their futures long positions. This situation can lead to an increase in liquidity risk as the firms must meet margin calls (arrange for additional collateral).

Furthermore, the sale of assets and borrowing in the short-term money market to secure funds can lead to the purchase of foreign currencies, potentially causing exchange rate fluctuations. These mechanisms, characterized by asset fire sales, short-term borrowing, and foreign exchange purchases, can contribute to sharp increases in interest rates and exchange rates, thereby inducing turmoil in financial markets, including disruptions of short-term financial instruments such as commercial paper (CP) and repurchase agreements (RP).

Moreover, securities firms engaged in ELS sales have the option to invest a portion of their ELS sales proceeds in bonds issued by specialized credit finance companies, as illustrated in Figure 7. When examining the capital-raising activities and bond holdings of specialized credit finance companies as of 2018, it is evident that these entities sourced approximately 76.2% (equivalent to KRW 147.1 trillion) of their funds through the issuance of bonds. Notably, among these bonds, 37.4% were held by securities firms, as depicted in Figure 7.

The increasing interconnectedness between securities firms and specialized credit finance companies through such bonds can lead to an elevated rollover risk for specialized credit finance companies. This risk could potentially impact not only securities firms but also specialized credit companies in the event of a sudden decline in the assets underpinning the ELS.

As shown above, considering the characteristics of the structured securities market in South Korea, such as the ELS revenue structures, the rapid growth of this market, and the hedging practices of securities firms (utilizing bonds and index futures for self-hedging), it is possible that the issuance of structured securities has had varying effects on financial stability and systemic risk in the Korean economy. Therefore, I analyze the impact of derivative-linked securities issuance on systemic risk later in this paper.

IV. Data and Methodology

A. *Systemic risk measure*

There exist various approaches by which to measure systemic risk, and many prior studies have relied on the two prominent indicators of ΔCoVaR (Adrian and Brunnermeier, 2016) and MES (Acharya *et al*., 2017). The combination of these indicators is appealing due to their complementary perspectives. ΔCoVaR considers banks as "risk inducers" and estimates the additional value at risk (VaR) that a financial institution contributes to the overall systemic risk level when it encounters distress. In contrast, MES treats banks as "risk recipients" and calculates their conditional equity losses when distress strikes the financial system.

In the context of our study, which analyzes the impact of equity-linked securities (ELS) issuance on systemic risk, it is more appropriate to consider individual financial institutions as risk inducers. Consequently, I use ΔCoVaR in the primary analysis, with MES employed to assess the robustness of this approach.

Firstly, following Adrian and Brunnermeier (2016), ΔCoVaR is defined as follows:

$$\Delta CoVaR_q^{system|i} = CoVaR_q^{system|X^i=VaR_q^i} - CoVaR_q^{system|X^i=VaR_{50}^i}$$

Here, X^i represents the stock returns of financial institution i, and q signifies the q-th percentile, i.e., the value at risk (VaR). $C(X^i)$ is the conditional event for financial institution i, and $C(X^i)$ is defined conditionally for the financial system (S). I estimate ΔCoVaR using the dynamic conditional correlation (DCC) model (Brownlees and Engle, 2012).

As a robustness check, I also use MES (marginal expected shortfall) as a systemic risk measure, as mentioned above. MES is defined as follows:

$$MES_{i,t}(C) = E(r_{i,t+1} \,|\, r_{m,t+1} < C)$$

In short, MES is defined as the expected value of a financial institution's returns when the financial system's returns fall below C, where C is set to -2%, following the methodology proposed by Brownlees and Engle (2012).

B. *Summary statistics*

I use daily returns of KOSPI indices for the banking, securities, insurance, and overall financial sectors from January of 2006 to December of 2020 to estimate ΔCoVaR at different time points. Table 2 provides basic statistical measures for the returns of each sector's index.

To analyze the impact of equity-linked securities (ELS) issuance on systemic risk (ΔCoVaR and MES), I devised a fixed-effects panel regression model. Within the fixed-effects model, I controlled for various macroeconomic variables, including the

TABLE 2—SUMMARY STATISTICS OF THE FINANCIAL SECTOR INDEX

	Obs	Mean	Standard Deviation	Min	Max
Banks	3,708	0.005	1.914	-14.840	14.390
Securities Firms	3,708	0.013	2.228	-14.630	14.560
Insurance Firms	3,708	0.014	1.640	-11.110	11.580
Financial Industry Index	3,708	0.004	1.584	-12.250	11.280

TABLE 3—SUMMARY STATISTICS OF THE MAIN VARIABLES

	Obs	Mean	Standard Deviation	Min	Max
ELS outstanding (trillion won)	10,650	1.92	2.23	0.00	12.16
Total assets (trillion won)	10,650	68.53	126.31	1.29	578.35
Capital/asset ratio	10,650	0.12	0.04	0.06	0.36
Bank of Korea policy rate (%)	10,650	2.07	0.72	0.75	5.25
Fed policy rate (%)	10,650	0.71	0.74	0.13	2.5
GDP growth of South Korea (YoY, %)	10,650	2.94	1.82	-2.6	7.9
Consumer Price Index of South Korea (YoY, %)	10,650	1.82	1.17	-0.4	4.8

Korean policy interest rate, U.S. policy interest rate, Korean Consumer Price Index, and GDP. Table 3 provides descriptive statistics for these variables.

Furthermore, I employed the daily stock returns of a total of 15 financial institutions, consisting of five banks, five securities firms, and five insurance companies, to estimate ΔCoVaR for each of these financial institutions.

V. Empirical Results

A. *Systemic risk contribution by sector*

In an analysis estimating ΔCoVaR across banking, securities, and insurance sectors over different time periods, I observed significant increases in ΔCoVaR during global financial crises, specifically the Global Financial Crisis, the European Sovereign Debt Crisis, and the COVID-19 Crisis (Figure 8). These findings are consistent with the concept of systemic risk, which aims to measure the heightened risk across the entire financial system during crises. Additionally, during these three crisis periods, the increase in ΔCoVaR across all sectors corroborates studies that focused on financial distress, where financial distress is defined according to ΔCoVaR criteria. Specifically, this implies situations in which the weekly returns of individual sector indices decline to the bottom 5% from the median value.

The increase in ΔCoVaR across all sectors signifies a heightened impact on the overall financial system's risk profile. This phenomenon manifests as an increase in the correlation between the financial sector indices and individual financial institution returns, as well as an increase in the bankruptcy risk of individual financial institutions.

Upon examining specific estimates, the findings are as follows (Table 4). Over the entire analysis period from January of 2006 to December of 2020, the average ΔCoVaR estimates for the banking, securities, and insurance sectors are 2.03%,

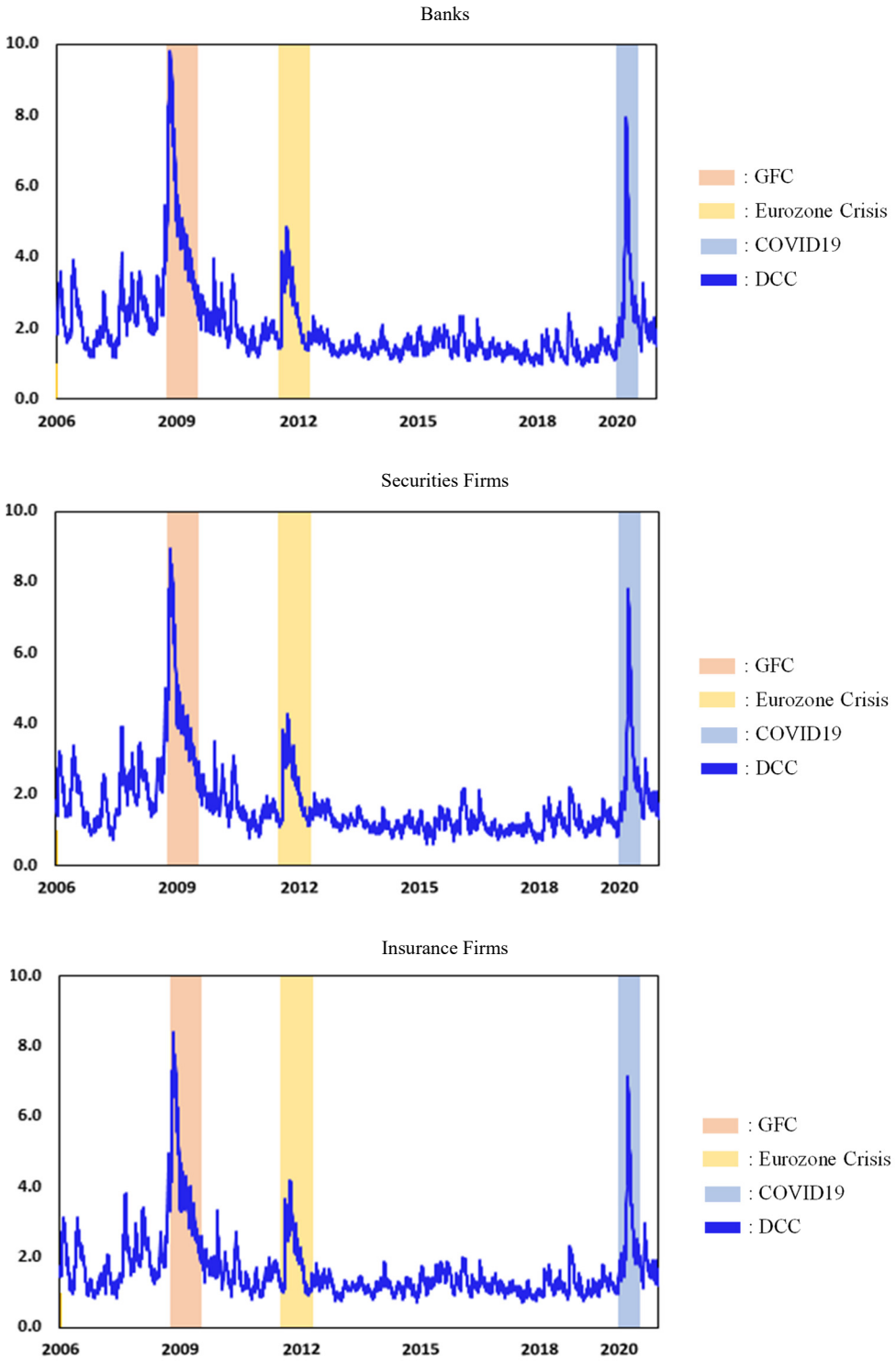

FIGURE 8. ΔCoVaR (DCC) TIME SERIES BY INDUSTRY AND CRISIS

Source: Author's calculation.

TABLE 4—ΔCoVaR, ASSET VaR, AND MARKET VaR OF BANKS SECURITIES FIRMS AND INSURANCE FIRMS BY DIFFERENT TIME PERIODS

Whole Period	Banks	Securities Firms	Insurance Firms
ΔCoVaR	2.03 (1.12)	1.75 (1.07)	1.64 (0.96)
Asset VaR	2.76 (1.22)	3.27 (1.41)	2.39 (1.01)
Market VaR	2.3 (1.18)	2.3 (1.18)	2.3 (1.18)
Global Financial Crisis	Banks	Securities Firms	Insurance Firms
ΔCoVaR	5.24 (1.82)	4.73 (1.68)	4.3 (1.62)
Asset VaR	6.58 (2.07)	6.31 (2.23)	4.62 (1.52)
Market VaR	5.66 (1.99)	5.66 (1.99)	5.66 (1.99)
European Sovereign Debt Crisis	Banks	Securities Firms	Insurance Firms
ΔCoVaR	2.57 (0.95)	2.27 (0.86)	2.05 (0.88)
Asset VaR	3.45 (1.04)	3.93 (1.16)	2.16 (0.52)
Market VaR	2.79 (0.21)	2.79 (0.21)	2.79 (0.21)

Note: Figures in the table represent the average value, and ( ) represents the standard deviation.

1.75%, and 1.64%, respectively. In other words, when the daily returns of individual sector indices fall to the bottom 5% from the median value, the daily 5% value at risk (absolute value of the lower fifth percentile) for the financial sector index increases on average by 2.03, 1.75, and 1.65 percentage points, respectively. This implies that distress in individual sectors has an impact on the overall increase in downside risk for the financial system (corresponding averages of 2.03%, 1.75%, and 1.65%). Considering that the average 5% value at risk for the financial sector index over the entire analysis period (January 2006 to December 2020) is 2.30%, the ΔCoVaR estimates indicate that the impact of each sector on the overall financial system is non-negligible (averages of 2.03%, 1.75%, and 1.65%)

The average estimated ΔCoVaR values for different sectors during the Global Financial Crisis period (October 2008 to June 2009) are 5.24%, 4.73%, and 4.30% respectively. These figures are markedly elevated in comparison to the average ΔCoVaR estimates for the entire analysis period of January of 2006 to December of 2020, which are 2.03%, 1.75%, and 1.65%, respectively. Specifically, the averages during the crisis period exceed the long-term averages correspondingly by 3.21, 2.98, and 2.65 percentage points. Additionally, this difference is notably greater than the standard deviations of ΔCoVaR, 1.12%, 1.07%, and 0.96%, for the sectors over the entire analysis period. The ratios between the differences and these standard deviations are 2.86, 2.79, and 2.76, respectively.

These findings imply a statistically significant increase in systemic risk within these sectors during the period of the Global Financial Crisis.

During the period of the Global Financial Crisis (October 2008 to June 2009), the average 5% VaR for the financial sector index was 5.66%. This represents an

increase of 3.66 percentage points compared to the average 5% VaR of 2.30% for the entire analysis period (2008.10 to 2009.6). These data imply increased overall risk within the financial sector during the crisis, consistent with the concept of rising systemic risk during periods of financial instability.

Similarly, during the European Sovereign Debt Crisis (January 2010 to June 2012), the maximum ΔCoVaR values for the banking, securities, and insurance sectors were 4.87%, 4.27%, and 4.17%, respectively. These figures are significantly higher than the average ΔCoVaR estimates for the entire analysis period from January of 2006 to December of 2020, which are 2.03%, 1.75%, and 1.65%. The specific increases in these values are correspondingly 2.84, 2.52, and 2.52 percentage points. Moreover, these increases are 3.75, 3.2, and 3.21 times greater than the standard deviations of ΔCoVaR for the sectors over the entire analysis period, which are 1.12%, 1.07%, and 0.96%.

Such findings strongly suggest that systemic risk escalated during the European Sovereign Debt Crisis, aligning with the notion that the overall risk within the financial sector intensifies during crisis periods.

During the COVID-19 Crisis period (January 2020 to June 2020), the average ΔCoVaR values for the banking, securities, and insurance sectors were 3.31%, 3.12%, and 2.88%, respectively. These figures are considerably higher than the average ΔCoVaR estimates for the Global Financial Crisis period (October 2008 to June 2009), which were 2.03%, 1.75%, and 1.65%. Specifically, the COVID-19 Crisis period averages exceed the Global Financial Crisis period averages by 2.19, 2.05, and 1.92 percentage points, respectively. These increases are also 2.95, 2.91, and 3 times greater than the standard deviations of ΔCoVaR for the sectors during the Global Financial Crisis period (1.12%, 1.07%, and 0.96%).

Moreover, during the period of securities firms' margin call events (March 1 to March 31, 2020), as referred to above, a significant surge in ΔCoVaR was observed. The peak ΔCoVaR values during this period for the banking, securities, and insurance sectors were 7.94%, 7.81%, and 7.16%, respectively. These values are 7.1, 7.3, and 7.46 times greater than the standard deviations of ΔCoVaR during the

TABLE 5—ΔCOVAR, ASSET VAR, AND MARKET VAR OF BANKS SECURITIES FIRMS AND INSURANCE FIRMS DURING COVID-19 AND 2020 MARGIN CALL CRISIS

COVID-19	Banks	Securities Firms	Insurance Firms
ΔCoVaR	3.31 (1.69)	3.12 (1.7)	2.88 (1.53)
Asset VaR	4.24 (1.62)	4.51 (2.17)	3.7 (1.66)
Market VaR	3.66 (1.82)	3.66 (1.82)	3.66 (1.82)
2020 Margin Call Crisis	Banks	Securities Firms	Insurance Firms
ΔCoVaR	4.93 (2.11)	4.75 (2.12)	4.41 (1.96)
Asset VaR	5.29 (1.92)	5.73 (2.9)	4.6 (1.91)
Market VaR	5.39 (2.28)	5.39 (2.28)	5.39 (2.28)

Note: Figures in the table represent the average value, and ( ) represents the standard deviation.

Global Financial Crisis period (1.12%, 1.07%, and 0.96%). They are approximately 0.81 to 0.87 times the peak ΔCoVaR values observed during the Global Financial Crisis (9.82%, 8.94%, and 8.40%) and about 1.63 to 1.82 times the peak ΔCoVaR values during the European Sovereign Debt Crisis (4.87%, 4.27%, and 4.17%).

In summary, these findings imply that systemic risk increased during the COVID-19 Crisis, albeit at a magnitude smaller than that of the Global Financial Crisis but greater than that of the European Sovereign Debt Crisis. Particularly during the securities firms' margin call events in the initial phase of the COVID-19 Crisis, these results suggest that the overall risk within the Korean financial market was markedly elevated.

B. *Systemic risk contributions by individual financial institutions*

When comparing the difference in ΔCoVaR among industry sectors over the entire analysis period, ΔCoVaR for the securities and insurance sectors was lower than that of the banking sector. Furthermore, individual banks (including bank holding companies), securities firms, and insurance companies exhibited similar trends in their ΔCoVaR values compared to the industry-specific ΔCoVaR indices (see Figure 9 and Table 6).

To delve into specifics, as of the end of 2020, the ΔCoVaR for the top five banks and bank holding companies ranged from 1.61 to 1.80, notably more significant than the values of 1.20 to 1.56 observed for the five securities firms and the range of 0.58 to 1.13 observed for the five insurance companies. This analysis highlights a tendency to find larger ΔCoVaR values among the major banks and bank holding companies compared to those of securities and insurance firms.

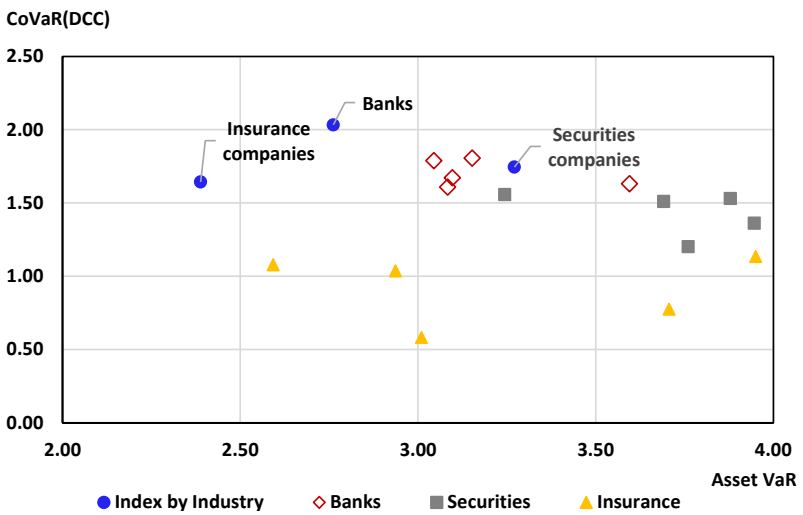

FIGURE 9. JAN. 2006 ~ DEC. 2020 ΔCOVAR (DCC) - ASSET VAR SCATTERPLOT

Note: Five banks (Shinhan, KB, Hana, Woori, IBK), five securities firms(Mirae Asset, Meritz, Korea-Investment, Samsung), and five insurance firms (Mirae Asset Life, Samsung Life, Hanhwa Life, DB, Lotte) constitute the sample for the CoVaR and Asset VaR calculations.

Source: Author's calculations.

TABLE 6—ΔCOVAR AND ASSET VAR BY EACH INDUSTRY AND FIRM FROM 2006 TO 2020

Banks	Bank Industry Index	Shinhan	KB	Hana	Woori	IBK
CoVaR	2.03 (1.12)	1.79 (1.03)	1.67 (1.00)	1.63 (0.91)	1.80 (1.02)	1.61 (0.97)
Asset VaR	2.76 (1.22)	3.05 (1.16)	3.10 (1.40)	3.60 (1.58)	3.15 (0.90)	3.08 (1.40)
Securities Firms	Securities Industry Index	Mirae Asset	NH	Korea-Investment	Samsung	Meritz
CoVaR	1.75 (1.07)	1.53 (0.95)	1.51 (0.95)	1.36 (0.81)	1.56 (0.92)	1.20 (0.94)
Asset VaR	3.27 (1.41)	3.88 (1.66)	3.69 (1.47)	3.95 (1.33)	3.24 (1.27)	3.76 (1.49)
Insurance Firms	Insurance Industry Index	Samsung Life	Hanhwa	Mirae Asset Life	Lotte	DB
CoVaR	1.64 (0.96)	1.08 (0.50)	1.04 (0.47)	0.58 (0.30)	0.78 (0.71)	1.13 (0.80)
Asset VaR	2.39 (1.01)	2.59 (0.99)	2.94 (1.23)	3.01 (1.33)	3.71 (2.14)	3.95 (1.71)

Note: Figures in the table represent the average value, and ( ) represents the standard deviation.

This outcome aligns with banks' status and role in the Korean financial market and system compared to securities and insurance companies. While it is true that the proportion of non-banking sector assets relative to banks has increased over the past decade, the overall estimation results of ΔCoVaR throughout the analysis period underscore the relative significance of banks compared to securities and insurance firms within the Korean financial market.

This analysis highlights the prevailing importance of banks in the Korean financial landscape, in contrast to securities and insurance companies, despite the observed growth in the non-banking sector's asset share over the past ten years.

Furthermore, during the Global Financial Crisis, the average ΔCoVaR for individual banks, securities firms, and insurance companies ranged from 4.26% to 4.78%, 3.59% to 4.17%, and 2.81% to 3.40%, respectively. Compared to banks, the average ΔCoVaR values for securities firms and insurance companies were smaller, ranging from 0.09% to 1.19% and from 0.86% to 1.97%, respectively.

In contrast, during the European Sovereign Debt Crisis period, the average ΔCoVaR for banks, securities firms, and insurance companies ranged from 1.65% to 1.87%, 1.26% to 1.60%, and 0.84% to 1.19%, respectively. Notably, compared to banks, the average ΔCoVaR for securities firms and insurance companies was relatively small, ranging from 0.05% to 0.61% and 0.68% to 1.03%, respectively. Therefore, during the Global Financial Crisis, the ΔCoVaR for banks relative to securities firms and insurance companies was higher than it was during the European Sovereign Debt crisis period.

This implies that during the Global Financial Crisis, the impact of financial distress experienced by banks on the overall financial market was more significant than in the European Sovereign Debt crisis period. This difference could be attributed to the higher relative share of assets held by banks in the overall financial market during the Global Financial Crisis and the heightened importance of core banking activities such as lending and deposit-taking within the broader financial system.

Meanwhile, during the COVID-19 Crisis period, especially during the margin call

TABLE 7—ΔCoVaR AND ASSET VaR BY EACH INDUSTRY AND FIRM DURING THE GLOBAL FINANCIAL CRISIS (OCT. 2008 ~ JUN. 2009)

Banks	Bank Industry Index	Shinhan	KB	Hana	Woori	IBK
CoVaR	5.24	4.78	4.48	4.26	-	4.43
	(1.82)	(1.69)	(1.54)	(1.48)	-	(1.54)
Asset VaR	6.58	6.71	7.18	8.73	-	7.18
	(2.07)	(1.64)	(2.10)	(2.79)	-	(2.61)
Securities Firms	Securities Industry Index	Mirae Asset	NH	Korea-Investment	Samsung	Meritz
CoVaR	4.73	4.17	4.14	3.59	4.16	3.76
	(1.68)	(1.64)	(1.61)	(1.37)	(1.39)	(1.33)
Asset VaR	6.31	7.63	7.07	6.21	5.07	5.74
	(2.23)	(2.58)	(2.41)	(1.36)	(1.58)	(2.61)
Insurance Firms	Insurance Industry Index	Samsung Life	Hanhwa	Mirae Asset Life	Lotte	DB
CoVaR	4.30	-	-	-	2.81	3.40
	(1.62)	-	-	-	(0.96)	(1.52)
Asset VaR	4.62	-	-	-	6.04	8.92
	(1.52)	-	-	-	(2.27)	(3.57)

Note: Figures in the table represent the average value, and ( ) represents the standard deviation.

TABLE 8—ΔCoVaR AND ASSET VaR BY EACH INDUSTRY AND FIRM DURING EUROPEAN SOVEREIGNDEBT CRISIS (APR. 2010 ~ JUN. 2012)

Banks	Bank Industry Index	Shinhan	KB	Hana	Woori	IBK
CoVaR	2.12	1.87	1.81	1.65	-	1.66
	(0.70)	(0.63)	(0.60)	(0.62)	-	(0.61)
Asset VaR	2.87	3.18	3.22	3.77	-	3.47
	(0.78)	(0.76)	(0.90)	(0.80)	-	(0.82)
Securities Firms	Securities Industry Index	Mirae Asset	NH	Korea-Investment	Samsung	Meritz
CoVaR	1.80	1.56	1.51	1.34	1.60	1.26
	(0.67)	(0.56)	(0.55)	(0.48)	(0.60)	(0.65)
Asset VaR	3.22	4.00	4.05	4.23	3.49	2.82
	(0.83)	(1.11)	(1.32)	(0.89)	(0.96)	(0.49)
Insurance Firms	Insurance Industry Index	Samsung Life	Hanhwa	Mirae Asset Life	Lotte	DB
CoVaR	1.61	1.19	1.19	-	0.84	1.08
	(0.63)	(0.50)	(0.47)	-	(0.49)	(0.45)
Asset VaR	2.10	2.42	2.99	-	2.52	3.76
	(0.46)	(0.65)	(0.79)	-	(0.46)	(0.73)

Note: Figures in the table represent the average value, and ( ) represents the standard deviation.

event, the difference in ΔCoVaR between the securities industry and the banking sector decreased significantly compared to the periods of the Global Financial Crisis and the European Sovereign Debt Crisis. As indicated in Table 9, during the COVID-19 Crisis, the average ΔCoVaR of many securities firms relative to banks was higher than that of specific banks. This suggests that during the COVID-19 Crisis and the margin call period, the securities industry had a relatively more significant impact on the overall risk of the financial system compared to the periods of the Global Financial Crisis and the European Sovereign Debt Crisis.

This implication arises from the fact that during the Global Financial Crisis and the European Sovereign Debt Crisis, the average ΔCoVaR of securities firms relative to banks was lower, suggesting that during the COVID-19 Crisis and the margin call

TABLE 9 —ΔCOVAR AND ASSET VAR BY EACH INDUSTRY AND FIRM DURING THE COVID-19 CIRISIS (JAN. 2020 ~ JUN. 2020)

Banks	Bank Industry Index	Shinhan	KB	Hana	Woori	IBK
CoVaR	3.31 (1.69)	3.03 (1.62)	2.82 (1.50)	2.80 (1.49)	2.62 (1.58)	2.95 (1.56)
Asset VaR	4.24 (1.62)	4.36 (1.53)	4.63 (1.84)	4.98 (1.97)	3.93 (1.37)	4.17 (1.71)
Securities Firms	Securities Industry Index	Mirae Asset	NH	Korea-Investment	Samsung	Meritz
CoVaR	3.12 (1.70)	2.77 (1.56)	2.79 (1.54)	2.50 (1.41)	2.75 (1.42)	2.28 (1.51)
Asset VaR	4.51 (2.17)	5.53 (2.91)	4.71 (1.96)	5.72 (2.66)	4.49 (2.24)	4.93 (2.51)
Insurance Firms	Insurance Industry Index	Samsung Life	Hanhwa	Mirae Asset Life	Lotte	DB
CoVaR	2.88 (1.53)	2.39 (1.22)	2.11 (1.18)	1.05 (0.67)	1.68 (1.28)	1.94 (1.28)
Asset VaR	3.70 (1.66)	4.27 (2.29)	5.96 (3.38)	4.01 (2.21)	5.08 (2.10)	5.10 (1.56)

Note: Figures in the table represent the average value, and ( ) represents the standard deviation.

TABLE 10 —Δ COVAR AND ASSET VAR BY EACH INDUSTRY AND FIRM DURING THE MARGIN CALL SHOCK IN MAR. 2020

Banks	Bank Industry Index	Shinhan	KB	Hana	Woori	IBK
CoVaR	4.93 (2.11)	4.53 (2.04)	4.24 (1.93)	4.19 (1.93)	4.94 (2.29)	4.42 (1.97)
Asset VaR	5.29 (1.92)	5.14 (1.61)	5.58 (2.20)	5.76 (2.32)	5.69 (2.15)	5.50 (2.29)
Securities Firms	Securities Industry Index	Mirae Asset	NH	Korea-Investment	Samsung	Meritz
CoVaR	4.75 (2.12)	4.30 (1.96)	4.26 (1.93)	3.92 (1.74)	4.08 (1.76)	3.75 (1.90)
Asset VaR	5.73 (2.90)	6.90 (3.96)	5.71 (2.49)	6.58 (3.21)	5.23 (2.94)	7.41 (4.42)
Insurance Firms	Insurance Industry Index	Samsung Life	Hanhwa	Mirae Asset Life	Lotte	DB
CoVaR	4.41 (1.96)	3.77 (1.52)	3.52 (1.48)	1.78 (0.97)	3.00 (1.59)	3.12 (1.76)
Asset VaR	4.60 (1.91)	6.51 (2.76)	7.73 (3.84)	6.15 (3.15)	6.61 (2.75)	6.21 (2.11)

Note: Figures in the table represent the average value, and ( ) represents the standard deviation.

period, the securities industry had a more pronounced influence on the financial system, potentially due to factors such as margin calls on overseas assets underlying ELS products and securities firms' foreign currency liquidity shortages, which contributed to increased rollover risks and short-term interest rate spikes during the initial phase of the COVID-19 Crisis.

C. *Analysis of the impact of ELS (equity-linked securities) on systemic risk*

In the following section, we analyze the impact of ELS (equity-linked securities) issuance on CoVaR (conditional value-at-risk) by means of fixed-effects regression, as represented by the equation below. The specific regression model is as follows:

$$\Delta CoVaR_{i,t} = \alpha + \beta_1 LN(ELS_{i,t} + 1) + \beta_2 Asset_{i,t} + \beta_3 Capital\ Ratio_{i,t} + \gamma X_t + fixed\ effect_i + \varepsilon_{i,t}$$

The control variables included in the model are macroeconomic factors, specifically the Korean base interest rate, the U.S. base interest rate, the Korean Consumer Price Index (CPI), and gross domestic product (GDP).

In this section, we estimate the change in conditional value-at-risk (ΔCoVaR) based on weekly stock returns. The outstanding balance of ELS (equity-linked securities) issuance is also examined on a weekly basis, while asset, capital ratio and macroeconomic control variables are considered on a quarterly basis. To align the periods of the dependent variable (ΔCoVaR) and the independent variable (outstanding balance of ELS issuance), ΔCoVaR was estimated using weekly stock returns in the fixed-effects regression model.

The analysis spans multiple periods, including three crisis intervals and two non-crisis intervals. Specifically, the crisis periods are the (1) Global Financial Crisis, (2) European Sovereign Debt Crisis, and (3) COVID-19 Crisis. The non-crisis intervals are the (4) Post-Global Financial Crisis to the Pre-European Sovereign Debt Crisis and the (5) Post-European Sovereign Debt Crisis to the Pre-COVID-19 Crisis.

Tables 11 and 12 present the descriptive statistics for ΔCoVaR and the outstanding balance of ELS issuance across these analysis periods. As observed in earlier estimations of ΔCoVaR using daily data, the magnitude of ΔCoVaR was highest during the Global Financial Crisis, followed by the COVID-19 Crisis and the European Sovereign Debt Crisis, in descending order.

Table 13 presents the results of the fixed-effects regression analysis across different time periods. The analysis reveals that the increase in ELS issuance had a significant impact on the increase in ΔCoVaR during each of the three crisis periods. Additionally, during the periods prior to the European Sovereign Debt crisis and before the COVID-19 Crisis, i.e., the Post-Global Financial Crisis, I did not find a

TABLE 11—SUMMARY STATISTICS OF ΔCoVaR BY EACH REGRESSION ANALYSIS PERIODS

Period	Mean	Standard Deviation	Max	Min
① Global Financial Crisis (Oct. 2008 ~ Jun. 2009)	1.37	0.52	3.13	0.41
② European Sovereign Debt Crisis (Apr. 2010 ~ Mar. 2012)	0.70	0.26	2.25	0.28
③ COVID-19 Shock (Feb. 2020 ~ Apr. 2020)	0.96	0.38	1.90	0.33
④ Between ① and ②	0.78	0.34	1.95	0.28
⑤ Between ② and ③	0.54	0.14	1.21	0.20

TABLE 12—SUMMARY STATISTICS OF ELS BY EACH REGRESSION ANALYSIS PERIODS

Period	Mean	Standard Deviation	Max	Min
① Global Financial Crisis (Oct. 2008 ~ Jun. 2009)	1.24	1.23	4.32	0.02
② European Sovereign Debt Crisis (Apr. 2010 ~ Mar. 2012)	0.88	0.94	5.57	0.00
③ COVID-19 Shock (Feb. 2020 ~ Apr. 2020)	2.63	2.40	7.70	0.01
④ Between ① and ②	0.85	0.86	3.74	0.01
⑤ Between ② and ③	2.30	2.46	12.16	0.00

TABLE 13—EFFECT OF ELS OUTSTANDING ON ΔCOVAR

Variables	(1) Global Financial Crisis	(2) European Sovereign Debt Crisis	(3) COVID-19 Shock	(4) Period between (1) and (2)	(5) Period between (2) and (3)
Ln (ELS outstanding + 1)	1.802*** (0.493)	0.263*** (0.000)	1.205*** (0.207)	0.239 (0.170)	-0.002 (0.003)
Total assets (Trn KRW)	-0.010 (0.027)	-0.001*** (0.000)	0.004*** (0.000)	-0.015*** (0.001)	-0.000** (0.000)
Capital/asset ratio	0.062*** (0.013)	0.348*** (0.111)	3.022*** (0.087)	1.400** (0.610)	-0.254*** (0.005)
Bank of Korea policy rate (%)	0.618*** (0.044)	0.021*** (0.003)	0.236*** (0.018)	1.804*** (0.051)	0.006* (0.004)
Fed policy rate (%)	-1.361*** (0.095)	0.162*** (0.035)	-0.595*** (0.006)	1.994*** (0.366)	-0.019*** (0.002)
GDP growth of South Korea (YoY, %)	-0.309*** (0.050)	-0.017*** (0.002)	0.040*** (0.002)	0.000 (0.006)	-0.024*** (0.001)
Consumer Price Index of South Korea (YoY, %)	0.205*** (0.010)	0.021** (0.009)	0.000 (.)	0.313*** (0.043)	-0.020*** (0.005)
Firm Fixed Effect			O		
Observation	623	1841	234	624	7,328

Note: *, **, and *** represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

significant influence of ELS issuance on ΔCoVaR through the regression analysis. Similar results were obtained when varying the number of control variables in the model (see Tables A1-A3). Furthermore, to conduct a robustness check, I estimated systemic risk based on MES and performed a fixed-effects regression analysis as well (see Tables 14 and A4- A6).

The impact of the outstanding balance of equity-linked securities (ELS) on ΔCoVaR was greatest during the Global Financial Crisis, followed by the COVID-19 Crisis and the European Sovereign Debt Crisis in decreasing order. Specifically, during the Global Financial Crisis, a 1% increase in the outstanding balance of ELS issuance led to an approximate increase of 0.018 percentage points in ΔCoVaR, with this estimate being statistically significant. Considering that the average ΔCoVaR for the securities firms analyzed during the Global Financial Crisis was 1.37% and that the average ELS outstanding amount was 1.24 trillion won with a standard deviation of 1.23 trillion won, the volatility of ELS issuance was high, and its impact on systemic risk was significant. For instance, if the outstanding balance of ELS issued by securities firms increased by 10% during the Global Financial Crisis, ΔCoVaR would rise by 0.18 percentage points, which is approximately 13% of the average ΔCoVaR at that time. Meanwhile, during the European Sovereign Debt Crisis and the COVID-19 Crisis periods, a 1% increase in the ELS outstanding balance resulted in increments of 0.003 and 0.012 percentage points in ΔCoVaR, respectively, and these estimates are also statistically significant.

Furthermore, as part of a robustness check, I estimated systemic risk based on MES and conducted the same fixed-effects regression analysis (see Table 14). The analysis results indicated that during crisis periods, the impact of ELS issuance on MES was notably significant.

TABLE 14—EFFECT OF ELS OUTSTANDING ON MES

Variables	(1) Global Financial Crisis	(2) European Sovereign Debt Crisis	(3) COVID-19 Shock	(4) Period between (1) and (2)	(5) Period between (2) and (3)
Ln (ELS outstanding)	2.027*** (0.078)	0.234** (0.103)	5.152*** (0.869)	0.056*** (0.009)	-0.043* (0.025)
Total assets (Trn KRW)	-0.080 (0.136)	0.005 (0.004)	-0.065 (0.050)	0.039*** (0.005)	-0.000 (0.000)
Capital/asset ratio	12.329** (5.493)	8.458*** (0.140)	73.069*** (5.492)	3.625*** (1.030)	-3.057*** (0.953)
Bank of Korea policy rate (%)	1.512** (0.666)	-0.009 (0.221)	-4.205*** (0.483)	-3.369*** (0.713)	-0.218 (0.181)
Fed policy rate (%)	-2.318*** (0.654)	1.663 (1.506)	-1.413*** (0.022)	-1.734* (0.891)	-0.335*** (0.122)
GDP growth of South Korea (YoY, %)	-0.159 (0.691)	-0.152** (0.067)	-0.149*** (0.040)	-0.075*** (0.009)	-0.232*** (0.028)
Consumer Price Index of South Korea (YoY, %)	0.715*** (0.026)	0.087*** (0.008)	0.000 (.)	0.289*** (0.001)	-0.141*** (0.029)
Firm Fixed Effect			O		
Observation	623	1,783	234	624	7,259

Note: *, **, and *** represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

VI. Conclusion

I use the widely recognized system risk analysis method, ΔCoVaR, to investigate the systemic risk within the banking and non-banking sectors (specifically, securities firms and insurance companies) in South Korea. Additionally, I examine the impact of financial institutions' issuance of equity-linked securities (ELS) on systemic risk as measured by ΔCoVaR.

The findings of this paper reveal that systemic risk in both the banking and non-banking sectors increased substantially during global financial crises, specifically the Global Financial Crisis, the European Sovereign Debt Crisis, and the COVID-19 pandemic. Although the banking sector exhibited a higher level of systemic risk compared to the securities and insurance sectors, the inter-sector systemic risk differentials varied across these crises. Notably, during the March 2020 margin call crisis, the disparity in systemic risk between the banking and securities sectors decreased significantly when compared to that during previous crises, indicating the heightened impact of the securities sector on the overall financial system's risk.

Furthermore, the findings demonstrate that an increase in the outstanding balance of ELS issuance by financial institutions is associated with an increase in ΔCoVaR, particularly during the three crisis periods and during a significant drop in the Hang Seng Index. These findings emphasize the growing importance of monitoring and enhancing supervisory measures concerning systemic risk in the non-banking sector in South Korea.

In light of these results, it is evident that South Korea's macroprudential management and regulatory framework should adapt to the increasing significance of non-banking institutions. Vigilant monitoring and regulatory measures aimed at controlling systemic risk within the non-banking sector are essential components of the

framework to maintain financial stability.

A potential avenue for future research related to this study could involve exploring the utilization of market-based systemic risk measures such as ΔCoVaR in the macroprudential management and supervision of non-banking institutions. Specifically, one could consider research on incorporating market-based systemic risk measures into an assessment of the systemic importance of financial institutions.

Currently, the selection of systematically important financial institutions (SIFIs), including banks and bank holding companies, relies on indicator-based criteria. These criteria are used to select institutions for mandatory additional capital requirements. Indicator-based criteria involve assessing the systemic importance of financial institutions by selecting relevant indicators and assigning fixed weights to calculate scores for each bank or bank holding company.

However, this approach may have limitations when used to capture changing market dynamics and information. Using market-based systemic risk measures such as ΔCoVaR could complement indicator-based criteria and enhance the monitoring of the systemic importance of both banking and non-banking financial institutions. By incorporating market-based systemic risk measures, policymakers could better assess the impact of these institutions on the overall downside risk of the financial system, potentially leading to more effective regulatory and supervisory policies.

Furthermore, future research could explore appropriate liquidity metrics and liquidity ratios for monitoring foreign exchange (FX) liquidity in securities firms, considering both ELS issuance and their hedging activities. Since the margin call crisis, authorities have introduced measures to enhance FX liquidity management in non-bank financial institutions, including strengthening FX liquidity ratios and conducting FX stress tests. Research in this area could aim to identify the most suitable liquidity indicators and ratios that take into account ELS issuance and hedging, potentially leading to more efficient policy measures.

Additionally, considering the various interconnections between banking and non-banking sectors, there could be research on systemic risk analyses and macroprudential monitoring methods that account for the associated linkages. Presently, the government and the central bank in South Korea utilize stress testing models based on financial institutions' interbank networks when conducting a financial stability analysis. Securities firms that issue ELS and engage in hedging activities may establish links with other capital market participants through overall holdings and short-term borrowing in financial markets. Reflecting the characteristics of non-bank financial institutions, research could explore the development of systemic risk analysis and stress testing models based on financial institutions' debt networks to consider these interconnections more comprehensively.

Lastly, it would be worthwhile to consider research into the impact of non-bank financial institutions, such as money market funds (MMFs) and collective investment schemes, and their behavior on the financial markets. Recently in the UK, there was a threat to financial stability due to a surge in government bond yields stemming from liability-driven investment (LDI) activities. To address this, the Bank of England intervened by purchasing government bonds to stabilize yields and restore financial stability.

Research in this area could investigate how the behavior and activities of non-bank financial institutions, including MMFs and investment schemes, influence

financial stability. Understanding the dynamics between these institutions and the broader financial markets, particularly during periods of market stress or unexpected events, can provide insights into potential vulnerabilities and systemic risks. This research can be valuable for policymakers and regulators to develop more effective measures to safeguard financial stability in the face of evolving market dynamics and behaviors.

APPENDIX

As an additional robustness check, I utilized a hierarchical fixed-effects panel regression model, as described in this section.

TABLE A1—HIERARCHICAL REGRESSION ANALYSIS ON ΔCoVaR DURING THE GLOBAL FINANCIAL CRISIS PERIODS (OCT. 2008 ~ JUN 2009)

Variables	Dependent Variable : ΔCoVaR						
Ln (ELS outstanding + 1)	7.731***	7.412***	7.076***	6.822***	5.503***	3.103***	1.802***
	(0.642)	(0.655)	(0.610)	(0.685)	(0.532)	(0.548)	(0.555)
Total assets (Trn KRW)		-0.030**	0.004	0.006	0.002	-0.010	-0.010
		(0.013)	(0.013)	(0.013)	(0.010)	(0.010)	(0.009)
Capital/asset ratio			6.951***	6.744***	4.599***	0.680	0.062
			(0.708)	(0.753)	(0.589)	(0.672)	(0.650)
Bank of Korea policy rate (%)				0.015	0.724***	0.638***	0.618***
				(0.018)	(0.038)	(0.036)	(0.035)
Fed policy rate (%)					-1.443***	-1.276***	-1.361***
					(0.071)	(0.068)	(0.066)
GDP growth of South Korea (YoY, %)						-0.621***	-0.309***
						(0.062)	(0.073)
Consumer Price Index of South Korea (YoY, %)							0.205***
							(0.028)
Firm Fixed Effect							
Observations	623	623	623	623	623	623	623

Note: *, **, and *** correspondingly represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

TABLE A2—HIERARCHICAL REGRESSION ANALYSIS ON ΔCoVaR DURING THE EUROPEAN SOVEREIGN DEBT CRISIS (APR. 2010 ~ MAR. 2012)

Variables	Dependent Variable : ΔCoVaR						
Ln (ELS outstanding + 1)	0.452***	0.477***	0.480***	0.263***	0.264***	0.246***	0.263***
	(0.036)	(0.038)	(0.038)	(0.048)	(0.048)	(0.050)	(0.050)
Total assets (Trn KRW)		-0.001**	-0.001**	-0.002***	-0.002***	-0.002***	-0.001***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Capital/asset ratio			-0.448	0.268	0.261	0.313	0.348
			(0.281)	(0.293)	(0.294)	(0.297)	(0.297)
Bank of Korea policy rate (%)				0.103***	0.101***	0.063*	0.021
				(0.014)	(0.014)	(0.033)	(0.039)
Fed policy rate (%)					0.250	0.199	0.162
					(0.433)	(0.435)	(0.435)
GDP growth of South Korea (YoY, %)						-0.012	-0.017*
						(0.009)	(0.010)
Consumer Price Index of South Korea (YoY, %)							0.021*
							(0.011)
Firm Fixed Effect				O			
Observations	1,841	1,841	1,841	1,841	1,841	1,841	1,841

Note: *, **, and *** correspondingly represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

TABLE A3—HIERARCHICAL REGRESSION ANALYSIS ON ΔCoVaR DURING COVID-19 CRISIS (FEB. 2020 ~ APR. 2020)

Variables	Dependent Variable : ΔCoVaR						
Ln (ELS outstanding + 1)	5.450***	5.097***	4.925***	1.059***	0.974***	1.205***	1.205***
	(0.711)	(0.707)	(0.704)	(0.363)	(0.256)	(0.229)	(0.229)
Total assets (Trn KRW)		0.022***	0.023***	0.001	0.001	0.004*	0.004*
		(0.007)	(0.007)	(0.004)	(0.002)	(0.002)	(0.002)
Capital/asset ratio			15.458**	-4.498	-4.488*	3.022	3.022
			(6.953)	(3.378)	(2.377)	(2.329)	(2.329)
Bank of Korea policy rate (%)				-1.203***	0.409***	0.236**	0.236**
				(0.044)	(0.114)	(0.104)	(0.104)
Fed policy rate (%)					-0.596***	-0.595***	-0.595***
					(0.040)	(0.036)	(0.036)
GDP growth of South Korea (YoY, %)						0.040***	0.040***
						(0.005)	(0.005)
Consumer Price Index of South Korea (YoY, %)							0.000
							(.)
Firm Fixed Effect				O			
Observations	234	234	234	234	234	234	234

Note: *, **, and ***correspondingly represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

TABLE A4—HIERARCHICAL REGRESSION ANALYSIS ON MES DURING THE GLOBAL FINANCIAL CRISIS PERIODS (OCT. 2008 ~ JUN 2009)

Variables	Dependent Variable : MES						
Ln(ELS outstanding + 1)	6.413***	5.933***	4.758***	3.233***	3.075***	2.633***	2.027**
	(1.036)	(1.017)	(0.971)	(0.941)	(0.922)	(0.921)	(0.928)
Total assets (Trn KRW)		-0.384***	-0.216***	-0.066	-0.069	-0.088	-0.080
		(0.072)	(0.071)	(0.070)	(0.068)	(0.068)	(0.067)
Capital/asset ratio			33.970***	24.142***	20.757***	12.591***	12.329***
			(3.959)	(3.952)	(3.919)	(4.506)	(4.463)
Bank of Korea policy rate (%)				0.715***	1.914***	1.615***	1.512***
				(0.088)	(0.243)	(0.255)	(0.254)
Fed policy rate (%)					-2.492***	-2.022***	-2.318***
					(0.471)	(0.485)	(0.487)
GDP growth of South Korea (YoY, %)						-1.436***	-0.159
						(0.403)	(0.534)
Consumer Price Index of South Korea (YoY, %)							0.715***
							(0.199)
Firm Fixed Effect				O			
Observations	623	623	623	623	623	623	623

Note: *, **, and *** correspondingly represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

TABLE A5—HIERARCHICAL REGRESSION ANALYSIS ON MES DURING THE EUROPEAN SOVEREIGN DEBT CRISIS (APR. 2010 ~ MAR. 2012)

Variables	Dependent Variable : MES						
Ln (ELS outstanding + 1)	0.512***	0.481***	0.491***	0.237***	0.239***	0.224***	0.234***
	(0.043)	(0.044)	(0.044)	(0.048)	(0.048)	(0.048)	(0.048)
Total assets (Trn KRW)		0.011***	0.011***	0.005**	0.005**	0.004*	0.005**
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Capital/asset ratio			4.960***	8.024***	7.972***	8.193***	8.458***
			(1.267)	(1.253)	(1.253)	(1.252)	(1.259)
Bank of Korea policy rate (%)				0.621***	0.610***	0.164	-0.009
				(0.055)	(0.055)	(0.146)	(0.175)
Fed policy rate (%)					2.327	1.827	1.663
					(1.875)	(1.876)	(1.877)
GDP growth of South Korea (YoY, %)						-0.126***	-0.152***
						(0.038)	(0.041)
Consumer Price Index of South Korea (YoY, %)							0.087*
							(0.048)
Firm Fixed Effect				O			
Observations	1,783	1,783	1,783	1,783	1,783	1,783	1,783

Note: *, **, and *** correspondingly represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

TABLE A6—HIERARCHICAL REGRESSION ANALYSIS ON MES DURING COVID-19 CRISIS (FEB. 2020 ~ APR. 2020)

Variables	Dependent Variable : MES						
Ln (ELS outstanding + 1)	26.041***	25.404***	23.732***	6.332***	5.732***	5.152***	5.152***
	(2.833)	(2.835)	(2.727)	(1.540)	(1.516)	(1.517)	(1.517)
Total assets (Trn KRW)		0.101*	0.117**	-0.052**	-0.052**	-0.065**	-0.065**
		(0.053)	(0.050)	(0.026)	(0.026)	(0.026)	(0.026)
Capital/asset ratio			232.880***	101.124***	101.320***	73.069***	73.069***
			(49.306)	(25.392)	(24.828)	(27.092)	(27.092)
Bank of Korea policy rate (%)				-8.608***	-4.887***	-4.205***	-4.205***
				(0.344)	(1.184)	(1.203)	(1.203)
Fed policy rate (%)					-1.393***	-1.413***	-1.413***
					(0.425)	(0.420)	(0.420)
Consumer Price Index of South Korea (YoY, %)						-0.149**	-0.149**
						(0.061)	(0.061)
GDP growth of South Korea (YoY, %)							0.000
							(.)
Firm Fixed Effect				O			
Observations	234	234	234	234	234	234	234

Note: *, **, and *** correspondingly represent significance at the 10%, 5%, and 1% levels, and ( ) is the standard error.

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Effects of Intellectual Property Rights Protection on Services Export Diversification in Developing Countries†

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The effects of the betterment of enforced intellectual property rights (IPRs) provisions on services export diversification are investigated. The analysis used an unbalanced panel dataset of 76 developing countries over the period of 1970-2014. The empirical analysis is based on the feasible generalized least squares estimator. It suggests that the implementation of weaker IPR protection fosters services export diversification in less developed countries (i.e., those whose real per capita incomes are less than US$ 1458.60), including those with a low level of export product upgrading. Conversely, in relatively advanced developing countries (countries whose real per capita income exceeds US$ 3356.80), including those with high levels of export product upgrading, the implementation of stronger IPR laws induces greater services export diversification. Finally, the analysis revealed the existence of a non-linear relationship between IPR protection and services export diversification. The implementation of stronger intellectual property laws spurs services export diversification in countries with high degree of IPR protection, especially when IPR protection exceeds a certain level, recorded here as having a score of 1.197. In contrast, in countries with weaker IPR protection, in particular those with IPR protection levels that score less than 0.915, it is rather the implementation of weaker intellectual property laws that promotes services export diversification.

Key Word: Intellectual Property Rights, Services Export Diversification, Export Product Upgrading, Developing Countries
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I. Introduction

Does the strengthening of intellectual property rights (IPRs) systems contribute to enhancing services export diversification? The present study aims to address this question, which, to the best of our knowledge, has received little attention in the literature.

The importance of services exports for economic growth and development has now been well established in the literature (e.g., Hoekman, 2017; Hoekman and Shepherd, 2017; Kong *et al*., 2021; Lanz and Maurer, 2015). Interestingly, a recent study has provided empirical evidence that exporting a wide range of services items across different services sectors (including both traditional and modern services[1]), as well as exporting sophisticated services items, are strongly beneficial for economic growth. This provides policymakers with new avenues for promoting economic growth and development (e.g., Anand *et al*., 2012; Gnangnon, 2021a; Mishra *et al*., 2011; Stojkoski *et al*., 2016).

In the meantime, the process of global diffusion and the strengthening of intellectual property rights (IPRs) systems that followed the entering into force of the Trade-Related Aspects on Intellectual Property Rights (TRIPS) Agreement[2] on January 1st, 1995, has led to a rich body of literature[3] on the economic effects of changes in IPRs. The global transformation of IPR standards is underpinned by the theoretical hypothesis that the strengthening of IPRs systems will provide incentives to innovate and, in this way, to promote economic growth and development. In reality, the effectiveness of IPRs in achieving higher economic growth and development has been the subject of a much debate in both policy and academic circles (e.g., Chang, 2001; Dinopoulos and Segerstrom, 2010; Eicher and García-Peñalosa, 2008; Gould and Gruben, 1996; Hudson and Minea, 2013; Kim *et al*., 2012; Lorenczik and Newiak, 2012).

Specifically, the effects of IPRs on international trade are ambiguous (e.g., Grossman and Helpman, 1990; Grossman and Lai, 2004; Helpman, 1993; Maskus and Penubarti, 1995). In one study by Maskus and Penubarti (1995), for example, IPR systems were found to have ambiguous effects on international trade. The strengthening of IPRs can increase firms' market power and encourage them to engage in monopolistic behavior, thereby increasing prices and reducing sales. On the other hand, stronger IPRs can provide incentives to export patentable goods to

[1] There is no clear distinction between traditional and modern services in the literature. For example, Eichengreen and Gupta (2013a) consider that "traditional services" include trade and transport, tourism, financial services and insurance, while "modern services" encompass communications, computer, information, and other related services. According to Sahoo and Dash (2017), traditional services include transport and travel services, while modern services encompass transportability and tradability, financial services, insurance, business processing and software services.

[2] The TRIPS Agreement is one of the founding agreements of the World Trade Organization (WTO). It sets out the minimum standards of intellectual protection to be provided by WTO members in the following fields: copyright and related rights; trademarks, including service marks; geographical indications; industrial designs; patents, including the protection of new varieties of plants; the layout-designs of integrated circuits; and undisclosed information, including trade secrets and test data. Further information on the TRIPS Agreement can be found online at: https://www.wto.org/english/tratop_e/trips_e/trips_e.htm and https://www.wto.org/english/tratop_e/trips_e/ta_docs_e/modules1_e.pdf

[3] See for example Dinopoulos and Segerstrom (2010), Eicher and García-Peñalosa (2008), Hudson and Minea (2013), Kim *et al*. (2012), or Panda *et al*. (2020). See also the literature reviews provided by Hassan *et al*. (2010), Mrad (2017), and Park and Lippoldt (2008).

countries with stronger intellectual property protection, as the risk of imitation in such countries is low. Building on models of dynamic general equilibrium with two regions ('north' and 'south'), where the north innovates and the south imitates technologies invented in the north, Helpman (1993) posited four channels through which IPRs can influence trade between countries: terms of trade, inter-regional allocations of manufacturing, product availability, and research and development (R&D) investment patterns. In addition to the empirical literature on the effects of IPRs on international trade, including on export and import flows[4], other works have investigated the effect of IPRs on certain aspects of export product upgrading, including export product diversification and export product quality improvement (e.g., Campi and Dueñas, 2016; Dong *et al*., 2022; Glass and Wu, 2007; Gnangnon and Moser, 2014; Liu *et al*., 2021; Ndubuisi and Foster-McGregor, 2018; Song *et al*., 2021). However, we are not aware of a study that has investigated the relationship between changes in IPRs and services export diversification.

The General Agreement on Trade in Services[5] (GATS) has provided no specific definition of "a service" but has defined four different modes of services trade (see Article I:2 of the GATS) in light of the intangible nature of many services products. These are the cross-border supply of services (mode 1), consumption abroad (mode 2), the commercial presence (mode 3), and the presence of natural persons (mode 4).

The link between IPRs and innovation in the goods sector has been the subject of important research (e.g., Chen and Puttitanun, 2005; Naghavi and Strozzi, 2015; Sweet and Maggio, 2015). Innovation is important and prevalent in both the goods and services sectors (e.g., Peters, 2009; Zahler *et al*., 2014). Therefore, one could question the relevance of protecting innovation in the services sector, as has been the case in the goods sector. In this regard, research such as that by Maskus (2008) has emphasized the need for IPR protection in sectors such as information technology, the internet, digital entertainment, and financial services, as these sectors have engaged in significant innovation. However, to the best of our knowledge, researchers have not investigated whether IPR protection stimulates the diversification of services export items.

The present paper aims to fill this void in the literature by building on recent works[6] on the macroeconomic determinants of services export diversification in an effort to examine the effects of strengthening IPR protection on services export diversification. We argue that stronger IPRs would affect services export diversification through the corresponding effects on innovation.

The empirical exercise here uses the two-step system generalized method of moments (GMM) estimator, with empirical support for the hypothesis that the betterment of enforced IPRs contributes significantly to enhancing services export diversification, in particular when enforced IPR protection reaches relatively high levels. Additionally, the strengthening of IPR protection induces greater services export diversification, and this effect is greater in advanced countries than in relatively less advanced economies.

[4]See for example Branstetter *et al*. (2011), Delgado *et al*. (2013), Falvey *et al*. (2009), Ivus and Park (2019), Panda *et al*. (2020), and Yang and Maskus (2009).

[5]See online at: https://www.wto.org/english/docs_e/legal_e/26-gats.pdf

[6]These studies include Anand *et al*. (2012), Eichengreen and Gupta (2013a), Gnangnon (2020a; 2020b; 2021b; 2021c; 2021d; 2021e; 2021f), and Sahoo and Dash (2017).

In the remaining part of the analysis, Section II provides a theoretical explanation underpinning the effect of IPRs on services export diversification. Section III presents the empirical strategy, and section IV interprets empirical outcomes. Section V concludes the paper.

II. Theoretical considerations

This paper postulates that the implementation of stronger intellectual property laws would affect services export diversification through a positive innovation effect. The initial discussion focuses on the issue of innovation in the services sector (Section II. A), after which the paper explores how IPR protection could affect services export diversification through the innovation channel (Section II. B).

A. *On the importance of innovation in the services sector*

While the prevalence of innovation in the goods (including manufacturing) sector and the link between IPRs and innovation in the goods sector are well documented in the literature,[7] innovation in the services sector (and the effect of IPRs on innovation in this sector) has received less attention (e.g., Love and Mansury, 2007; Pires *et al*., 2008; Zahler *et al*., 2014).

Love and Mansury (2007) documented how new services introduced via innovation occur through external linkages, particularly with customers, suppliers, and strategic alliances, as well as through both the presence of a highly qualified workforce and an unqualified workforce. Pires *et al*. (2008) used firm-level data to compare innovative activities in the various manufacturing and services sectors in Portugal, showing statistically that service firms do not underperform manufacturing firms in terms of innovation. Additionally, the highest performing service sectors (e.g., financial services) are as innovative as the highest performing manufacturing sectors (high-technology manufacturing). Zahler *et al*. (2014) used firm-level data on the manufacturing and services sector for Chile to compare manufacturing and tradable services from a joint trade and innovation perspective. Their analysis has revealed interesting findings, showing that manufacturing firms tend to have a much higher propensity to export than services firms but that services firms that do export are not necessarily much larger than non-exporters. While exporters tend to be more skill-intensive than non-exporters, the export skills premium in the services sector is greater than that in the manufacturing sector. While services firms are as innovative as manufacturing firms in terms of both the inputs and outputs of innovative activities (this is in line with the findings by Pires *et al*., 2008), services firms tend to rely relatively more on non-technological forms of innovation than manufacturing firms. Non-technological forms of innovation include innovations in product design and organizational management in production, the work environment, or the management structure of the firm, while ‘technological’ innovation refers to the introduction of new products or processes in the market, and expenditures related to

[7]See for example, Akiyama and Furukawa (2009), Brüggemann *et al*. (2016), Chen and Puttitanun (2005), Naghavi and Strozzi (2015), Papageorgiadis and Sharma (2016), and Sweet and Maggio (2015).

R&D, physical equipment acquisitions and training related to these factors (see Zahler *et al*., 2014, p.954). On another note, in both the manufacturing and services sectors, exporters exhibit higher innovation performance than non-exporters, and within each group of exporters and non-exporters, services firms have a higher propensity to innovate than manufacturing firms.

Using data from German manufacturing and service firms, Peters (2009) indicated the presence of path-dependence in innovation, both in the manufacturing and services sector, as past innovation experience positively drives current innovation in both manufacturing and service sector firms. Nevertheless, persistence is less prevalent and state-dependent effects are less pronounced in the services sector than in the manufacturing sector. The author has concluded that the implications of the presence of state dependence in innovation behavior are that innovation-stimulating policy programs open up potential long-lasting effects.

A relatively nascent strand of the literature has emphasized the link between IPRs and services innovation. For example, Miles *et al*. (2000) underlined the fact that many service firms do not patent, as the patent system often deals with more tangible innovations. Noting that the intangible nature of many service innovations creates challenges for IPRs systems, they discussed the management of knowledge, innovation, and intellectual property in knowledge-intensive business services. Maskus (2008) explored the different interrelationships between innovation in service industries and the need for IPR protection, concluding that IPRs are of increasing importance in sectors such as information technology, the internet, digital entertainment, and financial services, as these sectors have brought forth significant innovations. He also noted that IPR protection would be relevant in other services sectors that have not made much use of IPRs but where innovations were emerging. Bader (2008) stressed the importance of IPR protection for service innovations in the financial services industry sector (the case of the reinsurance company Swiss was studied). Battisti *et al*. (2014) used the Eurostat Fourth Community Innovation Survey (CIS4) dataset on 17 service sectors across 18 countries, finding that radical innovations are concentrated in the knowledge-intensive research and development sectors. Interestingly, across all sectors, IPRs tend to be used by leading innovators to protect their ideas and by service innovators to engage in international sales. Using Japanese firm-level data, Morikawa (2014) found that while service firms have shown fewer product innovations than manufacturing firms, the productivity of innovative service firms is very high. At the same time, services firms tend not to hold many patents (see also Miles *et al*., 2000), although their holding of trade secrets is similar to that by manufacturing firms. In addition, patents and trade secrets influence in the same way product innovations in both the manufacturing and the service sectors, while trade secrets affect process innovations only for manufacturing firms.

The relatively brief literature review provided in this section shows that stronger intellectual property laws for services products can promote innovation and the development of services exports while also enhancing services export diversification. However, in the absence of data on indicators of services innovation at the aggregate (macroeconomic) level, we postulate that regardless of the possible effect of strengthening IPRs on services export diversification through the services innovation channel, improved IPRs can affect services export diversification through

export product upgrades, such as export product diversification, export product quality improvements and greater economic complexity[8] (i.e., the export of sophisticated products).

B. *How could IPRs affect services export diversification through the export product upgrading avenue?*

In this section, we describe how IPR strengthening could affect services export diversification through the channel of export product upgrading. First, this involves an examination of the theoretical literature exploring how IPR strengthening affects export product upgrading. Second, we discuss how export product upgrading affects services export diversification.

Some works have considered how IPRs affect export product upgrading (e.g., Campi and Dueñas, 2016; Dong *et al*., 2022; Glass and Wu, 2007; Gnangnon and Moser, 2014; Liu *et al*., 2021; Ndubuisi and Foster-McGregor, 2018; Song *et al*., 2021). Glass and Wu (2007) developed a model where northern firms innovate to improve the quality of existing products and may, later, shift production to the south by engaging in foreign direct investment, with southern firms then possibly imitating the products of multinationals. They showed empirically that stronger intellectual property laws can reduce imitation and shift innovation away from improvements in existing products toward the development of new products. Gnangnon and Moser (2014) documented empirically that legal protections for minor and adaptive inventions encourage the diversification of export products in both developed and developing countries. Campi and Dueñas (2016) found (for the agricultural sector) that the strengthening of IPRs has, *inter alia*, exerted a negative effect on the intensive margin of agricultural trade and a positive impact on the extensive margin of agricultural trade. Ndubuisi and Foster-McGregor (2018) established empirically that stronger intellectual property laws promote exports at extensive margins. Dong *et al*. (2022) used firm-product level data from Chinese exporters and city-level data on IPR protection to test empirically the effect of IPRs on export product quality. This effect was expected to materialize through strengthened R&D inputs, new product development, and mitigated financial constraints. The authors showed that the betterment of de facto IPRs contributes to enhancing the upgrade of export product quality, although this effect varies across geographic regions (it is not statistically significant for certain regions). Song *et al*. (2021) investigated the effect of domestic and foreign intellectual property rights (IPR) protection on quality upgrading using firm-level data from China. They postulated that the effect of IPR protection on firms' export quality depends on whether the innovation-induced effect - which promotes export product quality upgrading - dominates the threshold induced effects, which inhibit quality upgrading. Their empirical analysis revealed that the innovation channel dominates the threshold effects channel, as both domestic and foreign IPR protection positively influence export quality upgrading. Liu *et al*. (2021) found that the effects of patent protection on export quality upgrading depend

[8]The concept of "economic complexity" provides an indication of the information about the amount of "productive knowledge" (i.e., the technical know-how/the set of capabilities) embedded in the productive structure (and hence export structure of a country) (e.g., Hidalgo and Hausmann, 2009; Hausmann *et al*., 2013; Mishra *et al*., 2020).

on the technological stage of the country in question. Specifically, patent protection helps to improve export product quality if an economy's product quality is sufficiently close to the world frontier level. On another note, in a recent study Sweet and Maggio (2015) documented why a country's level of economic complexity is a better proxy of its level of innovation than traditional indicators such as the number of patents granted or disbursements on research and development (R&D) - used to measure the level of innovation in a country. Sweet and Maggio (2015) demonstrated empirically that strengthening IPR systems generates a greater level of economic complexity, which genuinely reflects a country's level of innovative inputs.

This short literature review conveys the message that strengthening IPR protection is likely to induce greater export product diversification and/or greater improvements of export product quality, as well as a higher degree of economic complexity.

On the other hand, the strengthening of IPR protection is associated with greater export product upgrading. First, as services are strongly embedded in manufactured exports (e.g., Ceglowski, 2006; Jiang and Zhang, 2021; Kimura and Lee, 2006; Lodefalk, 2014; Su *et al*., 2021), we can expect that the export of manufacturing products, including those that are more sophisticated,[9] would reflect higher services production by, for instance, through the introduction of new services during the manufacturing production process. This expansion of services production can be associated with the diversification of services exports at intensive margins (i.e., an increase in the number of existing service items exported) or with the diversification of services exports at extensive margins (i.e., the introduction of new service export products).

Second, in a recent paper, Gnangnon (2022) provided empirical evidence that greater economic complexity (as a measure of innovation input) is positively associated with services export diversification. The paper builds on the theoretical argument that countries that export increasingly complex products would likely experience higher penetration in international markets for goods and develop a network in such a market that could, in turn, be used to export a wide range of services items. This argument is drawn from the "network effect" hypothesis developed by Eichengreen and Gupta (2013b), which holds that a country with a high penetration rate in goods markets would likely use the networks established in these markets to export and eventually diversify its services export items. Eichengreen and Gupta (2013b) and Sahoo and Dash (2014) provided empirical support for this hypothesis. Building on the same arguments, Gnangnon and Priyadarshi (2016) reported that greater export product diversification is associated with a rise in commercial services exports by least developed countries. Gnangnon (2020a) and others have reported that the diversification of export products fosters the diversification of services exports, and Gnangnon (2021b) demonstrated empirically that a higher manufactured export share in total exports induces greater services export diversification. Taking a cue from the findings of work by Gnangnon (2021a), it can be expected that innovation would enhance services export diversification through its positive impact on export product diversification, especially considering that Chen (2013) established that innovation (as measured by patent counts) fosters export product diversification both at extensive margins (i.e.,

[9]Exports of sophisticated manufacturing products can be associated with greater economic complexity.

by increasing the number of products exported from a country) and at intensive margins (i.e., by increasing the export value of each product from a country). As export product diversification exerts a positive effect on services export diversification (e.g., Gnangnon, 2020a), one can expect that innovation would promote services export diversification through its positive impact on export product diversification.

In a nutshell, while greater IPRs[10] protection encourages export product upgrading, greater export product upgrading enhances services export diversification. We therefore expect that improving IPRs would contribute to fostering services export diversification through its effect of greater export product upgrading, i.e., greater export product diversification, export product quality improvements and greater economic complexity. Furthermore, given that the strengthening of IPR protection increases with the development level (e.g., Auriol *et al*., 2023; Chu *et al*., 2014; Hudson and Minea, 2013; Kim *et al*., 2012; Parello, 2008), one can expect that the positive effect of IPR protection on services export diversification would be greater in countries with higher development levels.

Against this backdrop, we postulate the following three hypotheses:

Hypothesis 1: The betterment of IPRs will foster the diversification of services exports.

Hypothesis 2: The positive effect of the betterment of IPRs on services export diversification will be greater in countries with higher development levels.

Hypothesis 3: The positive effect of the betterment of IPRs on services export diversification will be greater with a higher degree of export product upgrading, including a greater level of export product diversification, a better quality of export products, and a greater level of economic complexity.

The next section will test these hypotheses empirically.

III. Empirical strategy

This section initially presents the baseline model specification used to test the effect of IPR protection on services export diversification empirically (Section III. A). Next, we conduct a data analysis of key variables of interest, in particular the indicators of enforced IPR protection and services export diversification (Section III. B). Third, we present the econometric approach used in the analysis (Section III. C).

[10]As indicated later in the analysis, patent protection is based on patentee rights, which covers the duration of patent protection relative to the international standard, subject matter that is patentable (or not unpatentable), participation in international intellectual property rights agreements, the enforcement mechanisms available, and how limited (or less restricted) the patenting exceptions are (such as any requirement to practice the invention or license the patents to third parties) (see Park, 2008).

A. *Model specifications*

To examine the effect of IPR protection on services export diversification, we build on the recent works on the macroeconomic determinants of services export diversification or the services export structure (e.g., Anand *et al*., 2012; Eichengreen and Gupta, 2013a; Gnangnon, 2020a; 2020b; Gnangnon, 2021b; 2021c; 2021d; 2021e; 2021f; Gnangnon, 2022; Sahoo and Dash, 2017). Specifically, the baseline specification includes the variable of interest "PRIE" along with its squared term, as well as a set of control variables derived essentially from the previous works cited above. These control variables are the real per capita income, denoted as "GDPC" (representing a proxy for the development level of a country); inward foreign direct investment denoted as "FDI;" financial development ("FINDEV"); the level of human capital accumulated ("HUM"); the degree of trade openness ("OPEN"); a proxy for the institutional quality, measured according to the degree of democratization in a country ("POLITY2"); and the population size ("POP").

For the sake of brevity, we do not present here a discussion on the theoretical effects of control variables to be used in the baseline model on services export diversification. We refer readers to work by Gnangnon (2020a; 2020b), Gnangnon (2021b; 2021c; 2021d; 2021e; 2021f) and Gnangnon (2022) for a detailed and theoretical discussion of the effects of each these variables on services export diversification.

We consider the following baseline model:

$$\begin{aligned} SEC_{it} = {} & \beta_0 + \beta_1 PRIE_{it} + \beta_2 Log(GDPC)_{it} + \beta_3 HUM_{it} + \beta_4 TRPOL_{it} + \\ & \beta_5 FINDEV_{it} + \beta_6 RENT_{it} + \beta_7 POLITY2_{it} + \beta_8 FDI_{it} + \beta_9 Log(POP)_{it} + \\ & \mu_i + \lambda_t + \omega_{it} \end{aligned} \quad , \tag{1}$$

where the subscript *i* represents the country and *t* stands for the time-period. On the basis of available data, we construct an unbalanced panel dataset of 76 developing countries over the period from 1970 to 2014. The dependent variable "SED" is the Theil index of services export diversification. It is obtained by taking the opposite value of the indicator of the services export concentration (denoted "SEC") calculated using the following formula (see for example, Agosin *et al*., 2012; Cadot *et al*., 2011): $SEC = \frac{1}{n}\sum_{k=1}^{n} \frac{x_k}{\mu} \ln\left(\frac{x_k}{\mu}\right)$, where $\mu = \frac{1}{n}\sum_{k=1}^{n} x_k$, n represents the total number of the (services) export lines $(k)\, n = \sum_{k=1}^{n} k$; and x_k denotes the amount of services exports associated with the services line "k". Values of the index "SEC" range from 0 to 100, with higher values of this index reflecting greater services export concentration and lower values indicating greater services export diversification. Thus, our indicator of services export diversification is computed as follows: $SED_{it} = 100 - SEC_{it}$, where the subscripts *i* and *t* stand respectively for the given country and given sub-period. Its values also range from 0 to 100, with higher values of the index indicating greater services export diversification and lower values reflecting a tendency for a greater services export concentration. Data pertaining to

the indicator "SED" cover the sub-periods of 1976-1980, 1981-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2005, 2006-2010, and 2011-2014. The computation of the services export diversification index was conducted by collecting data from a database developed by the International Monetary Fund (IMF) (see Loungani *et al*., 2017) on eleven major sectors of services (categories of services). Disaggregated data on services exports at the two-digit level are used, as this is the maximum digit level of disaggregated data available on services export items. In particular, we relied on eleven major sectors of services (categories of services) - at the one-digit level - and used the disaggregated data on services exports for sub-sectors at the two-digit level (see Table A1 for further details on the computation of these indices).

The main variable of interest in the analysis, which is "PRIE," is a measure of the effective patent protection, computed as the Index of Patent Protection (PRI) (see Park, 2008) multiplied by the Index of Legal Enforcement Effectiveness, as extracted from the Fraser Institute database. The Index of Patent Protection is based on patentee rights and comprises five components. These include the duration of patent protection relative to international standards, subject matter that is patentable (or not unpatentable), participation in international intellectual property rights agreements, the enforcement mechanisms available, and how limited (or less restricted) patenting exceptions are (such as any requirement to practice the invention or license the patents to third parties). Thus, the computed index "PRIE" accounts for the enforcement of the legal patent provisions in practice and captures the scope of effective IPR protection (see Hu and Png, 2012; Liu *et al*., 2021; Maskus and Yang, 2018). The values of this indicator vary from 0 to 5, with higher numbers reflecting strong patent rights. As data on the indicator "PRI" is available only every five years, data on the indicator "PRIE" is also available every five years. In the present analysis, data on "PRIE" cover the sub-periods of 1975, 1980, 1985, 1990, 1995, 2000, 2005, and 2010.

The variable "HUM," the index of human capital, represents the average years of total schooling for the population aged between 15 and 64. It is extracted from the Barro and Lee Dataset, updated in 2021 (Barro and Lee, 2013). Data on this variable is available every five years (like the indicator "PRIE") and covers the sub-periods of 1975, 1980, 1985, 1990, 1995, 2000, 2005, and 2010 in the present analysis.

Data on all other regressors used in the analysis cover the sub-periods of 1971-1975, 1976-1980, 1981-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2005, and 2006-2010. The variable "GDPC" is the real per capita income (constant 2015 US$). The variable "TRPOL" is an indicator of trade policy, measured here according to the index of freedom to trade internationally. Higher values of this index indicate greater freedom to trade internationally. The variable "FINDEV" is a proxy for financial development and is measured according to the share (in percentage) of domestic credit to the private sector by banks in GDP. The variable "POLITY2" is an indicator of the level of democracy based on the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive. Its values are between -10 and +10, with lower values reflecting more autocratic regimes and greater values indicating more democratic regimes. The variables "RENT," "FDI," and "POP" are respectively the share (in percentage) of total natural resources rents in GDP (a proxy for a country's dependence on natural resources), the share (in percentage) of net FDI inflows in

GDP, and the total population size.

The sources of all variables used in the analysis are provided in Table A1. Table A2 reports the list of the 76 countries used in the analysis. Table A3 reports descriptive statistics, including the standard statistics (mean, standard deviation, maximum and minimum) as well as the within-country and between-country variations of the variables used in the analysis. Table A4 lists countries on the basis the ascending values of the variable "PRIE" over the last sub-period, i.e., 2010 for this indicator (we explain later why we proceed in that way). This Appendix is also used in the subsequent analysis.

β_0 to β_9 are parameters to be estimated. μ_i refers to a country's unobservable time invariant characteristics that could affect services export diversification, and the λ_t variables are time dummies for global shocks that hit simultaneously all countries' services export diversification paths. ω_{it} is a well-behaving error term.

The structure of the panel dataset allows us to consider the variables "GDPC," "HUM," "TRPOL," "FINDEV," "RENT," "POLITY2," and "FDI" as exogenous, or at least weakly exogenous. For example, model (1) allows us to examine the effect of IPR protection and that of human capital, i.e., in year 1975, on the sub-period 1976-1980. Likewise, model (1) allows an estimation of the effects of the variables "GDPC," "TRPOL," "FINDEV," "RENT," "POLITY2," and "FDI" during, for instance, the sub-period of 1971-1975, on services export diversification in the sub-period 1976-1980. The same reasoning applies to all other sub-periods of the panel data. It is important to note that the indicator of the population size is treated as 'de facto' exogenous.

B. *Data analysis*

We provide in Figure 1 the development of the indicators of enforced IPR protection ("PRIE") and services export diversification ("SED") over the full

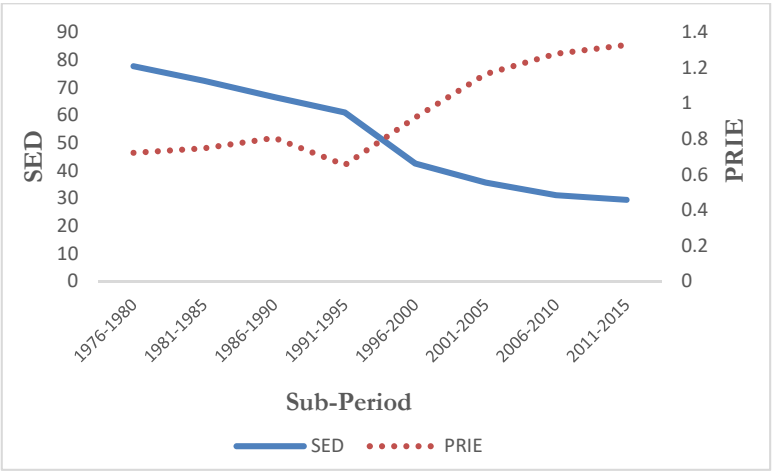

FIGURE 1. DEVELOPMENT OF THE INDICATORS OF INTELLECTUAL PROPERTY RIGHTS AND SERVICES EXPORT DIVERSIFICATION OVER THE FULL SAMPLE

Source: Author.

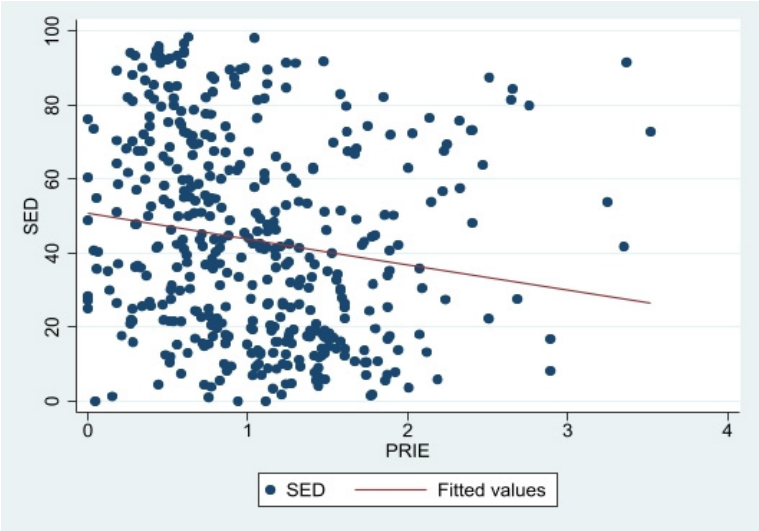

FIGURE 2. LINEAR CORRELATION PATTERN BETWEEN INTELLECTUAL PROPERTY RIGHTS AND SERVICES EXPORT DIVERSIFICATION OVER THE FULL SAMPLE

Source: Author.

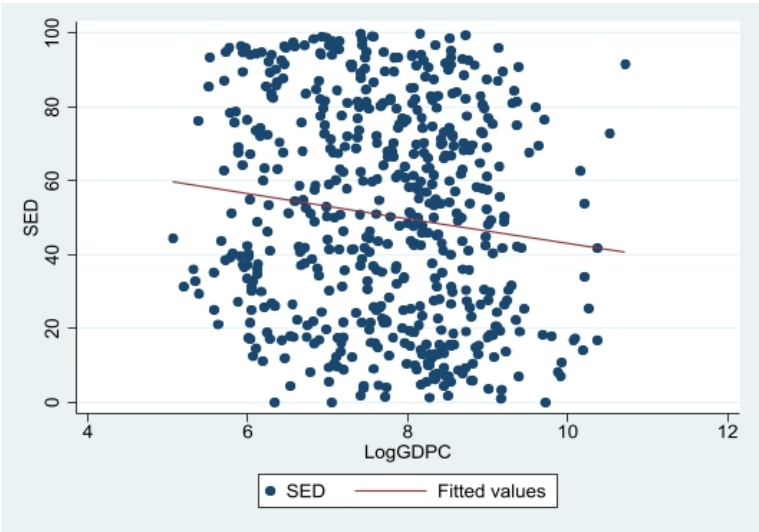

FIGURE 3. LINEAR CORRELATION PATTERN BETWEEN INTELLECTUAL PROPERTY RIGHTS AND REAL PER CAPITA INCOME OVER THE FULL SAMPLE

Source: Author.

sample. Figure 2 shows the correlation pattern between these two indicators over the full sample. Figure 3 presents the correlation pattern between real per capita income and the indicator of services export diversification. This figure helps provide initial insight into the correlation between services export diversification and a country's development level, as proxied by real per capita income.

We note from Figure 1 that the indicators "PRIE" and "SED" tend to move in

opposite directions. The index of IPR protection increased from 0.72 in 1975 to 1.33 in 2010, and the index "SED" decreased from 77.7 in 1976-1980 to 29.5 in 2011-2015. This suggests that while on average countries tended to strengthen their enforced IPR protection, they also tended to diversify their services export items less. Figure 2 shows a negative correlation between the two indicators. However, this does not imply negative causality, as the latter would be determined by an appropriate estimation of a model specification that links IPR protection to services export diversification. Figure 3 shows a negative correlation pattern between real per capita income and the indicator of services export diversification.

C. *Econometric approach*

We note from Table A2 that for all variables, except for the dependent variable "SED," the between-country variation of variables dominates the corresponding within-country variation. For the variable "SED," the between-country variation is lower than the within-country variation. In this context, the use of the within fixed-effects estimator to estimate model (1) would result in a loss of the efficiency of the estimates, as this estimator disregards between-country variations of variables. The feasible generalized least squares (FGLS) approach helps to address this concern, as it allows one to obtain more efficient estimates than those generated by the within fixed-effects estimator, especially in the presence of heteroskedasticity as well as serial and cross-sectional correlations in the residuals (e.g., Bai *et al*., 2021; Zellner, 1962). The FGLS estimator is particularly useful when the variance-covariance matrix of errors is unknown, as in such a case, the unknown matrix is estimated from the sample (Verbeek, 2012). The coefficients obtained from the estimation of model (1) or its variants by the FGLS approach represent the average effects, that is, the long-run average effect of each regressor on services export diversification (see Phillips and Moon, 1999). Many recent studies have used the FGLS approach in their analyses in conjunction with a panel dataset similar to ours (e.g., Can and Gozgor, 2018; Gnangnon, 2020c; 2023a; Meinhard and Portrafke, 2012; Nguyen and Su, 2021).

Overall, we estimate model (1) using primarily the FGLS estimator. However, for the sake of a proper comparison of estimates, we also present, only once, the results stemming from the estimation of model (1) using the within fixed-effects estimator (denoted "FE[11]").

The outcomes of the estimation of model (1) by means of the FE and FGLS estimators are presented respectively in columns [1] and [2] of Table 1. These outcomes help test hypothesis 1. Column [3] of the same Table allows for the testing of hypothesis 2. It contains outcomes arising from the estimation of a variant of model (1) that contains the interaction between real per capita income and the indicator "PRIE."

[11]When using this estimator, we correct the standard errors using the approach proposed by Driscoll and Kraay (1998) that helps deal with heteroscedasticity, serial correlations, and contemporaneous cross-sectional dependence in the residuals.

TABLE 1—EFFECT OF INTELLECTUAL PROPERTY RIGHTS ON SERVICES EXPORT DIVERSIFICATION (ESTIMATORS: FEDK AND FGLS (WITH PANEL-SPECIFIC FIRST-ORDER AUTOCORRELATION))

	FEDK	FGLS	
Variables	SED	SED	SED
	(1)	(2)	(3)
PRIE	8.644***	5.986***	-70.29***
	(2.854)	(2.232)	(7.862)
PRIE*Log(GDPC)			9.166***
			(1.036)
Log(GDPC)	5.399	-5.959***	-14.16***
	(5.135)	(1.289)	(1.246)
HUM	-3.471	3.033***	3.074***
	(2.460)	(0.553)	(0.497)
TRPOL	-4.252***	-2.320***	-1.901***
	(0.392)	(0.520)	(0.471)
FINDEV	-0.224***	-0.119***	-0.152***
	(0.0427)	(0.0331)	(0.0278)
RENT	0.975***	0.116	0.208**
	(0.338)	(0.0909)	(0.0834)
POLITY2	-1.009***	-0.754***	-0.476***
	(0.192)	(0.172)	(0.160)
FDI	0.450**	0.379**	0.0689
	(0.222)	(0.179)	(0.0924)
Log(POP)	-37.37***	-2.171***	-2.570***
	(10.28)	(0.617)	(0.567)
Constant	665.1***	161.3***	232.3***
	(188.2)	(15.56)	(15.62)
Observations - Countries	405 - 76	405 - 76	405 - 76
F-statistic (P-value)	587.58 (0.0000)		
Wald Chi2 Statistic (P-value)		1478.46 (0.0000)	1428.56 (0.0000)
Within R-squared	0.3934		
Pseudo R-squared		0.6204	0.6457

Note: 1) *p-value<0.1, **p-value<0.05, ***p-value<0.01, Robust standard errors are in parenthesis; 2) Pseudo R2 is calculated as the correlation coefficient between the dependent variable and corresponding predicted values; 3) Time dummies are included in the FGLS-based regressions.

The results in Table 2 allow for the testing of hypothesis 3. These outcomes were obtained by estimating three different variants of model (1). Each of these variants of model (1) includes an indicator of export product upgrading along with the corresponding interaction with the indicator "PRIE." The three export product upgrading indicators are the overall export product diversification (denoted as "EPD"), export product quality (denoted as "QUAL") and economic complexity (denoted as "ECOMP"). The indicator of overall export product diversification is obtained by taking the opposite value of the indicator of the overall export product concentration developed by the International Monetary Fund (IMF); it is computed using the Theil index and following the definitions and methods used in Cadot *et al*. (2011). The indicator "EPD" is the sum of the intensive and extensive components of export product concentration. It encompasses both the extensive and intensive

TABLE 2—EFFECT OF INTELLECTUAL PROPERTY RIGHTS ON SERVICES EXPORT DIVERSIFICATION (ESTIMATOR: FGLS (WITH PANEL-SPECIFIC FIRST-ORDER AUTOCORRELATION))

Variables	SED	SED	SED
	(1)	(2)	(3)
PRIE	35.03***	-51.10***	3.764
	(5.014)	(4.787)	(2.555)
PRIE*EPD	10.20***		
	(1.352)		
EPD	-8.399***		
	(1.528)		
PRIE*QUAL		66.40***	
		(6.310)	
QUAL		-19.01***	
		(6.548)	
PRIE*ECOMP			10.81***
			(1.944)
ECOMP			-8.639**
			(3.755)
Log(GDPC)	-6.009***	-7.741***	-5.580***
	(1.276)	(1.154)	(1.653)
HUM	3.170***	3.155***	2.888***
	(0.521)	(0.461)	(0.574)
TRPOL	-2.073***	-2.044***	-2.220***
	(0.526)	(0.491)	(0.591)
FINDEV	-0.120***	-0.194***	-0.178***
	(0.0324)	(0.0307)	(0.0345)
RENT	0.116	0.371***	0.115
	(0.107)	(0.112)	(0.102)
POLITY2	-0.745***	-0.612***	-0.354*
	(0.168)	(0.165)	(0.203)
FDI	0.207	0.160	0.356
	(0.210)	(0.105)	(0.385)
Log(POP)	-2.513***	-1.913***	-2.751***
	(0.678)	(0.494)	(1.001)
Constant	140.4***	185.9***	170.8***
	(19.35)	(12.79)	(27.07)
Observations - Countries	405 - 76	394 - 74	336 - 61
Wald Chi2 Statistic (P-value)	1899.42 (0.0000)	1145.18 (0.0000)	815.77 (0.0000)
Pseudo R-squared	0.6361	0.6679	0.6506

Note: 1) *p-value<0.1, **p-value<0.05, ***p-value<0.01, Robust standard errors are in parenthesis; 2) Pseudo R2 is calculated as the correlation coefficient between the dependent variable and the corresponding predicted values; 3) Time dummies are included in the FGLS-based regressions.

margins of concentration. Extensive export diversification reflects an increase in the number of new export products or trading partners, while intensive export diversification considers the shares of export volumes across active products or trading partners. If we denote as "EPC" the IMF's indicator of overall export product concentration, its transformation to obtain the indicator "EPD" is then as follows:

$EPD_{it} = -EPC_{it}$, where the subscripts i and t stand respectively for the given country and given sub-period. Higher values of the index "EPD" indicate greater overall export product diversification, and lower values reflect a tendency for a greater (overall) export product concentration.

The index of export product quality "QUAL" reflects the quality of existing exported products. It has been calculated using bilateral trade values and quantities at the SITC 4-digit level (see Henn *et al*., 2013; 2015). The calculation relies on an estimation methodology which derives quality from unit values, whereby export quality is measured according to the average quality (unit value) demanded in an exporter's present destination markets for any product. The trade dataset contains information about trade prices, values and quantities as well as information pertaining to preferential trade agreements and other gravity variables. Higher values of this indicator indicate higher export product quality levels.

Finally, the indicator "ECOMP" measures the economic complexity index, reflecting the diversity and sophistication of a country's export structure. Hence, it indicates the diversity and ubiquity of a country's export structure. It is estimated using data connecting countries to the products they export, applying the methodology in described in Hidalgo and Hausmann (2009). Higher values of this index reflect greater economic complexity.

IV. Interpretation of empirical results

The results in columns [1] and [2] of Table 1 show (with different magnitudes of the coefficients) that at the 1% level, the strengthening of IPR[12] protection promotes services export diversification. These outcomes confirm hypothesis 1, suggesting that the betterment of IPRs encourages services export diversification over the full sample. With regard to the control variables, we note that the estimates in columns [1] and [2] of the table are slightly different, both in terms of magnitude and statistical significance. Focusing on outcomes obtained using our preferred estimator, i.e., the FGLS estimator (see column [2]), we find that export product diversification is positively driven by improvements in human capital, higher FDI inflows, and a fall in the population size. Incidentally, countries tend to reduce their degree of services export diversification as they enjoy higher per capita incomes (the coefficient of the real per capita income is negative[13] and significant at the 1% level). Trade policy liberalization, financial development, and the improvement of

[12]Henceforth, we refer to "IPRs" as "enforced IPRs" given the way the indicator "PRIE" has been computed.

[13]The negative effect of real per capita income on services export diversification is consistent with the negative correlation pattern observed in Figure 3 between real per capita income and the indicator of services export diversification. Previous studies covered different samples and reported mixed evidence on the effect of real per capita income on services export diversification, depending on the topic under analysis. For example, Gnangnon (2021b; 2021c; 2022) found a positive effect of real per capita income on services export diversification when examining respectively the effect of manufactured exports, aid for trade, and economic complexity on services export diversification. However, Gnangnon (2020b) noted a positive effect of real per capita income on services export diversification when studying the effect of poverty on services export diversification. Ultimately, the effect of a country's development level on services export diversification needs to be examined deeply in another study. In the present study, the negative effect of the real per capita income on services export diversification may reflect differentiated effects of the strengthening of IRP on services export diversification across countries in the full sample. This is what we test later in the analysis.

institutions (proxied by greater democratization) are associated with greater services export concentration. These findings indicate, for example, that as countries liberalize their trade regime or as access to credit provided by the banking sector improves, firms tend to concentrate their services-related activities on a relatively limited number of services export items. Finally, natural resource dependence exerts, on average, no significant effect on services export diversification.

Turning to the outcomes reported in column [3] of Table 1, we find that the coefficient of the variable "PRIE" is negative and significant at the 1% level, while the interaction term related to the interaction variable "PRIE*Log(GDPC)" is positive and significant at the 1% level. These outcomes suggest that on average over the full sample, improved IPR protection induces greater services export diversification in countries whose real per capita income exceeds US$ 2140 [= exponential(70.29/9.166)]. Countries whose real per capita incomes are lower than US$ 2140, experience greater services export concentration. In other words, these findings indicate that for less developed countries, including least developed countries (LDCs) (i.e., countries whose real per capita incomes are lower than US$ 2140), it is rather weaker IPR protection that promotes services export diversification, while for relatively advanced developing countries, strengthening IPR protection promotes services export diversification. These outcomes appear to be consistent with the literature that supports weak IPR protection in less developed countries with a view to promoting imitation, and innovation at a later development stage. To get a clearer picture of the impact of IPR protection on services export diversification across countries in the full sample, we present in Figure 4, at the 95 percent confidence intervals, the marginal impact of IPR on services export diversification for varying levels of real per capita income. It appears from this figure that the marginal impact of IPR protection on services export diversification is negative for countries whose real per capita incomes are lower than US$ 1458.6 but

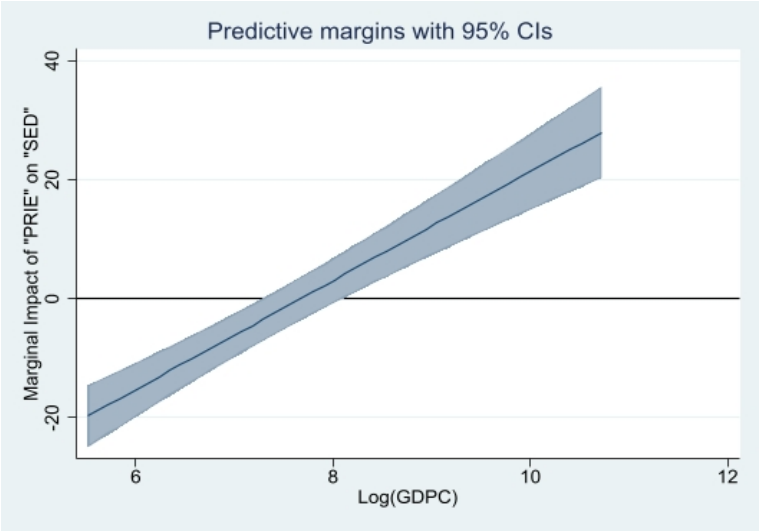

FIGURE 4. MARGINAL IMPACT OF "PRIE" ON "SED" FOR VARYING LEVELS OF REAL INCOME PER CAPITA

Source: Author.

positive for countries whose real per capita incomes are higher than US$ 3356.8. Countries whose real per capita incomes range from US$ 1458.6 to US$ 3356.8 experience no significant effect of IPR protection on services export diversification. In a nutshell, less developed countries, including LDCs, enjoy greater services export diversification when they adopt weakly enforced IPR protection, while relatively advanced developed countries promote their services export diversification when they strengthen their IPR protection. The lower countries' real per capita incomes are, the greater is the positive effect of weak IPR protection on services export diversification. On the other hand, with greater magnitudes of the positive effect of IPR protection on services export diversification increases, greater levels of IPR protection exist.

The outcomes in column [1] of Table 2 suggest that the coefficient of "PRIE" and the interaction term related to the interaction variable "PRIE*EPD" are both positive and significant at the 1% level, thereby suggesting that at the 1% level, export product diversification consistently induces greater services export diversification as counties improve their export product diversification level; on average over the full sample, the greater the degree of export product diversification, the higher the level of services export diversification. At the same time, the coefficient of the variable "EPD" is negative and significant at the 1% level. We display in Figure 5 the marginal impact[14] of IPR protection on services export diversification for varying degrees of export product diversification. According to this figure, it appears that this marginal impact increases as countries improve their degree of export product diversification. However, this factor is negative for countries with low degrees of export product diversification and positive for countries with relatively high levels of export product diversification. Putting it differently, developing countries such as

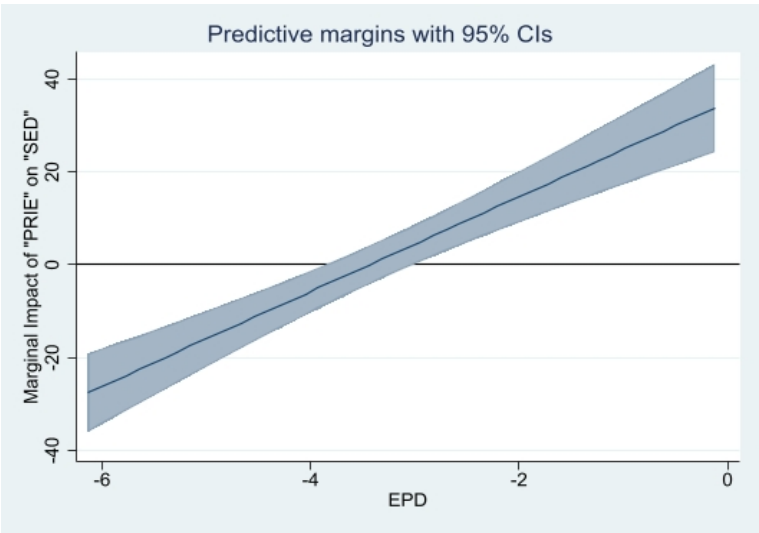

FIGURE 5. MARGINAL IMPACT OF "PRIE" ON "SED" FOR VARYING LEVELS OF "EPD"

Source: Author.

[14]The statistically significant marginal impacts at the 95 percent confidence intervals are those including only the upper and lower bounds of the confidence interval that are either above or below the zero line.

LDCs that have high degrees of export product concentration tend also to experience higher levels of services export concentration, while developing countries with relatively high degrees of export product diversification also tend to enjoy greater levels of services export diversification. These findings align, to some extent, with those in column [3] of Table 1, which suggest that less developed countries (likely to have high degrees of export product concentration) tend to have high levels of services export concentration, while relatively advanced developing countries (which tend to experience relatively higher degrees of export product diversification) have greater services export diversification.

The results in column [2] of Table 2 show that the coefficient of "PRIE" is negative and significant at the 1% level, while the interaction term of the variable "PRIE*QUAL" is positive and significant at the 1% level. These outcomes suggest that improved export product quality[15] levels promote services export diversification in countries whose level of export product quality exceeds 0.77 (= 51.10/66.4). This means that on average over the full sample, countries that have greater export product quality levels (i.e., values higher than 0.77) experience a positive effect of IPR strengthening on greater services export diversification, and the greater the level of export product quality, the higher the positive effect of improving IPR on services export diversification. Other countries (whose levels of export product quality are lower than 0.77) experience a negative effect of improving IPR protection on their services export concentration. In other words, these countries enjoy a positive effect of weak IPR protection on services export diversification. Figure 6 shows, at the 5% level, the marginal impact of IPR protection on services export diversification for varying levels of export product quality. It appears that while this marginal impact increases as the level of export product quality improves, only countries with a level

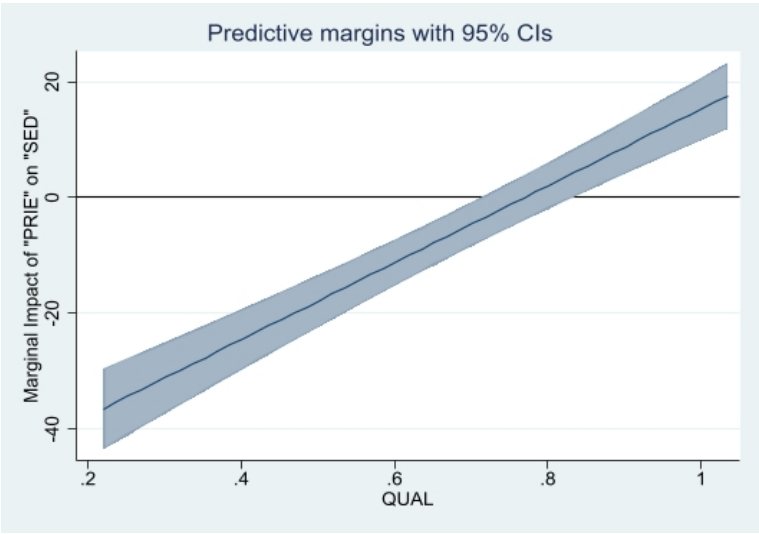

FIGURE 6. MARGINAL IMPACT OF "PRIE" ON "SED" FOR VARYING LEVELS OF "QUAL"

Source: Author.

[15]Values of the indicator of export product quality range from 0.22 to 1.05.

of export product quality higher than 0.83 experience a positive and significant effect of IPR protection strengthening on services export diversification. For countries whose levels of export product quality are lower than 0.72, weak IPR protection fosters services export product diversification, and lower levels of export product quality are linked to a greater positive effect of weak IPR protection on services export diversification. Finally, in countries whose levels of export product quality are between 0.72 and 0.83, there is no significant effect of IPR protection on services export diversification.

The estimates in column [3] of Table 2 reveal that the coefficient of "PRIE" remains positive, but not significant at the 10% level, whereas the interaction term related to the variable "PRIE*ECOMP" is positive and significant at the 1% level. On the basis of these outcomes, we will be tempted to deduce that on average over the full sample, and regardless of the degree of economic complexity, the betterment of IPR protection consistently enhances services export diversification, and the greater the level of economic complexity, the larger is the magnitude of the positive effect of IPR protection strengthening on services export diversification. Incidentally, the coefficient of the variable "ECOMP" is negative and significant at the 5% level. Figure 7 displays at the 5% level, the marginal impact of IPR protection on services export diversification for varying degrees of economic complexity. It shows that this marginal impact increases as the degree of economic complexity rises, but it can take both positive and negative values and is not always statistically significant. Countries whose degree of economic complexity exceeds 0.153 enjoy a positive and significant effect of fostering IPR protection on services export diversification. For these countries, the higher the degree of economic complexity is, the larger is the positive effect of economic complexity on services export diversification. In contrast, countries with lower levels of economic complexity (especially those whose degrees of economic complexity are lower than -0.8)

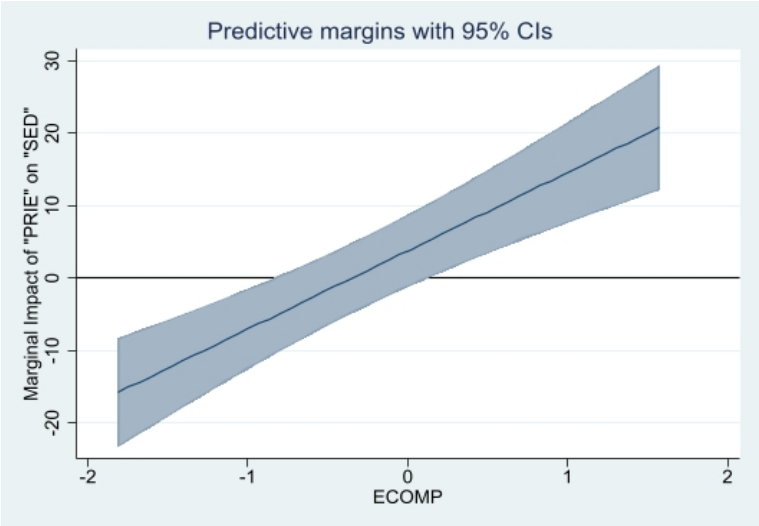

FIGURE 7. MARGINAL IMPACT OF "PRIE" ON "SED" FOR VARYING LEVELS OF "ECOMP"

Source: Author.

experience a negative (positive) effect of greater (weaker) IPR protection on services export diversification. For these countries, the lower the degree of economic complexity is, the higher the positive effect of weaker IPR protection on services export diversification also is. Finally, countries whose degree of economic complexity ranges is -0.8 and 0.153 experience no significant effect of IPR protection on services export diversification.

Overall, the findings from Table 2 suggest that weak IPR protection tends to promote services export diversification in countries with low degrees of export product upgrading, while strengthening IPR protection tends to foster services export diversification in countries with relatively high degrees of export product upgrading, regardless of whether the latter is export product diversification, improved export product quality, or an improved level of economic complexity.

The results of the control variables in Table 2 align broadly with those in column [2] of Table 1.

V. Further analysis

We dig deeper into the previous analysis by investigating the existence of a non-linear effect of IPR protection on services export production. The motivation for doing so comes from the observation in Figure 8 that there exists a non-linear correlation pattern, in the form of a U-shaped curve, between intellectual property rights and services export diversification over the full sample. To test this observation empirically, we estimate by means of the FGLS estimator a variant of model (1), which is nothing more than model (1) with the squared term of the variable "PRIE" included. The outcomes of this estimation are reported in Table 3.

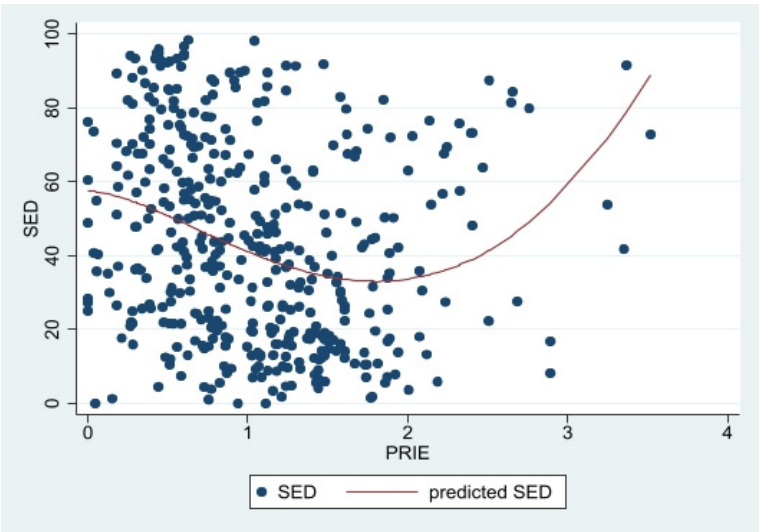

FIGURE 8. NON-LINEAR CORRELATION PATTERN BETWEEN INTELLECTUAL PROPERTY RIGHTS AND SERVICES EXPORT DIVERSIFICATION OVER THE FULL SAMPLE

Source: Author.

TABLE 3—NON-LINEAR EFFECT OF INTELLECTUAL PROPERTY RIGHTS ON SERVICES EXPORT DIVERSIFICATION (ESTIMATOR: FGLS (WITH PANEL-SPECIFIC FIRST-ORDER AUTOCORRELATION))

Variables	SED
	(1)
PRIE	-19.91***
	(2.648)
$PRIE^2$	9.824***
	(1.288)
Log(GDPC)	-6.778***
	(1.047)
HUM	3.085***
	(0.331)
TRPOL	-2.264***
	(0.386)
FINDEV	-0.0964***
	(0.0253)
RENT	0.232***
	(0.0828)
POLITY2	-0.358***
	(0.128)
FDI	0.139
	(0.103)
Log(POP)	-2.490***
	(0.552)
Constant	182.3***
	(13.12)
Observations - Countries	405 - 76
Wald Chi2 Statistic (P-value)	2412.90 (0.0000)
Pseudo R-squared	0.6491

Note: 1) *p-value<0.1, **p-value<0.05, ***p-value<0.01, Robust standard errors are in parenthesis; 2) Pseudo R2 is calculated as the correlation coefficient between the dependent variable and the corresponding predicted values; 3) Time dummies are included in the FGLS-based regressions.

The results in Table 3 show (with different magnitudes of the coefficients) that the coefficients of the variable "PRIE" and the corresponding squared terms are respectively positive and negative, and significant at the 1% level. These outcomes suggest that there is a non-linear effect of IPR protection on services export diversification that takes the form of a U-shaped curve. This finding confirms the non-linear correlation pattern observed in Figure 2. Based on these results, we can conclude that there is a level of "PRIE" above which the effect of IPRs on services export diversification changes sign; i.e., it becomes positive (as below this level, the effect is negative). Specifically, on average over the full sample, the strengthening of IPR protection promotes services export diversification in countries whose levels of PRIE exceed 1.013 [= 19.91/(2*9.824)]. To recall, values of "PRIE" range from 0 to 3.52 (see Table A3). We, therefore, deduce that on average, countries for which the IPR protection level exceeds 1.013 experience a positive effect of enforced IPR protection on services export diversification. For these countries, the greater the level of IPR protection is, the higher is the positive effect of IPR protection on services export diversification. Conversely, for countries whose level of IPRs is lower than

1.013, strengthening IPR protection leads to a greater services export concentration, with the magnitude of this effect increasing as the level of IPR protection decreases. In other words, for these countries, weak IPR protection fosters services export diversification, and weaker IPR protection levels are linked to greater levels of services export diversification.

Figure 9 presents, at the 95 percent confidence interval, the marginal impact of IPR protection on services export diversification for different levels of IPR protection. We note from this graph that the marginal impact of IPR protection on services export diversification increases as countries further strengthen their IPR protection. This outcome can take positive or negative values but is not always statistically significant at the 5% level. This marginal impact is not statistically significant for levels of IPR protection ranging from 0.915 to 1.197. As a result, countries whose levels of IPR protection range from 0.915 to 1.197 experience no significant effect of IPR protection on services export diversification. At the same time, for countries whose degrees of IPR protection are lower than 0.915 (i.e., falling between 0 and 0.915), the marginal impact is negative and significant at the 5% level. This suggests that the implementation of weaker (stronger) IPR protection exerts a positive (negative) and significant effect on services export diversification, with lower degrees of IPR protection meaning a higher positive effect of IPR protection on services export diversification. Conversely, countries whose level of IPR protection exceeds 1.197 experience a positive and significant effect of IPR protection on services export diversification (as the marginal impact is positive and significant at the 5% level). For these countries, with greater strengthening of IPR protection, the magnitude of the positive impact of IPR protection on services export diversification also increases. Overall, strengthening IPR protection contributes to enhancing services export diversification in countries with a high degree of IPR protection, especially when the IPR protection level exceeds a certain level, which

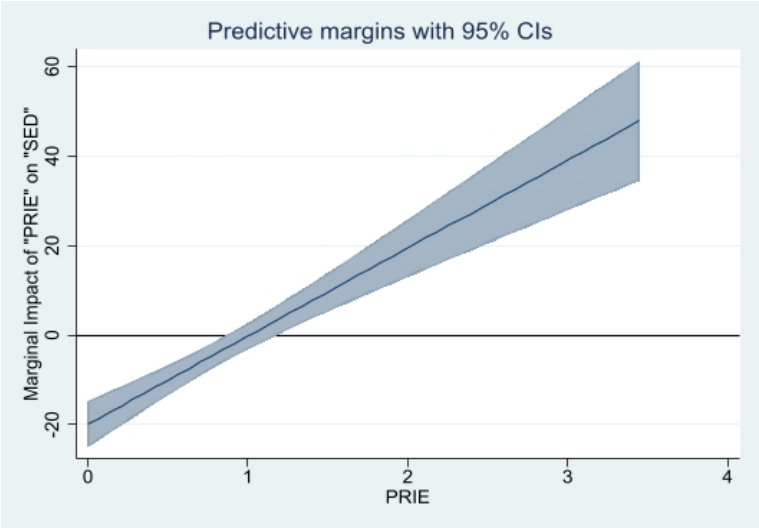

FIGURE 9. MARGINAL IMPACT OF "PRIE" ON "SED" FOR VARYING LEVELS OF "PRIE"

Source: Author.

is 1.197. Conversely, in countries with weaker IPR protection levels, including those with IPR protection levels lower than 0.915, it is rather the implementation of weaker IPR protection levels that promotes services export diversification.

As indicated earlier, Table A4 presents a list of countries in the full sample on the basis ascending values of the variable "PRIE" over the last sub-period of the analysis, i.e., in the year 2010 for the indicator "PRIE." It appears that many of those countries that have weakly enforced IPR protection are LDCs[16]. This is not surprising, as LDCs have been exempted from implementing the majority of the provisions contained in the TRIPS Agreement (see for example Article 66 of the TRIPS Agreement[17]). It is apparent in Table A3 that 18 countries[18] (ranging from Mozambique to Pakistan) had IPR values lower than 0.915 (many of them being LDCs) in 2010. Concurrently, 42 countries had levels of enforced IPR protection higher than (or equal to) the level of 1.197. These countries range, in ascending order in terms of the strength of IPR protection, from Costa Rica (with a value of PRIE in 2010 equal to 1.204) to Singapore (with a value of PRIE in 2010 equal to 3.370).

It should be noted that outcomes relating to the control variables in Table 3 are consistent with those in column [2] of Table 1.

VI. Conclusion

The present analysis investigates the effect of improving IPR protection of services export diversification using a panel dataset containing data from 76 countries (both developed and developing countries) over annual periods from 1970-2014. The results have shown that the implementation of weak IPR protection by less advanced developing countries (i.e., countries whose real per capita incomes are lower than US$ 2140) is associated with greater services export diversification, while in advanced developing countries, it is rather the implementation of stronger intellectual property laws that promotes services export diversification. The analysis has also explored the extent to which export product upgrading (that is, export product diversification, improved export product quality levels or improved economic complexity levels) matters with regard to the effect of IPR protection on services export diversification. The findings have revealed that weak IPR protection tends to promote services export diversification in countries with low degrees of export product upgrading, while stronger intellectual property laws tend to foster services export diversification in countries with relatively high degrees of export product upgrading. Finally, the analysis has revealed that IPR protection strengthening induces greater services export diversification in developing countries whose IPR protection levels exceed the value of 1.197. On the other hand, in countries with low levels of IPR protection, it is rather the implementation of weaker

[16]The category of least developed countries includes those poorest and most vulnerable (to external and environmental shocks) in the world. Information on this category of countries is provided online at https://www.un.org/ohrlls/content/least-developed-countries.

[17]The Agreement is accessible online at https://www.wto.org/english/docs_e/legal_e/27-trips.pdf.

[18]These countries are Mozambique, Myanmar, Bangladesh, Congo Democratic Republic, Papua New Guinea, Benin, Burundi, Cote d'Ivoire, Mali, Guyana, Panama, Niger, Indonesia, Gabon, Congo Republic, Honduras, Togo, and Pakistan.

IPR protection that stimulates services export diversification.

While the present analysis has not used an indicator of IPR protection that reflects specifically the protection of patent rights in the services sector, it has provided evidence of the effect of IPR protection on services export diversification through the avenue of export product upgrading. Any policy implication from the empirical analysis would involve a discussion on how IPR protection affects services export diversification through the export product upgrading channel.

The literature has provided that the strengthening of IPR protection can exert ambiguous effects on innovation; that is, it can enhance the market power of innovating firms and result in higher prices in the domestic markets. It can also reduce the risk of imitation and encourage the export of patentable products. The present study has shown that the implementation of weaker IPR protection promotes services export diversification in less developed countries, including those with a low level of export product upgrading. These countries, of which many LDCs, are exempted from the implementation of the TRIPS Agreement (from 1995), which allows them to adopt weaker IPR protection levels (see Gnangnon, 2023b), although membership in regional trade agreements could constrain them in their efforts to adopt and implement stronger intellectual property laws (e.g., Campi and Dueñas, 2019; Syam and Syed, 2023). On the other hand, IPR protection promotes services export diversification in relatively advanced developing countries, including those that foster export product diversification. Thus, strengthening IPR protection and ensuring that the legal provisions of IPRs are enforced in practice contributes to enhancing services export diversification, notably in countries that upgrade their export products.

The present study has also established that export product upgrading is an important channel through which the level of IPR protection could affect services export diversification. The WTO has established minimum standards of the protection and enforcement of intellectual property by each of its members. Many works have considered how IPR protection influences export product upgrading (e.g., Campi and Dueñas, 2016; Dong *et al*., 2022; Glass and Wu, 2007; Gnangnon and Moser, 2014; Liu *et al*., 2021; Ndubuisi and Foster-McGregor, 2018; Song *et al*., 2021). As noted above, they tend to show that while weak IPR protection can promote export product upgrading in less developed countries (including LDCs), stronger IPR protection enhances export product upgrading in relatively advanced countries among developing countries. On the other hand, export product upgrading tends to foster services export diversification (e.g., Gnangnon, 2020a; 2022). The findings of the present study do not contradict the existing literature to the extent that they show how weak IPR protection tends to foster services export diversification through greater export product upgrading in less developed countries, while stronger IPR protection matters for services export diversification through export product upgrading in relatively advanced countries. Insofar as less advanced countries, especially LDCs[19] tend to adopt weaker IPR protection levels (e.g., Auriol *et al*., 2023; Chu *et al*., 2014), and relatively advanced developing countries tend to strengthen their IPR protection levels, the issue is therefore what types of measures

[19]LDCs enjoy specific flexibilities in WTO agreements that have allowed them to reduce their IPR protection levels (e.g., Gnangnon, 2023b).

could accompany developing countries' IPR policies so as to enhance export product upgrading with a view ultimately to spurring the diversification of services exports. Policies to promote export product diversification, including those in developing countries, have been discussed in depth in the literature (e.g., Atolia *et al*., 2020; Hidalgo, 2022; Mosley, 2018; Salinas, 2021; Sweet and Maggio, 2015; Vogel, 2022).

While the present study does not focus on a specific country to provide policy recommendations tailored to that country, future analyses on this topic could explore, if relevant data are made available, how IPR protection strengthening affects services exports, including by services sector and item. This would help those who make policy recommendations specific to a country, or a group of countries, and hence inform decision-making at the national level.

APPENDIX

TABLE A1—DEFINITIONS AND SOURCES OF VARIABLES

Variable	Definition	Source
PRIE	This is the effective patent protection (PRIE) computed as the Index of Patent Protection (PRI) multiplied by the index of legal enforcement effectiveness. The Index of Patent Protection is based on patentee rights. The index comprises five components. These include the duration of patent protection relative to the international standard, subject matter that is patentable (or not unpatentable), participation in international intellectual property rights agreements, the enforcement mechanisms available, and how limited (or less restricted) the patenting exceptions are (such as any requirement to practice the invention or license the patents to third parties). The overall index of patent protection varies from zero to five, with higher numbers reflecting stronger patent rights.	The indicator "PRI" was developed by Park (2008); see data online at http://fs2.american.edu/wgp/www/. The index of legal enforcement effectiveness is extracted from the Fraser Institute (see online at https://www.fraserinstitute.org/). Note that the values of "PRI" in the database of Park (2008) range from 0 to 5, while in the database of the Fraser Institute, the values of the index of legal enforcement of contracts are between 0 and 10. Following Liu *et al*. (2021), to compute the indicator of "PRIE," we use the index of legal enforcement deflated by 10 so that its values now range from 0 to 1.
SED	This is the Theil index of services export diversification. It is obtained by taking the opposite value of the indicator of the services export concentration (denoted "SEC") calculated using the following formula (see for example, Agosin *et al*., 2012; Cadot *et al*., 2011): $SEC = \frac{1}{n}\sum_{k=1}^{n}\frac{x_k}{\mu}\ln\left(\frac{x_k}{\mu}\right)$, where $\mu = \frac{1}{n}\sum_{k=1}^{n} x_k$, where n represents the total number of (services) export lines (k) $n = \sum_{k=1}^{n} k$, and x_k stands for the amount of services exports associated with the services line "k." Values of the index "SEC" range from 0 to 100, with higher values of this index reflecting greater services export concentration and lower values indicating greater services export diversification. Thus, our indicator of services export diversification is computed as follows: $SED_{it} = 100 - SEC_{it}$, where the subscripts *i* and *t* stand respectively for the given country and the given sub-period. Higher values of the index "SED" indicate greater services export diversification, and lower values of the index reflect a tendency toward a greater services export concentration.	Author's calculation based on data extracted from the database developed by the International Monetary Fund (IMF) on international trade in services (see online at: https://data.imf.org/?sk=07109577-E65D-4CE1-BB21-0CB3098FC504). See also Loungani *et al*. (2017). The data used to compute the HHI indicator are sectoral data on services exports at the two-digit level, which is the maximum digit level of disaggregated data available on services. In particular, we relied on eleven major sectors of services (categories of services) – at the one-digit level - and used the disaggregated data on services exports for sub-sectors at the two-digit level. These eleven major services sectors are as follows (the sub-sectors are in brackets): Charges for the use of intellectual property n.i.e.; Construction; Financial services; Insurance and pension services; Maintenance and repair services n.i.e.; Manufacturing services on physical inputs owned by others; Other Business Services; Personal, cultural, and recreational services; Telecommunications, computer, and information services; Transport; and Travel.

TABLE A1—DEFINITIONS AND SOURCES OF VARIABLES (CONT'D)

Variable	Definition	Source
EPD	This is the index of the overall export product diversification. It is obtained by taking the opposite value of the indicator of the overall export product concentration developed by the International Monetary Fund (IMF) and is computed using the Theil index and following the definitions and methods used in Cadot *et al*. (2011). The overall Theil index of export product concentration is the sum of the intensive and extensive components of export product concentration. Indeed, export product diversification can occur either over product narrowly defined or trading partners. It can be broken down into the extensive and intensive margins of concentration. Extensive export diversification reflects an increase in the number of new export products or trading partners, while intensive export diversification considers the shares of export volumes across active products or trading partners. The calculation of the indicator has relied on a classification of products into "Traditional," "New," or "Non-Traded" products categories. If we define "EPC" as the IMF's indicator of overall export product concentration, then its transformation to obtain the indicator "EPD" is as follows: $EPD_{it} = -EPC_{it}$, where the subscripts *i* and *t* stand respectively for the given country and given sub-period. Higher values of the index "EPD" indicate greater overall export product diversification, and lower values reflect a tendency toward a greater (overall) export product concentration.	Details on the methodology used to calculate this index can be found in Henn *et al*. (2013; 2015). Data are available from the International Monetary Fund's Diversification Toolkit (see: https://www.imf.org/external/np/res/dfidimf/diversification.htm)
QUAL	This is the indicator of export product quality. It reflects the quality of existing exported products and a country's position on the quality ladder (implying world frontier value). It has been calculated using bilateral trade values and quantities at the SITC 4-digit level (see Henn *et al*., 2013; 2015). The calculation relies on an estimation methodology which derives quality from unit values, whereby export quality is measured according to the average quality (unit value) demanded in an exporter's present destination markets for any product. The trade dataset contains information on trade prices, values and quantities as well as information on preferential trade agreements, and other gravity variables. Higher values of this indicator indicate greater export product quality.	Details on the methodology used to calculate this index can be found in Henn *et al*. (2013, 2015). Data are available from the International Monetary Fund's Diversification Toolkit (see: https://www.imf.org/external/np/res/dfidimf/diversification.htm)
ECOMP	This is the economic complexity index. It reflects the diversity and sophistication of a country's export structure and hence indicates the diversity and ubiquity of that country's export structure. It has been estimated using data connecting countries to the products they export, applying the methodology as described in Hidalgo and Hausmann (2009). Higher values of this index reflect greater economic complexity.	MIT's Observatory of Economic Complexity (https://oec.world/en/rankings/eci/hs6/hs96)

TABLE A1—DEFINITIONS AND SOURCES OF VARIABLES (CONT'D)

Variable	Definition	Source
GDPC	Per capita Gross Domestic Product (constant 2015 US$)	World Development Indicators (WDI) of the World Bank.
FDI	This is the share (in percentage) of net inflows of foreign direct investment in GDP.	WDI
TRPOL	This is the index of freedom to trade internationally, with higher values meaning greater freedom to trade internationally. It is a composite index that includes several components. The latter include tariffs, regulatory trade barriers, black-market exchange rates and controls of the movement of capital and people. The values of the index of freedom to trade internationally range from 0 to 10. The index of freedom to trade internationally is one of the major components of the overall index of economic freedom. Details on the methodology used to calculate this index can be found online at: https://www.fraserinstitute.org/economic-freedom/approach	Data collected from the Fraser Institute (https://www.fraserinstitute.org/economic-freedom/dataset) (see Gwartney *et al*., 2022)
FINDEV	This is a proxy for financial development and is measured according to the share (in percentage) of domestic credit to private sector by banks in GDP.	WDI
HUM	This is the indicator of human capital. It is measured by the average years of total schooling for the population aged between 15 and 64.	Barro and Lee Database, updated in 2021 (see Barro and Lee, 2013). Accessible online at: https://barrolee.github.io/BarroLeeDataSet/BLv3.html
RENT	This is the share (%) of total natural resources rents in GDP.	WDI
POP	This is the measure of the total population.	WDI
POLITY2	This variable is an index extracted from the Polity IV Database (Marshall *et al*., 2018). It represents the degree of democracy based on the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive. Its values range from -10 to +10, with lower values reflecting autocratic regimes and greater values indicating democratic regimes. Specifically, a value of +10 for this index represents a strong democratic regime, while a value of -10 indicates a strong autocratic regime.	Polity IV Database (Marshall *et al.*, 2018)

TABLE A2—LIST OF THE 76 COUNTRIES IN THE FULL SAMPLE

Full Sample		
Algeria	Guatemala	Papua New Guinea
Argentina	Guyana	Paraguay
Bangladesh	Haiti	Peru
Benin	Honduras	Philippines
Bolivia	Hungary	Poland
Botswana	India	Romania
Brazil	Indonesia	Russian Federation
Bulgaria	Iran, Islamic Rep.	Rwanda
Burundi	Israel	Senegal
Cameroon	Jamaica	Sierra Leone
Chile	Jordan	Singapore
China	Kenya	South Africa
Colombia	Korea, Rep.	Sri Lanka
Congo, Dem. Rep.	Malawi	Syrian Arab Republic
Congo, Rep.	Malaysia	Tanzania
Costa Rica	Mali	Thailand
Cote d'Ivoire	Mauritius	Togo
Cyprus	Mexico	Trinidad and Tobago
Czechia	Morocco	Tunisia
Dominican Republic	Mozambique	Türkiye
Ecuador	Myanmar	Uganda
Egypt, Arab Rep.	Nepal	Ukraine
El Salvador	Nicaragua	Uruguay
Fiji	Niger	Zambia
Gabon	Pakistan	
Ghana	Panama	

TABLE A3—DESCRIPTIVE STATISTICS, INCLUDING THE WITHIN-COUNTRY AND BETWEEN-COUNTRY VARIATIONS OF VARIABLES USED THE FULL SAMPLE

Variable		Mean	Standard deviation	Minimum	Maximum	Observations
SED	Overall	43.262	26.844	0.000	98.451	N = 405
	Between		12.846	15.728	68.894	n = 76
	Within		23.873	-13.307	99.028	T bar = 5.329
PRIE	Overall	1.052	0.622	0.000	3.520	N = 405
	Between		0.520	0.000	2.500	n = 76
	Within		0.376	-0.204	2.173	T bar = 5.32895
EPD	Overall	-3.282	1.052	-6.135	0.000	N = 405
	Between		0.990	-5.557	-1.398	n = 76
	Within		0.454	-6.852	-1.211	T bar = 5.329
QUAL	Overall	0.778	0.149	0.220	1.051	N = 394
	Between		0.158	0.243	1.004	n = 74
	Within		0.048	0.547	0.970	T bar = 5.324
ECOMP	Overall	-0.222	0.702	-1.813	1.577	N = 336
	Between		0.722	-1.714	1.483	n = 61
	Within		0.203	-1.057	0.516	T bar = 5.5082
GDP	Overall	4372.986	5514.461	248.169	45405.570	N = 405
	Between		5403.560	278.021	28423.130	n = 76
	Within		2185.708	-11498.550	24837.660	T bar = 5.329
HUM	Overall	6.610	2.741	0.951	12.959	N = 405
	Between		2.718	1.454	12.673	n = 76
	Within		1.101	3.450	10.237	T bar = 5.329
TRPOL	Overall	5.959	1.866	0.000	9.957	N = 405
	Between		1.371	1.196	9.453	n = 76
	Within		1.306	1.452	9.393	T bar = 5.329
FINDEV	Overall	31.446	27.136	0.000	203.165	N = 405
	Between		26.426	1.786	176.081	n = 76
	Within		13.428	-28.480	101.843	T bar = 5.329
RENT	Overall	6.012	7.300	0.000	43.365	N = 405
	Between		7.413	0.001	35.077	n = 76
	Within		2.661	-5.011	18.417	T bar = 5.329
POLITY2	Overall	2.533	6.002	-9.000	10.000	N = 405
	Between		4.937	-8.300	10.000	n = 76
	Within		3.618	-10.273	11.023	T bar = 5.329
FDI	Overall	2.542	5.106	-3.561	86.490	N = 405
	Between		5.563	-1.051	47.020	n = 76
	Within		3.406	-36.927	42.012	T bar = 5.329
POP	Overall	64400000	190000000	753645.6	1320000000	N = 405
	Between		169000000	756561.4	1190000000	n = 76
	Within		32600000	-227000000	383000000	T bar = 5.329

TABLE A4—LIST OF COUNTRIES IN THE FULL SAMPLE ALONG WITH VALUES OF THE VARIABLE "PRIE" FOR THE LAST SUB-PERIOD, I.E., 2010-2014, PROVIDED IN ASCENDING ORDER

Country	PRIE	Country	PRIE	Country	PRIE
Mozambique	0	Mauritius	1.129	Argentina	1.604
Myanmar	0.037	Guatemala	1.161	Tanzania	1.606
Bangladesh	0.182	Sri Lanka	1.166	Cyprus	1.608
Congo, Dem. Rep.	0.183	Rwanda	1.167	Romania	1.620
Papua New Guinea	0.280	Nepal	1.171	Tunisia	1.625
Benin	0.296	Malawi	1.174	Kenya	1.728
Burundi	0.560	Jordan	1.176	Mexico	1.761
Cote d'Ivoire	0.682	Botswana	1.180	Morocco	1.771
Mali	0.728	Costa Rica	1.204	Nicaragua	1.779
Guyana	0.755	Algeria	1.217	Bulgaria	1.848
Panama	0.756	Bolivia	1.238	Poland	1.854
Niger	0.757	Uganda	1.257	Thailand	1.872
Indonesia	0.783	Jamaica	1.261	Israel	1.873
Gabon	0.807	Egypt, Arab Rep.	1.268	Ukraine	1.910
Congo, Rep.	0.833	Dominican Republic	1.274	South Africa	1.923
Honduras	0.863	Ghana	1.323	Türkiye	2.006
Togo	0.871	Paraguay	1.328	Russian Federation	2.073
Pakistan	0.891	Brazil	1.370	Malaysia	2.089
Senegal	0.938	Cameroon	1.407	Czechia	2.135
Iran, Islamic Rep.	0.995	Fiji	1.420	China	2.395
Zambia	1.019	Sierra Leone	1.426	Hungary	2.508
Uruguay	1.029	India	1.427	Chile	2.655
Syrian Arab Republic	1.056	El Salvador	1.441	Korea, Rep.	2.894
Colombia	1.086	Philippines	1.441	Singapore	3.370
Trinidad and Tobago	1.112	Peru	1.553		
Haiti	1.126	Ecuador	1.579		

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거시경제와 금융안정을 종합 고려한 최적 통화정책체계 연구†

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한국은행은 금융위기 이후인 2011년 법 개정을 통해 기존의 물가안정 이외에 금융안정 책무를 추가로 부여받았는데, 그 이후 장기간에 걸쳐 가계신용이 소득 여건에 비해 빠르게 증가해 온 결과 최근의 가계부채 상황은 소비와 성장을 제약하고 부정적 경제충격 발생 시 위기 발생 가능성을 높일 수 있다는 우려가 제기되고 있다. 현재의 금융불균형 누증 상황이 앞으로 우리 금융·경제의 안정적 흐름을 제약하지 않도록 정부와 중앙은행이 더욱 유의해야 할 시기인 것으로 판단된다. 본 연구는 BIS가 중장기 경제안정화를 위해 거시·금융안정(macro financial stability)을 모색하고자 제안한 정책운용 체계인 통합적 물가안정목표제(IIT)의 국내 적용 가능성을 점검해 보고, 정책적 시사점을 도출해 보았다. 우선 VAR 모형을 통해 통화정책의 주택가격, 가계부채 파급효과를 살펴본 결과, 금융위기 이후 금리 인하에 따른 위험선호 경향이 뚜렷하게 증대된 것으로 나타났다. 또한 DSGE 모형을 통해 2000년 이후 2021년까지 약 20여 년간의 통화정책 운영 행태를 분석해 본

Key Word: 거시경제·금융안정, 통화정책체계, 금리준칙, 가계부채
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* Referee Reports Completed: 2024. 1. 7

† 본 연구는 한국은행 연구용역 사업으로 수행되었다. 다만, 본 연구 결과는 집필자들의 개인 연구 내용이며, 한국은행의 공식 견해와는 무관함을 밝힌다. 본 연구에 소중한 조언을 아끼지 않으신 익명의 두 분 심사위원님들과 박철범 교수님(고려대 경제학과), 엄상민 교수님(경희대 경제학과), 한국은행 경제모형실 세미나 참가자분들께도 깊은 감사를 드린다. 아울러 본 연구 수행에 필요한 자료정리 등 관련 업무를 최선을 다해 지원해 준 한국은행 이시은 조사역님께도 진심으로 감사를 표한다.

결과, 한국은행은 기준금리 결정 시 물가와 성장을 종합적으로 고려하면서, 가계신용 증가에도 일부 대응한 것으로 나타나 약한 형태의 IIT를 운영한 것으로 분석되었다. 다만, 금리평활화 계수가 매우 높게 추정되어 금리 조정에 상당히 신중했던 것으로 나타났다. 한편, 중앙은행 손실함수를 최소화하는 최적 금리준칙을 추정해 본 결과, 물가와 성장을 균형적으로 감안하면서, 경제 여건 변화에 대응하여 기준금리를 보다 적극적으로 조정하고, 소득 여건에 비해 가계부채가 빠르게 증가하는 경우에는 가계신용 상황에도 유의하는 정책이 바람직한 정책방안으로 분석되었다. 이 같은 연구결과를 고려할 때 BIS가 제안한 통합적 물가안정목표제는 중장기 시계에서 우리 경제의 안정적 성장을 뒷받침할 수 있는 정책체계 대안으로 고려해 볼 수 있을 것으로 판단된다.

Ⅰ. 서 론

전통적으로 거시경제의 안정을 목적으로 통화정책을 운영하는 중앙은행이 가계신용 등 금융안정 요인에도 대응해야 하는지 여부에 대해서는 그간 학계와 국제기구, 각국 중앙은행 간에 이견이 존재해 왔다. 미 연준과 IMF는 금융불균형 발생 시 중앙은행의 통화정책이 아닌 거시건전성 정책으로 대응하는 것이 바람직하다는 입장을 견지해 왔다. 이는 통화정책은 경제 전반에 영향을 미치는 거시정책으로서 금융불균형 완화를 목적으로 활용될 경우 실물경제에 의도하지 않은 부작용을 초래할 우려가 있는 반면, 거시건전성 정책은 과열된 금융·자산 부문에 한정하여 선별적으로 영향을 미치게 되므로 금융안정 정책의 효율성이 담보된다는 점에 기인한다. 이에 따라 통화정책은 물가안정에, 거시건전성 정책은 금융안정에 중점을 두고 운영하는 분리대응원칙(separation principle)이 바람직하다는 견해이다.

그런데 금융위기 발생을 계기로 과도한 가계신용 누증, 주택가격 거품 등 금융불균형 누증은 결과적으로 경제위기를 초래하는 등 금융안정 리스크가 거시경제에 막대하고 장기적인 영향을 미친다는 사실이 확인되면서, 중앙은행이 통화정책 운용 시 성장과 물가 등 거시경제 안정 이외에도 금융불균형 완화를 위해서도 적극 대응할 필요가 있다는 견해가 확산되었다. 이는 가계신용, 주택가격 등에 대한 통화정책의 파급효과가 확대[1]된 상황에서는 금융불균형 누증을 완화하기 위해 통화정책을 활용하는 것이 금융·경제 안정화 도모에 효과적이라는 점에 기인한다. 이에 더해 거시건전성 정책은 규제 회피 가능성 등으로 상황에 따라

[1]Borio and Zhu(2012) 등은 통화정책의 위험선호 경향이 증대된 상황에서는 금융불균형 완화를 위해 통화정책을 활용하는 것이 바람직하다는 견해를 제기하고 있다. 본고의 분석 등에서 금융위기 이후 기준금리 조정에 따른 가계신용과 주택가격의 반응이 이전 기간에 비해 상당폭 확대된 것으로 나타나, Borio and Zhu(2012)의 견해가 우리나라에서도 성립할 가능성이 높은 것으로 보인다.

금융불균형 완화 효과가 불확실할 수 있는 데다, 금융불균형 누증은 지속가능한 성장을 제약함으로써 성장과 물가 등 거시경제의 안정이라는 통화정책 본연의 목표 달성을 어렵게 할 수 있다는 점도 중앙은행의 통화정책 대응 필요성을 뒷받침하고 있다.

금융위기 이후 통화정책의 금융불균형 대응 필요 견해가 널리 확산되면서 주요국 중앙은행의 책무에 전통적인 물가안정 외에 금융안정을 추가하는 국가들이 증가하기 시작하였다.[2] 우리나라에서도 2011년 한은법 개정을 통해 한국은행의 통화정책 목적에 금융안정 조항이 추가되었다.[3] 그런데 한국은행은 주요국 중앙은행과 달리 통화정책 결정 시 금융안정 요인을 어떻게 고려하는 것이 바람직한지에 대한 논의와 합의가 아직까지 충분히 이루어지지 못한 상황이다.[4]

이 같은 상황에서 우리나라 가계부채 규모는 금융위기 이후 디레버리징을 경험한 미국 등 주요 선진국과 달리 증가세를 지속해 왔다. 특히 코로나19 이후에는 경제위기에도 불구하고 주택가격 상승을 배경으로 가계신용이 빠른 속도로 증가[5]하여 최근 우리나라 가계부채 비율(104.5%, 2022년 말 기준)은 주요국 중 3번째[6]로 높은 수준까지 상승하였다.

학계와 주요 국제기구 등의 연구 결과에 따르면, 이 같은 가계부채 누증은 소비 등 성장을 제약할 뿐만 아니라 대내외 부정적 충격 시 위기 발생 가능성을 높이고, 경기 복원력을 상당폭 약화시키는 것으로 알려져 있다. 예를 들면 Cechtti *et al.*(2011)과 Lombardi *et al.*(2017) 등의 연구에서는 GDP 대비 가계신용비율이 각각 85% 및 80%를 상회할 경우 성장(GDP)의 둔화요인으로 작용하게 됨을 밝혔으며, Jordà *et al.*(2015) 등의 분석에 따르면

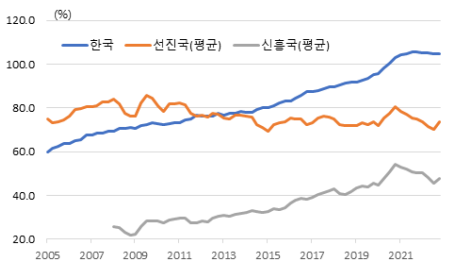

Figure 1. Trends in Household Debt in Major Countries (2005~2022)

Note: As a share of GDP, BIS.

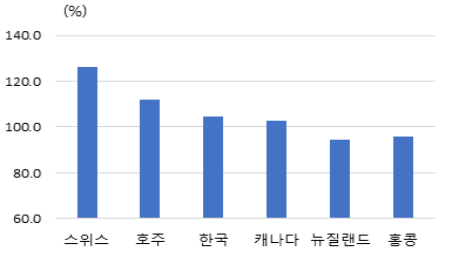

Figure 2. Household Debt to GDP Ratio in Major Countries

Note: As of 2022: Q4, BIS.

[2]금융위기 이후 IMF(2010)의 조사 결과 등에 따르면, 서베이 대상 국가 중 90% 이상의 대다수 중앙은행들이 금융안정 책무를 부여받고 있는 것으로 나타났다.

[3]한국은행법 제1조 ②, "한국은행은 통화신용정책을 수행함에 있어 금융안정에 유의해야 한다."

[4]예를 들면 한국은행은 2018년 11월 금통위 회의에서 기준금리를 25bp 인상(1.50%→1.75%)하면서 가계대출 증가세 지속 등 금융안정에 유의할 필요성을 중점적으로 고려하였다. 당시 예금은행 가계대출 증가율은 7% 후반대(2018년 10월: 7.9%→11월: 7.8%, 전년 동월 대비)를 나타내었으며, 서울 APT 가격은 14%를 웃도는 높은 상승률(2018년 10월: 14.4%→11월: 14.2%, 전년 동월 대비)을 지속하였다. 당시 금통위 의사록을 살펴보면, 다수 위원들은 금융불균형 누적에 유의해야 한다는 의견을 제시하면서 금리 인상을 주장한 반면, 2명의 금통위원은 금융불균형 완화보다 거시경제의 하방 위험에 초점을 두고 금리 동결의 소수의견을 제시하면서 금통위 내에서도 동 이슈에 대한 이견이 컸던 것으로 보인다.

[5]2019년 말 대비 2022년 말 기준 가계부채비율 상승폭(+9.5%p)을 보면 우리나라는 홍콩(+14.4%p)에 이어 세계 2번째로 빠른 것으로 나타났다.

[6]2022년 말 가계부채비율(BIS 기준): 스위스(126.4%) 〉 호주(111.9%) 〉 한국(104.5%).

소득 여건을 벗어난 과도한 가계신용 증가와 주택가격 상승이 동반하여 발생할 경우 이 같은 부정적 파급효과가 더욱 심화되는 것으로 나타났다. 또한 Park *et al.*(2022; 2023) 등에서도 민간부채 누증이 실물경제에 미치는 효과를 분석해 본 결과, 가계부채 증가는 단기적으로 생산 증가를 유발하지만 3년 이후의 중기 시계에서는 성장의 둔화요인으로 작용하는 것으로 분석되었으며, 기업부채의 경우에는 중기적 시계뿐만 아니라 단기적으로도 생산 증가 효과가 유의하지 않은 것으로 추정되었다. 민간부채 중 가계부채 누증은 선진국에서, 기업부채의 경우에는 신흥국에서 부정적 효과가 두드러진 것으로 분석되었다. 한편, 최근 국내 연구로 권도근 외(2023)는 우리나라를 포함한 국가별 패널분석을 통해 가계부채 증가는 단기적으로 경기부양 효과가 있으나, 중장기적으로는 성장둔화와 경기침체 요인으로 작용하는 것으로 추정하였다. 특히 동 연구에서는 가계신용 규모가 GDP 대비 80%를 초과할 경우 성장에 미치는 부정적 효과가 확대되는 것으로 분석되어 기존의 주요 연구 결과에 부합하였다.

국내 금융불균형 누증이 거시경제에 미치는 부정적 파급효과에 대한 우려가 높아지는 가운데 BIS는 2019년 거시경제와 금융안정을 종합적으로 고려하는 정책체계인 Integrated Inflation Targeting(이하 'IIT') Framework을 제안하면서, 동 체계가 성장과 물가만을 고려하는 물가안정목표제에 비해 중장기 경제안정화 도모에 보다 효과적이라는 입장을 밝혔다. 동 견해에 따르면, 중앙은행의 금융안정 도모 책무가 보다 강화될 필요가 있으며, 실제 통화정책 운용 시 금융안정 요인을 체계적으로 고려할 것을 권고하고 있다. 특히 금리준칙에 민간신용 관련 변수를 명시적으로 반영할 경우 성장과 물가뿐만 아니라 금융안정도 효과적으로 도모할 수 있다고 밝혔다. 아울러 중앙은행이 정책결정 과정의 투명성을 제고하고

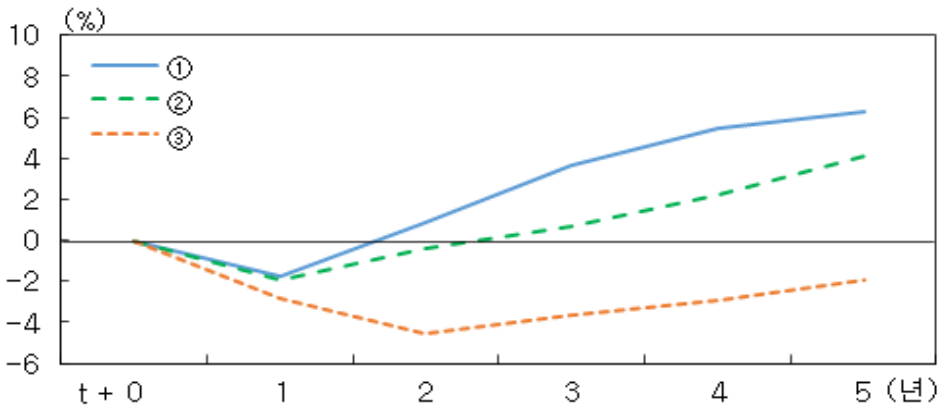

Figure 3. The Speed of Recovery by Financial and Economic Situation After Economic Downturn

Note: 1) t+0 indicates the year starting an economic downturn; 2) ① In cases where there is no simultaneous surge in housing prices or increase in household credit before an economic downturn. ② Cases where housing prices surged before an economic downturn. ③ Cases where there was a sharp increase in housing prices and a significant rise in household credit before an economic downturn.

Source: Jordà *et al.*(2015).

커뮤니케이션을 강화하는 것은 경제주체들의 효율적 기대형성을 통해 금융·경제 안정 도모 등 중앙은행 책무를 효율적으로 달성하는 데 도움이 된다는 의견을 제시하였다.

한편, 이와 관련하여 Shin and Shin(2023)은 한국의 경우 거시금융 전반의 안정을 도모하는 정책체계(macro-financial policy framework)에 통화정책을 함께 고려하는 것이 중요하고 중앙은행의 금융안정 책무가 명확히 설정될 필요가 있으며, 통화정책과 거시건전성 정책이 일관된 방식으로 운용되는 것이 중요하다는 견해를 제기하였다.

이에 본 연구는 코로나19 이후 국내 가계부채 누증에 대한 우려가 높아지고 있는 상황에서 향후 중장기 시계에 있어 한국은행이 거시경제와 금융안정을 효과적으로 도모하기 위한 정책체계를 마련하기 위해 BIS가 제안한 IIT7의 국내 적용 가능성을 점검해 보고, 최적의 통화정책 운용 전략을 분석해 보았다. 본고는 크게 4장으로 구성되어 있다. 제Ⅱ장에서는 VAR 모형 분석을 통해 2000년부터 2021년까지 주요 충격(주택가격·가계신용·통화정책 등) 발생 시의 경제변수 반응을 살펴보고, 그 결과를 금융위기 전후로도 구분하여 비교해 본다. 제Ⅲ장에서는 DSGE 모형을 구축하여 2000년 이후 실증적 금리준칙(Taylor Rule) 추정을 통해 한국은행이 실제 운영해 온 통화정책 행태를 분석하고, 중앙은행 손실함수 분석을 통해 중기적 시계에서 거시경제·금융안정을 도모할 수 있는 최적 금리준칙을 추정해 본다. 제Ⅳ장에서는 연구 결과를 요약하고 정책적 시사점을 도출한다.

Ⅱ. VAR 모형 및 추정 결과

1. VAR 모형 개관

본격적인 DSGE 모형 분석에 앞서 본 장에서는 우리나라 통화정책과 주택시장 사이의 상호작용에 관한 시계열 데이터로부터의 분석을 시행한다. 이를 위해 구조적 VAR 모형을 사용하는데, 동 모형은 외생적 통화정책 식별이 용이하고 추정이 간편하다는 점 등을 토대로 미국 등 선진국뿐만 아니라 우리나라를 대상으로 한 통화정책 효과 실증분석에 활발하게 이용되어 왔다.

이를 위해 다음의 축약형 VAR 모형(reduced-form VAR model)을 설정하였다.

$$(1) \qquad Z_t = \mu_0 + DX_t + B_1 Z_{t-1} + ... + B_k Z_{t-k} + u_t, \ t = 1, ..., T$$

위 식에서 Z_t 및 X_t는 각각 내생변수 및 외생변수 벡터를 나타내며, μ_0은 상수 벡터를 의미한다. B_j는 내생변수에 대응하는 계수행렬($1 \le j \le k$)이며, D는 외생변수의 계수행렬을 나타낸다. u_t는 잔차항 벡터로, $E(u_t) = 0$, $E(u_t u'_t) = \Sigma$, 그리고 $s \neq t$일 때 $E(u_t u'_s) = 0$을 만족한다.

[7] IIT의 주요 내용에 대해서는 부록 1을 참조하기 바란다.

본 연구에서는 내생변수가 성장(GDP; y_t), 물가(CPI; p_t), 명목 정책금리(r_t), 실질주택가격(hp_t), GDP 대비 가계신용비율(hc_t)로 구성된 5변수 VAR을 구축하였다. 성장, 물가 및 정책금리는 통화정책 충격 식별에 있어 필수적인 변수이므로 포함되었다. 실질주택가격 및 가계신용비율은 통화정책과 금융안정 변수인 주택시장과 가계부채 간의 상호작용 분석 시 핵심이 되는 변수들이다. 동 모형 추정 시 미국의 성장(y_t^*), 미 국채 10년물 금리(i_t^*), 원유가격(op_t) 및 한국의 주요 교역국 대비 실질실효환율($reer_t$)을 외생변수로 통제해 주었는데, Han and Hur(2020)에서 보인 바 있듯이 이러한 변수는 재화시장 및 자본시장 개방도가 높은 우리나라의 특성을 반영함으로써 국내 통화정책 충격 식별의 신뢰성을 높여주는 역할을 한다.[8]

분석기간은 아시아 외환위기(Asian currency crisis) 및 한국은행의 물가안정목표제(inflation targeting)가 명시적으로 도입된 이후인 2000년 1/4분기부터 가장 최근의 데이터가 가용한 2021년 4/4분기까지로 설정하였다. 추정 시 모형의 시차구조(k)는 다양한 시차 선택 기준을 고려하여 3기로 설정하였다.

모형의 추정을 위해 베이지안(Bayesian) 방법을 사용하였다. 베이지안 분석 시 필수적인 모수의 사전분포(prior distribution)는 기존 미국을 대상으로 한 문헌인 Uhlig(2005)과 Mountford and Uhlig(2009) 등의 설정을 원용하였다. 구체적으로 식 (1)에 주어진 축약형 VAR의 계수행렬과 분산-공분산 행렬의 사전분포가 무한(∞) 분산을 가지는 노말-위샤트(Normal-Wishart) 분포를 따른다고 가정하였는데, 특히 사전분포의 무한(∞) 분산 가정은 사전분포로부터 오는 계수에 대한 정보를 최소화함으로써 계수행렬과 분산-공분산 행렬의 사후(posterior) 추정치를 기존의 OLS 추정치와 비슷하게 하는 역할을 한다. 이는 본고의 결과와 OLS를 사용한 기존 연구의 결과 간 추정 방법으로 인해 발생하는 차이를 최소화하기 위한 것이다.

일반적으로 식 (1)에 주어진 축약형 VAR 잔차항의 분산-공분산 행렬의 비대각(off-diagonal) 원소들은 0이 아닌 값을 가지며, 따라서 축약형 모형의 잔차항들은 상호 상관관계를 가지게 된다. 따라서 상호 독립적인 외생적 충격 식별을 위해 축약형 VAR을 다음과 같이 구조적 VAR(structural VAR)로 선형변환한다.

$$AZ_t = A\mu_0 + ADX_t + AB_1Z_{t-1} + \ldots + AB_kZ_{t-k} + e_t \quad (2)$$

위 식에서 A는 내생변수 벡터와 같은 차원을 가지는 정방행렬이며, $Au_t = e_t$를 만족한다. e_t는 구조적 충격 벡터로서 $E(e_t) = 0$, $E(e_t e'_t) = \Omega$를 만족하며, Ω는 대각행렬이다. 일반적으로 이러한 성질을 만족하는 A 행렬은 무수히 많이 존재하며, 따라서 외생적 충격이 유일하게 식별되기 위해서는 A 행렬에 추가적 가정이 필요하다. 본고에서는 A 행렬 식별을 위해 내생변수들 간의 외생성에 순서를 가정하는 순차적 나열(recursive ordering) 방식을 도입한다(Sims, 1980). 변수들 간의 외생성 순서는 위에서 언급한 대로 성장(y_t), 물가(p_t),

[8]이 논문의 추정에 사용된 자료에 대한 자세한 설명은 부록 3에 제시되어 있다.

정책금리(r_t), 실질주택가격(hp_t), 가계신용비율(hc_t)로 한다. 동 식별 방식을 원용한 기존의 통화정책 문헌에서는 일반적으로 정책금리가 해당 기의 성장과 물가를 관측한 이후 결정되는 현실을 반영하여, 성장과 물가가 정책금리보다 외생적이라고 가정한다. 이렇게 결정된 정책금리에 금융안정 관련 변수들이 영향을 받는다고 상정하여 주택가격 및 가계신용비율을 정책금리보다 덜 외생적으로 처리하였다.[9]

추정된 축약형 모형의 계수행렬과 분산-공분산 행렬의 사후분포에서 5천개의 표본을 추출한 후, 각 표본에 대해서 위의 외생적 충격 식별 방법을 적용하여 최종적으로 5천개의 통화정책, 주택가격 및 가계신용비율 충격을 도출하였다.

2. VAR 모형 충격반응함수 추정 결과

Figure 4에는 위와 같은 방식으로 식별된 외생적 주택가격 1% 상승 충격에 대한 모형 내생변수들의 반응이 요약되어 있다. 주택가격 상승으로 성장은 단기적으로 증가하며, 물가 또한 상승한다. 이러한 반응은 해당 기간 동안 주택가격이 경기를 회복시키는 양(+)의 수요충격으로서의 특징을 가지는 것을 나타낸다. 한편, 해당 충격에 대해 정책금리가 단기적으로

(Unit: %)

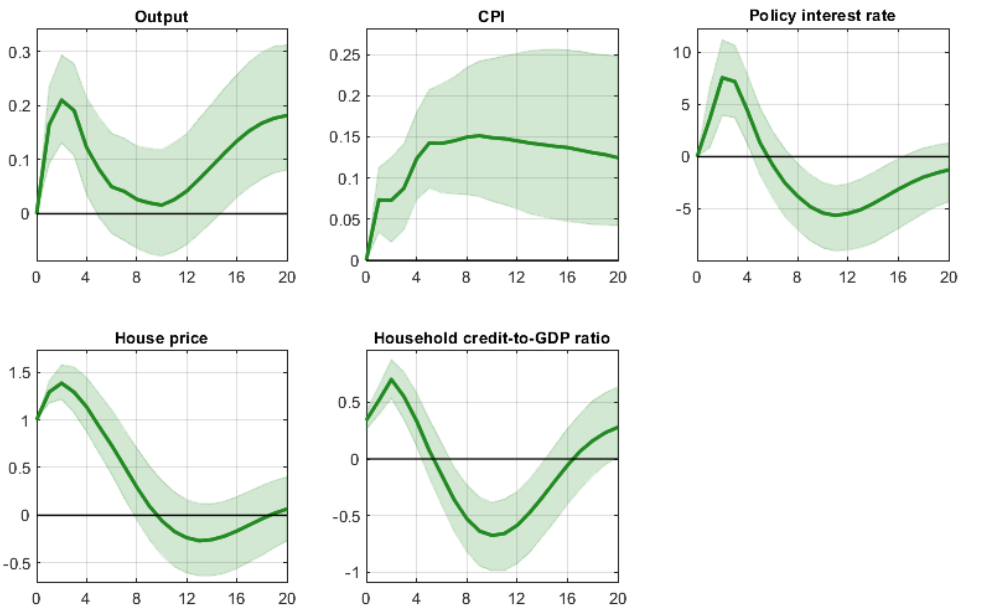

Figure 4. VAR Impulse Response Function: Positive Housing Price Shocks

Note: In each graph, solid lines and shaded areas represent the median and 68% error band estimates, respectively, with the x-axis indicating the period in quarter after the shocks.

[9]2011년에 금융안정이 명시적으로 통화정책의 책무 중 하나로 명시된 우리나라의 경우, 성장과 물가 이외에도 주택시장이나 가계신용 변수들 또한 통화정책 결정 시 중요한 영향을 미칠 수 있다는 점을 고려하여 정책금리, 실질주택가격 및 가계신용비율 변수들의 순서를 바꾸어서도 해당 모형을 추정하였는데, 충격반응함수에 큰 차이가 없는 것으로 판명되었다.

인상되는 것으로 분석되어, 주택가격 상승 등에 따른 금융불균형 발생 시 중앙은행이 통화정책으로 대응했다는 점을 시사한다. 마지막으로 가계신용비율의 반응이 주택가격의 반응과 비슷한 모습을 나타내는데, 주택가격 상승에 따라 가계신용비율도 단기적으로 증가하였다가 충격 7분기 이후부터 음(-)의 반응으로 전환한다. 한 가지 주지할 점은 이러한 가계신용비율의 반응을 주택가격 상승으로 인한 성장의 단기적 증가 반응과 결합해 보면, 주택가격 상승에 따라 단기적으로는 가계신용의 증가가 성장의 증가보다 빠르다는 것이다.

외생적 가계신용비율 1% 증가 충격에 대한 충격반응함수는 Figure 5에 보고되어 있다. 주택가격 충격과 마찬가지로 가계신용비율의 외생적 증가는 단기적으로 성장을 증가시키는 것으로 판명되었다. 다만, 해당 충격이 물가 및 정책금리에 미치는 영향은 단기적으로 중간값 기준 양(+)으로 분석되었으나, 에러밴드(error band)가 충격 이후 모든 시점에 걸쳐 0을 포함하고 있어서 통계적으로 유의하지는 않은 것으로 나타났다. 한편, 가계신용비율 상승으로 인해 주택가격 또한 단기적으로 상승하는데, 이러한 결과를 Figure 4의 결과와 종합해 보면, 2000년대 이후 주택가격과 가계신용비율 사이에 강한 공행성(comovement)이 존재하는 것을 알 수 있다.

Figure 6는 VAR 모형으로부터 식별된 100bp 정책금리 인상 충격에 대한 충격반응함수를 나타낸다. 정책금리 인상으로 인해 중간값 기준 성장과 물가 모두 상당기간 동안 하락하며, 이러한 결과는 음(-)의 수요충격으로서의 긴축적 통화정책 충격의 성격과 부합하는 것으로 보인다. 또한 이러한 충격에 대해 주택가격 및 가계신용비율이 모두 충격 이후 2~3년

(Unit: %)

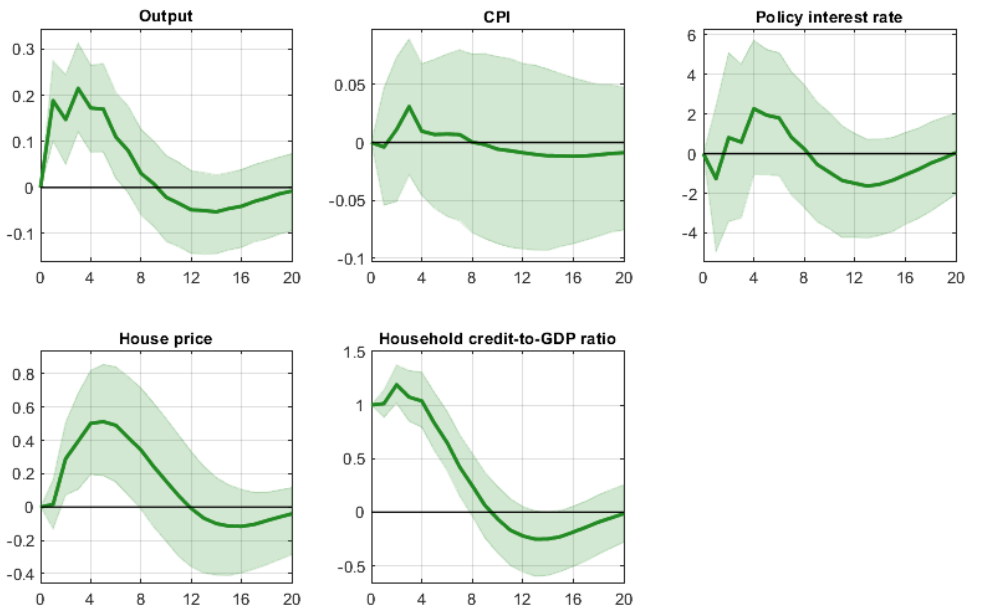

Figure 5. VAR Impulse Response Function: Positive Household Credit-to-GDP Ratio Shocks

Note: In each graph, solid lines and shaded areas represent the median and 68% error band estimates, respectively, with the x-axis indicating the period in quarter after the shocks.

(Unit: %)

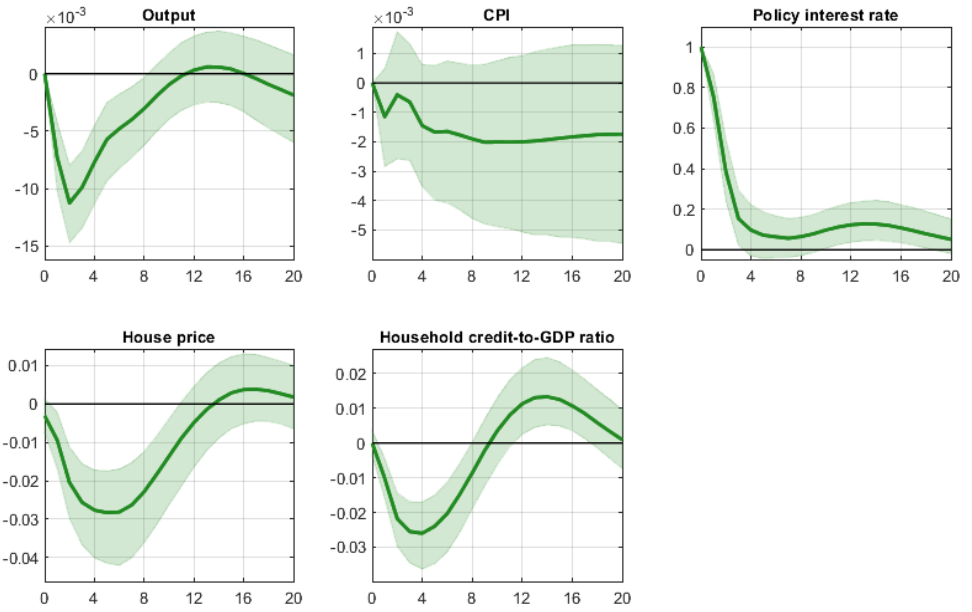

Figure 6. VAR Impulse Response Function:
100 Basis Points Policy Interest Rate Increase Shocks

Note: In each graph, solid lines and shaded areas represent the median and 68% error band estimates, respectively, with the x-axis indicating the period in quarter after the shocks.

동안 감소하는 것으로 나타나, 경제학 이론이 제시하는 금리와 자산가격(주택) 및 가계부채 사이의 음(-)의 상관관계가 데이터로부터도 관측되는 것을 알 수 있다.

3. VAR 모형 충격반응함수 추정 결과: Subsample 분석

위 절에서는 2000년 이후 자료를 이용하여 VAR 모형에 기반한 세 가지 외생적 충격의 반응함수를 분석하였다. 그러나 잘 알려져 있다시피 2008~09년의 글로벌 금융위기(global financial crisis: GFC)는 전 세계적으로 금융시장의 제도 변화 및 해당 시장에 대한 정책적 규제 강화의 계기가 되었으며, 주택시장과 이와 관련한 가계대출 행태 또한 예외가 아니었다. 이러한 측면에서 GFC를 포함한 2000년대와 이후 기간인 2010년대를 구분하여 해당 VAR 분석을 시행하고, 두 샘플에 대한 시사점이 달라지는지 여부를 시산하고자 한다. 이를 위해 앞에서 설명한 VAR 모형을 2000년 1/4분기 ~ 2010년 4/4분기까지와 2011년 1/4분기 ~ 2021년 4/4분기까지의 샘플로 나누어 분석한다.

Figure 7은 양(+)의 주택가격 충격에 대한 서브샘플 충격반응함수를 비교하고 있다. 가장 먼저 성장의 반응을 보면 샘플별로 큰 차이를 보이는 것을 알 수 있다. 2000년대 샘플의 경우 주택가격 상승 충격에 대해 성장이 단기적으로 증가하는 것으로 분석되는 반면, 2010년대에 대해서는 상당 기간 성장이 음(-)의 반응을 보이는 특징을 나타낸다. 이러한 충격

(Unit: %)

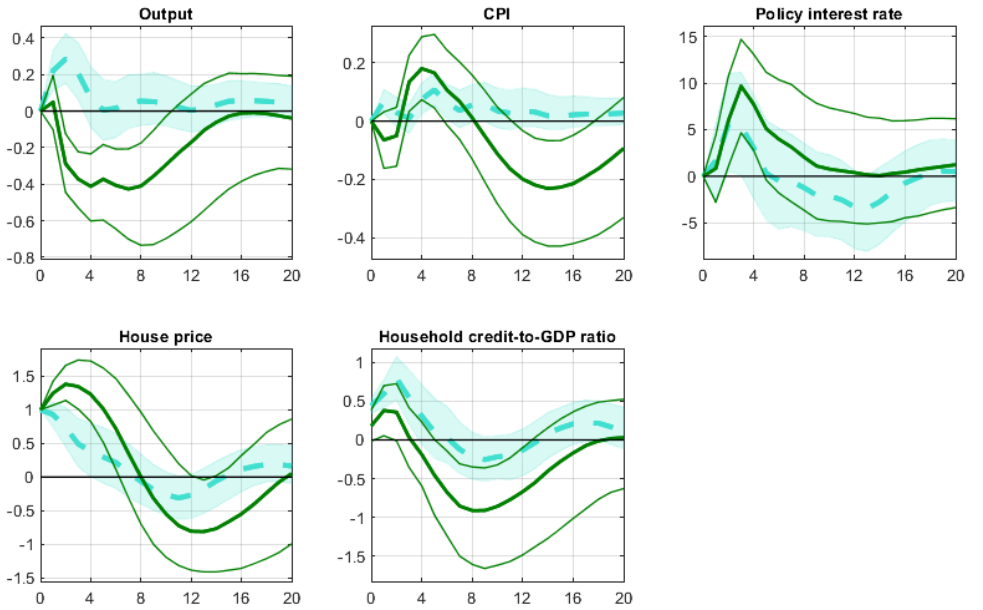

Figure 7. VAR Impulse Response Function: Positive Housing Price Shocks, Subsample

Note: 1) In each graph, dashed lines and shading represent the median and 68% error band estimates for the 2000s period, while solid thick and thin lines represent the median and 68% error band estimates for the 2010s period, respectively; 2) In each graph, the x-axis represents the period in quarters after the shocks.

반응함수의 패턴 변화는 이전과는 다르게 2010년대에 들어 주택가격 상승과 경기부양 사이의 양(+)의 공행성이 더 이상 관측되지 않음을 시사한다. 이와 같은 성장의 반응은 물가의 반응과 연관 지어 생각했을 때 더욱 흥미로운데, 2000년대에는 주택가격 상승 충격에 대해 상당 기간 물가가 상승하는 반응을 보인 반면, 이후 기간에 대해서는 해당 충격이 성장의 위축과 중기 시계에서의 물가 상승을 일으킨다. 이러한 결과는 2010년대 이후 기간에는 주택가격 상승 충격이 단기적으로 부정적 총 공급 충격의 성격을 가짐을 나타낸다.

한편, 주택가격 상승 충격에 대한 정책금리의 반응도 또한 샘플별로 상당히 다른 것으로 분석되었다. 2010년대의 경우 2000년대보다 주택가격 상승에 대해 정책금리가 더 큰 폭으로 인상된 것으로 나타났으며, 이는 주택가격에 대한 통화정책의 반응도가 최근 기간에 더욱 증대되었을 가능성을 시사한다. 마지막으로 가계신용비율의 반응 또한 2010년대에 들어서 모든 시계에 걸쳐 더욱 큰 폭으로 감소하였고, 그 변동성 또한 이전 기간에 비해 크게 증가한 것으로 추정되었다. 이는 주택가격 변화에 대해 가계신용비율의 변화가 2010년대에 들어 더욱 민감해진 것으로 해석할 수 있다.

가계신용비율에 대한 외생적 충격의 서브샘플 충격반응함수는 Figure 8에 제시되어 있다. 성장 및 물가에 대한 영향은 샘플별로 유사한데, 외생적 가계신용비율의 상승은 성장과 물가를 모두 상당 기간 동안 증가시키는 것으로 분석되었다. 다만, 이전 시기에 비해 2010년대에 성장과 물가의 반응이 더 지속적(persistent)인 것으로 나타났다는 특징을 보이며,

(Unit: %)

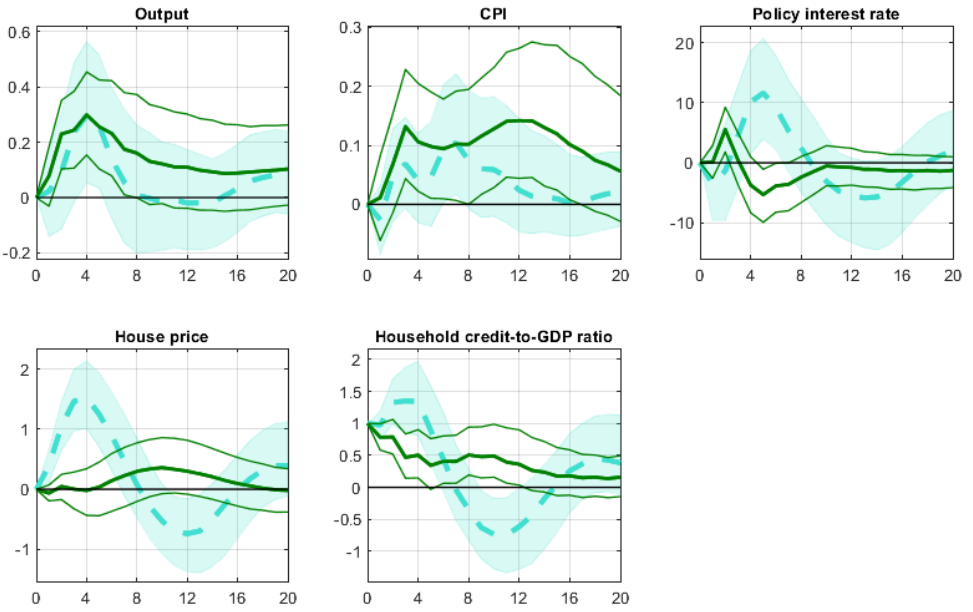

Figure 8. VAR Impulse Response Function:
Positive Household Credit-to-GDP Ratio Shocks, Subsample

Note: 1) In each graph, dashed lines and shading represent the median and 68% error band estimates for the 2000s period, while solid thick and thin lines represent the median and 68% error band estimates for the 2010s period, respectively; 2) In each graph, the x-axis represents the period in quarters after the shocks.

이러한 결과의 일부는 가계신용비율 충격에 대한 해당 변수 자체의 반응이 더 지속적이 된 것과 연관을 가지는 것으로 볼 수 있다. 반면, 해당 충격에 대한 정책금리와 주택가격 반응의 정도는 2010년대에 들어 약화된 결과가 도출되었다.

VAR 충격반응함수 분석의 마지막으로 Figure 9은 외생적 통화긴축 충격에 대한 서브샘플 충격반응함수를 비교하고 있다. 가장 눈에 띄는 점은 비슷한 통화정책 충격에 대해 모형 내 모든 내생변수의 반응도가 2010년대에 들어 크게 증가한다는 것이다. 이러한 결과의 일환으로 긴축적 통화정책 충격에 대해 모든 변수들의 2000년대 충격반응함수는 통계적으로 0으로부터 다르지 않게 추정된다. 반면, 2010년대 샘플에 대해서는 해당 충격이 성장, 물가, 주택가격 및 가계신용비율 모두를 단기적으로 유의하게 감소시키는 것으로 분석되었다. 이러한 결과는 통화정책 변화가 거시경제 및 금융안정에 미치는 영향이 GFC 기간 이후에 대해 더욱 강화되었음을 시사한다.

(Unit: %)

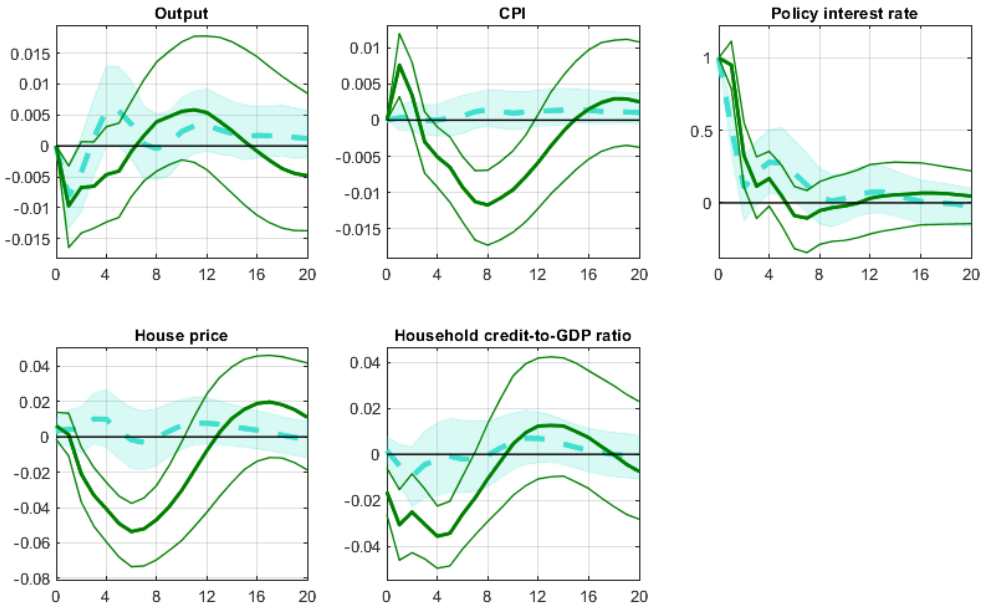

Figure 9. VAR Impulse Response Function:
100 Basis Points Policy Interest Rate Increase Shocks, Subsample

Note: 1) In each graph, dashed lines and shading represent the median and 68% error band estimates for the 2000s period, while solid thick and thin lines represent the median and 68% error band estimates for the 2010s period, respectively; 2) In each graph, the x-axis represents the period in quarters after the shocks.

Ⅲ. DSGE 모형 및 추정 결과

위 Ⅱ장에서 살펴본 VAR 모형의 결과는 우리나라 통화정책과 주택시장·가계신용 등 금융안정 변수들 사이에 밀접한 상호작용이 존재함을 시사한다. 이러한 결과를 바탕으로 본 장에서는 통화정책에 관련된 구조적 모수(structural parameter)를 명시적으로 식별할 수 있는 DSGE 모형을 설정하고, 이를 바탕으로 통화정책과 금융안정 간의 관계를 연구한다. 나아가 중장기 시계에서 거시경제와 함께 금융안정을 효율적으로 달성하기 위한 최적 금리 준칙을 도출하는 것을 목표로 한다.

1. DSGE 모형 개관

본 연구에서는 주택시장을 명시적으로 고려한 폐쇄경제 뉴케인지언 모형인 Iacoviello (2005)의 모형을 확장하여 분석한다. 모형의 개략적인 구조는 다음과 같다.[10] 먼저 가계를 저축가계(patient household) 및 차입가계(impatient household)로 나눈다. 두 가계 모두

[10]본 연구에서 원용한 DSGE 모형에 대한 구체적인 설명은 부록 2에 제시되어 있다.

자신의 효용을 소비재의 소비뿐만 아니라 주택서비스의 소비에서 얻는다고 가정한다. 저축가계는 노동 공급을 하며, 소비재 소비, 주택 소비, 자본과 토지를 기업에 임대하고 남은 저축을 차입가계에 대출한다. 차입가계는 노동 공급을 하며 소비재와 주택 소비를 한다는 점에서는 저축가계와 동일하나, 그들의 주택 가치를 담보로 저축가계로부터 차입을 한다는 결정적인 차이점을 가진다. 이와 같은 차입가계의 명목부채를 B_t''이라고 표시한다. Iacoviello(2005)에서와 같이 주택 공급은 고정되어 있다고 가정한다.

모형 내의 기업 부문은 기업가(entrepreneurs)와 독점적 경쟁기업인 소매기업(retailer)으로 구성되어 있다. 기업가는 주택과 노동을 이용하여 중간재를 생산하는 경제주체이며, 소매기업은 기업가로부터 독점적 경쟁시장에서 중간재를 구매하고 동질적인(homogeneous) 최종재를 생산하여 완전경쟁시장에 판매하는 역할을 한다.

본 모형에서 중앙은행은 다음과 같은 테일러(Taylor) 준칙을 따라서 정책금리를 결정한다고 가정한다.

$$\hat{r}_t = \rho_r \hat{r}_{t-1} + (1-\rho_r)\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t\right) + \sigma_r \epsilon_t^r \tag{3}$$

위 식에서 $\hat{X}$(hat) 기호는 변수 X의 정상상태(steady state)로부터의 퍼센트 격차(percentage deviation)를 나타낸다. r_t와 π_t 및 y_t는 각각 t기의 정책금리, 물가 및 성장을 의미한다. ϵ_t^r은 $i.i.d.\ N(0,1)$의 분포를 따르는 통화정책 충격이며, σ_r은 이러한 통화정책 충격의 표준편차(standard deviation)를 나타낸다.

DSGE 모형을 통한 본고의 핵심 연구주제 가운데 두 가지는 다음과 같다: [1] "2000년대 이후 기간 동안 통화정책이 성장과 물가 이외에 금융안정 변수에 반응해 왔는가?"; [2] "만약 그렇다면 어떠한 금융안정 변수에 반응했는가?" 이와 같은 질문에 대한 실증적 해답을 찾기 위해 본고에서는 식 (3)에 제시된 금리준칙과 더불어 다음 다섯 가지의 추가적 준칙을 각각 고려한다.

$$\hat{r}_t = \rho_r \hat{r}_{t-1} + (1-\rho_r)\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + \phi_q \hat{q}_t\right) + \sigma_r \epsilon_t^r \tag{4}$$

$$\hat{r}_t = \rho_r \hat{r}_{t-1} + (1-\rho_r)\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + \phi_b \hat{b}_t''\right) + \sigma_r \epsilon_t^r \tag{5}$$

$$\hat{r}_t = \rho_r \hat{r}_{t-1} + (1-\rho_r)\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + \phi_{\Delta q} \Delta \hat{q}_t\right) + \sigma_r \epsilon_t^r \tag{6}$$

$$\hat{r}_t = \rho_r \hat{r}_{t-1} + (1-\rho_r)\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + \phi_{\Delta b} \Delta \hat{b}_t''\right) + \sigma_r \epsilon_t^r \tag{7}$$

$$\hat{r}_t = \rho_r \hat{r}_{t-1} + (1-\rho_r)\left(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t + \phi_s \hat{s}_t''\right) + \sigma_r \epsilon_t^r \tag{8}$$

식 (4)에서 q_t는 실질주택가격을 의미하며, 이러한 금리준칙은 통화정책이 물가와 성장뿐만 아니라 주택가격 정상상태로부터의 퍼센트 격차에 반응하는 것을 모형화하고 있다. 이와 유사하게 식 (5)는 금리준칙에 가계부채 정상상태로부터의 퍼센트 격차가 명시적으로 반영된 것으로 해석할 수 있다. 식 (6)과 (7)은 실질주택가격 및 가계부채의 퍼센트 격차 대신

해당 변수의 증가율에 통화정책이 반응하는 것을 상정한 준칙이다. 마지막으로 식 (8)의 s_t''는 $s_t'' \equiv b_t''/y_t$로 정의되는 GDP 대비 가계신용비율을 나타내며, 따라서 해당 준칙은 통화정책이 물가 및 성장과 함께 가계신용비율에 반응해 왔음을 상정한다. 우리나라 시계열을 이용하여 모형 모수 추정 시 식 (3)~(8)의 금리준칙을 가정한 여섯 가지의 모형을 추정한다. 이러한 각 모형의 데이터 적합도(data fit)를 비교함으로써 샘플기간 동안의 데이터를 가장 잘 설명하는 금리준칙을 식별해 내고자 하는 것이다.

동 모형에는 여섯 개의 외생적 충격이 모형화되어 있는데, 위에서 언급한 *i.i.d.* 통화정책 충격을 제외한 나머지 다섯 개의 충격은 모두 1차 자기회귀(autoregressive: AR) 과정을 따른다고 가정한다. AR(1)으로 주어지는 다섯 개의 충격은 각각 생산성(productivity), 선호(preference), 물가(inflation), 주택선호(housing preference) 및 가계신용비율(household debt-to-GDP ratio) 충격이다. 한편, 앞의 Ⅱ장 충격반응함수에서도 나타난 바와 같이 VAR 모형 등을 통해 데이터로부터 직접적으로 식별되는 통화정책 등 주요 거시경제 충격에 대해 성장, 소비 및 투자 등의 거시변수의 반응이 단조적(monotonic)이 아닌 낙타등(hump-shaped) 모양으로 나타남이 잘 알려져 있다(Christiano *et al.*, 2005). 데이터에서 관측되는 이러한 점진적이고 지속적인 반응과 부합하는 반응을 DSGE 모형 내에서 생성하기 위하여 본고에서는 소비 습관(consumption habit)과 자본의 조정비용(adjustment cost in capital)을 모형에 반영한다.

2. 데이터 및 DSGE 모형 추정

위에서 개관한 모형의 모수를 우리나라 데이터를 이용하여 식별한다. 구체적으로 모형에 여섯 개의 외생적 충격이 설정되어 있으며, 따라서 확률적 특이(stochastic singularity) 문제에 직면하지 않기 위해서는 여섯 개의 시계열을 이용하여 모형을 추정하여야 한다. 추정에 사용된 여섯 개의 변수들은 1인당 실질 국내총생산, 1인당 실질 민간소비, 물가(CPI), 명목 정책금리(한국은행 기준금리), 실질주택가격 및 GDP 대비 가계신용비율이다. 앞 장에서의 VAR 분석과 동일한 샘플기간을 이용하였으며, 따라서 2000년 1/4분기 ~ 2021년 4/4분기 기간의 분기별 데이터를 이용하였다. 본고의 DSGE 모형은 경제성장 요소를 제외하고 경기변동 요소만을 고려한 정상성(stationarity)을 가정한 모형이며, 이러한 이유로 모형 추정에 사용하는 추세(trend)를 가지는 변수 또한 추세 제거 후 사용하여야 한다. 이를 위해 1인당 실질 국내총생산과 1인당 실질 민간소비 등 거시변수는 평활화 계수(smoothing parameter)값 1,600($\lambda = 1{,}600$)을 가지는 Hodrick-Prescott(HP) 필터를 사용하여 추세를 제거하였다. 한편, 금융순환 주기(financial cycle)는 경기변동 주기보다 더 긴 특성을 보인다는 기존 문헌의 결과에 기반하여 실질주택가격 및 가계신용비율 등의 금융변수는 $\lambda = 25{,}000$[11]과 같이 거시변수보다 큰 평활화 계수를 부여하여 추세를 제거하였다. 물가는 전년 동기 대비(YoY)로 구하였으며, 이로부터 한국은행의 시변(time-varying) 물가안정목

[11]한국은행이 금융안정보고서를 통해 민간신용갭 산출 시 적용하는 평활화 계수 기준을 적용하였다.

표수준(inflation target)을 차감하여 사용하였다. 마지막으로 명목 정책금리는 수준 변수 그대로를 사용하는 대신 명목기준금리에서 명목중립금리를 차감함으로써 시산한 명목기준금리의 중립금리로부터의 격차를 사용하였다.[12] 이와 같이 금리 수준 대신 중립금리로부터의 격차를 모형 추정에 사용함으로써 실물경제 및 금융변수에 대한 해당 시점의 통화정책 기조(stance)를 더욱 정확하게 포착하고자 하였다. 모형 추정에 사용된 추세가 제거된 시계열은 Figure 10에 나타나 있다.

모형 추정 시 데이터로부터 식별이 용이하지 않은 모수들은 Iacoviello(2005) 및 한국의 기존 문헌인 송인호(2014)에서 차용하거나 한국의 과거 정책 행태를 통해 캘리브레이션하였다. 이렇게 캘리브레이션된 모수들은 Table 1에 요약되어 있다.

나머지 모수들은 베이지안 방식을 이용하여 추정하였다(An and Schorfheide, 2007). 이를 위한 모수들의 사전분포는 Table 2의 두 번째부터 세 번째 열에 제시되어 있는데, 이러한 사전분포들은 기존 한국 및 미국을 대상으로 한 문헌과 부합하도록 설정하였다. 이와 같은 방식을 바탕으로 무작위보행 메트로폴리스-헤이스팅스 알고리즘(random-walk Metropolis-Hasting algorithm)을 이용하여 각 모수의 사후분포로부터 3만개 샘플을 도출하여 실증분석 결과를 시산하였다.

(Unit: %)

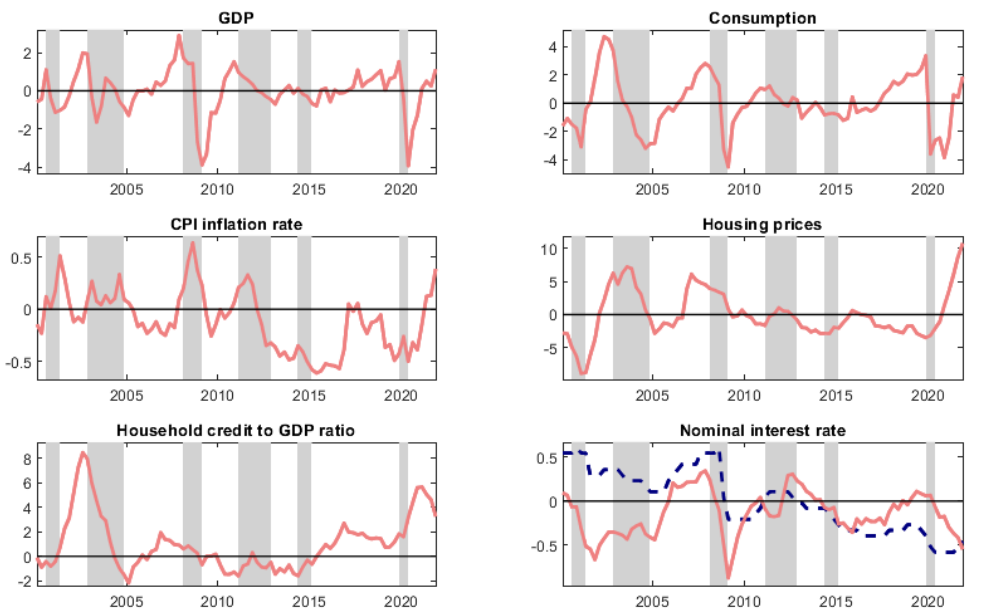

Figure 10. The Detrended Time Series Data used in the Estimation of the DSGE Model

Note: 1) The shaded areas in each graph indicate the recession periods identified by the OECD; 2) The blue dashed line in the last graph represents the time series with the sample mean subtracted, excluding only the pre-removed neutral rate from the nominal policy interest rate.

[12]명목중립금리는 오형석(2014)에서 제시한 방식으로 시산한 실질중립금리로부터 인플레이션 기대치를 더하여 산출하였다.

Table 1. Calibrated Parameters in the DSGE Model

모수		캘리브레이션 값	출처
β	(저축가계 시간 할인율)	0.99	Iacoviello(2005)
β''	(차입가계 시간 할인율)	0.95	Iacoviello(2005)
γ	(기업가 시간 할인율)	0.98	Iacoviello(2005)
j	(주택 서비스에 대한 가중치)	0.2	송인호(2014)
X	(정상상태 마크업)	1.15	Iacoviello(2005)
μ	(자본 비중)	0.3	송인호(2014)
ν	(주택 비중)	0.03	송인호(2014)
δ	(감가상각률)	0.025	Iacoviello(2005)
m	(기업가의 loan-to-value)	0.6401	샘플기간 동안 한국 평균 LTV 비율
m''	(가계의 loan-to-value)	0.6401	샘플기간 동안 한국 평균 LTV 비율

Table 2. The Prior and Posterior Distributions of the Estimated Parameters

모수	사전분포		사후분포	
			금리준칙: 식 (3)	금리준칙: 식 (8)
	Dist.	Mean (Std.)	Mean [5%, 95%]	Mean [5%, 95%]
h_b	B	0.7	0.42	0.45
(habit)		(0.1)	[0.32, 0.52]	[0.34, 0.56]
η	G	1.5	1.64	2.36
(labor elasticity)		(0.5)	[1.06, 2.29]	[1.43, 3.62]
ψ	N	6	0.11	0.10
(capital adj. cost)		(1.5)	[0.07, 0.16]	[0.07, 0.15]
θ	B	0.5	0.94	0.94
(price stickiness)		(0.05)	[0.93, 0.95]	[0.93, 0.95]
α	B	0.65	0.59	0.65
(patient HH wage share)		(0.05)	[0.51, 0.67]	[0.56, 0.73]
ρ_r	B	0.7	0.88	0.92
(MP AR(1))		(0.1)	[0.84, 0.92]	[0.89, 0.94]
ϕ_π	G	1.5	1.31	1.38
(MP inflation)		(0.15)	[1.10, 1.54]	[1.16, 1.62]
ϕ_y	G	0.5	0.77	0.89
(MP output)		(0.15)	[0.57, 1.01]	[0.65, 1.17]
ϕ_s	G	0.5		0.18
(MP HH credit/GDP)		(0.15)		[0.10, 0.28]
ρ_u	B	0.5	0.74	0.73
(inf. AR(1))		(0.2)	[0.67, 0.80]	[0.66, 0.79]
ρ_j	B	0.5	0.87	0.85
(housing AR(1))		(0.2)	[0.80, 0.94]	[0.78, 0.92]
ρ_a	B	0.5	0.86	0.87
(productivity AR(1))		(0.2)	[0.81, 0.90]	[0.82, 0.91]
ρ_z	B	0.5	0.39	0.34
(preference AR(1))		(0.2)	[0.25, 0.51]	[0.19, 0.48]
ρ_b	B	0.5	0.42	0.54
(HH credit AR(1))		(0.2)	[0.28, 0.56]	[0.38, 0.69]

Table 2. The Prior and Posterior Distributions of the Estimated Parameters (Cont'd)

모수	사전분포		사후분포	
			금리준칙: 식 (3)	금리준칙: 식 (8)
	Dist.	Mean (Std.)	Mean [5%, 95%]	Mean [5%, 95%]
σ_u	IG	0.5	0.05	0.05
(inflation std.)		(∞)	[0.04, 0.07]	[0.04, 0.07]
σ_j	IG	0.5	19.63	13.96
(housing std.)		(∞)	[7.53, 16.39]	[9.61, 19.31]
σ_a	IG	0.5	2.86	2.41
(productivity std.)		(∞)	[1.84, 4.33]	[1.66, 3.44]
σ_r	IG	0.5	0.15	0.15
(MP std.)		(∞)	[0.13, 0.18]	[0.13, 0.18]
σ_z	IG	0.5	2.29	2.44
(preference std.)		(∞)	[1.86, 2.81]	[1.97, 1.84]
σ_b	IG	0.5	1.53	1.60
(HH credit std.)		(∞)	[1.33, 1.76]	[1.39, 1.84]

Note: In the column indicating the distribution (Dist.), B, G, N, IG respectively refer to the Beta, Gamma, Normal, and Inverse Gamma distributions.

3. 각 DSGE 모형의 데이터 적합도

위에서 언급한 두 가지 질문 — [1] 샘플기간 동안 통화정책이 성장과 물가 이외에 금융안정 변수에도 반응해 왔는가?; [2] 만약 그렇다면 어떠한 금융안정 변수에 반응했는가? — 에 대한 모형에 근거한 해답을 얻기 위해 먼저 각 금리준칙을 상정하고 추정된 DSGE 모형들의 데이터 적합도를 비교한다.

Table 3에는 이와 같은 데이터 적합도의 결과가 제시되어 있다. 추정 결과, 데이터 설명력이 가장 높은 모형은 성장과 물가와 함께 GDP 대비 가계신용비율이 금리준칙에 반영(식 (8))된 모형으로 나타났다. 그다음으로는 통화정책이 성장, 물가와 가계신용 증가율($\Delta\hat{b}_t''$)에 반응(식 (7))하는 모형의 데이터 적합도가 높은 것으로 분석되었다. 전반적으로 금리준칙에

Table 3. The Goodness of Fit of Each DSGE Model to the Data

모형(금리준칙 반응 변수)		데이터 적합도 [순위]
성장 및 물가:	식 (3)	−673.8 [3]
성장, 물가 및 실질주택가격:	식 (4)	−691.0 [6]
성장, 물가 및 가계신용:	식 (5)	−682.2 [5]
성장, 물가 및 실질주택가격 증가율:	식 (6)	−676.0 [4]
성장, 물가 및 가계신용 증가율:	식 (7)	−672.5 [2]
성장, 물가 및 GDP 대비 가계신용비율:	식 (8)	−665.5 [1]

Note: The goodness of fit is assessed using Geweke's (1999) average log-marginal data density, where higher (or smaller absolute) values indicate a model that better fits the data.

주택가격 또는 주택가격 증가율이 포함된 모형의 데이터 적합도는 성장과 물가만 반영된 모형의 결과에 비해 열등한 것으로 분석되어, 2000년대 이후 기간에 통화정책이 주택가격 및 관련 변수에 반응했다는 증거는 데이터로부터 찾기 힘든 것으로 판단된다.

이와 같은 결과에 근거하여 본고에서는 성장 및 물가와 함께 통화정책이 가계신용비율에 반응하는 금리준칙인 식 (8)을 상정한 모형을 벤치마크 DSGE 모형으로 설정한다. 이후 논의될 실증분석 결과는 동 모형에 기반한 것임을 미리 밝혀둔다.

4. 벤치마크 DSGE 모형 모수의 사후분포 추정치

Table 2의 마지막 열은 벤치마크 모형의 구조 모수에 대한 사후분포를 보고하고 있다. 금리준칙의 모수를 제외한 나머지 모수는 기존 미국 및 한국 문헌인 Iacoviello(2005)와 송인호(2014) 등과 유사하게 추정되었다.

한편, 통화정책 관련 모수인 ρ_r은 평균이 0.92로 추정되어 상당히 높은 정책금리의 지속성을 의미하고 있다. 이러한 값은 분석기간 동안 기준금리가 한번 조정되면 이후 상당 기간 동안 변화가 없었던 과거 우리나라 통화정책의 실제 현상에 부합한다. 또한 Clarida *et al.* (1998)에서 제시된 금리준칙을 2001~14년간의 우리나라 데이터를 이용하여 축약형(reduced-form) 모형으로 추정한 김인준・김성현・김소영・김진일・신관호(2017)의 추정치인 0.9와 유사하다.

통화정책의 물가갭과 성장갭 반응도인 ϕ_π와 ϕ_y는 평균값 기준 각각 1.38과 0.89로 추정되어 해당 기간 동안 중앙은행이 물가안정목표제를 충실히 수행하였으며, 이 과정에서 경기상황도 적극 고려한 것으로 분석되었다. 이와 같은 성장에의 반응은 2000년 이후 우리나라 통화정책이 성장갭에 적극적으로 대응하였다는 김인준・김성현・김소영・김진일・신관호(2017)의 결과에도 부합한다. 마지막으로 통화정책의 가계신용비율갭의 반응도인 ϕ_s의 중간값 추정치는 0.18로 식별되어 샘플기간 동안 우리나라 통화정책은 약한(mild) 정도의 금융안정을 타기팅했던 것으로 판단된다. 그럼에도 불구하고 해당 모수의 90% 밴드 추정치는 0으로부터 상당히 이격되어 있으며, 이러한 결과를 통해 통화정책의 해당 금융안정변수 반응도가 통계적으로 유의한 수준임을 알 수 있다. 일반적으로 DSGE 모형에 모수를 추가할 경우 회귀분석의 조정된(adjusted) R^2와 유사하게, 새롭게 추가된 모수가 데이터를 설명하는 데 도움이 될 경우에만 Table 3에 나타난 평균 한계 데이터 밀도(average log marginal data density)가 향상되도록 설계되어 있다. 즉, 추가된 모수가 데이터를 설명하는 데 도움을 주지 않을 경우 평균 한계 데이터 밀도는 자동적으로 하락하는데, 모형의 금리준칙에 가계신용비율을 추가할 때 모형의 데이터 적합도가 높아지는 현상과 ϕ_s 추정치가 유의하게 0보다 크다는 점은 모두 2000년 이후 우리나라 통화정책 운용에 있어서 가계신용비율이 중요한 변수였음을 시사한다.

5. 모형으로부터 도출되는 시계열

모형의 추정이 적합하게 되었는지 평가하기 위해 모형으로부터 시산되는 동학(dynamics)을 구하여 실제 추정에 사용된 시계열과 비교한다. 이를 위해 모형으로부터 도출되는 시계열의 경로를 구하는데, 이는 구체적으로 다음과 같은 방식으로 이루어진다.

[1] 먼저 추정된 30,000개의 모수 집합에서 각각의 모수 집합을 추출하고, 이 모수의 집합하에서 추정에 사용된 실제 거시데이터를 가장 잘 설명하는 외생적 충격들의 시퀀스(sequence)를 칼만 평활화(Kalman smoothing)를 통해 구한다.
[2] [1]의 과정을 모든 모수 집합에 대해 30,000번 반복한다.
[3] [2]를 통해 얻어진 30,000개의 경로에 대해 각 시점별 평균을 구하여 실제 시계열과 비교한다.

이와 같은 방식으로 시산된 모형 동학으로부터 도출되는 시계열과 실제 시계열의 비교는 Figure 11에 표시되어 있다. 시산 결과, 가계신용비율을 제외하고는 모형으로부터 도출된 시계열이 실제 시계열과 상당히 유사한 것으로 판명되었다. 다만, 가계신용비율의 경우 모형으로부터 도출된 결과가 실제 시계열의 2000년대 초반과 후반 부분 변동을 설명하는 데 있어 약간의 격차를 보이는 것으로 나타났다. 이러한 현상의 원인으로는 모형 내에서 가계신용비율을 주로 설명하는 가계신용비율에 대한 외생적 충격이 극대화를 통한 일계조건

(Unit: %)

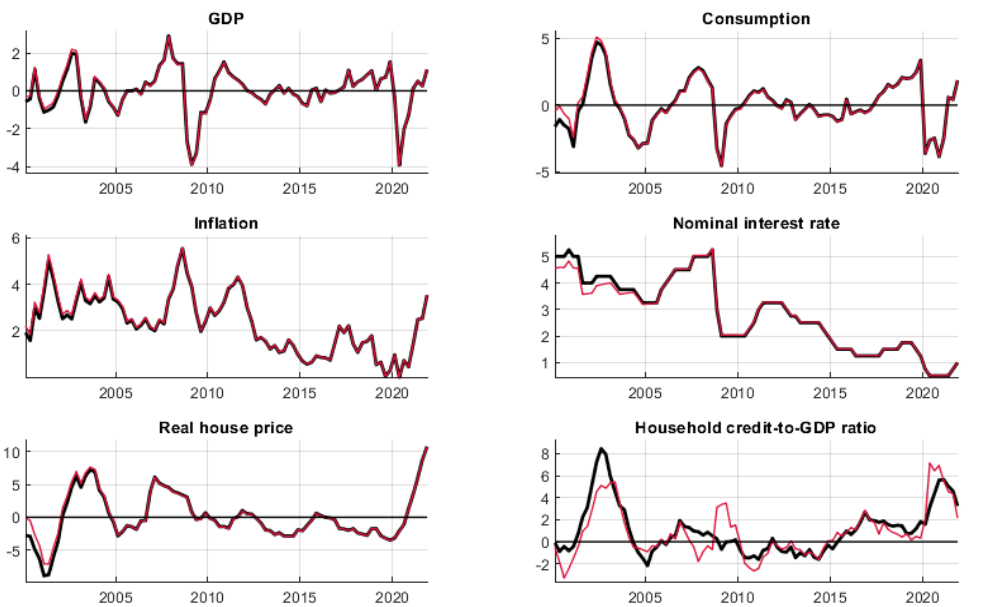

Figure 11. The Actual and Model-implied Time Series

Note: 1) In each graph, the bold solid line (black) represents the actual time series used for model estimation, while the thin solid line (red) represents the model-implied time series; 2) The model-implied time series represent the mean values of the posterior distribution at each point in time.

(first-order condition)으로 모형화된 구조적(structural) 충격이 아니라, 실제 가계신용비율 변동 중 설명되지 않는 부분에 대한 잔차(residual)와 같이 처리되어 있기 때문으로 추측된다. 그럼에도 불구하고 모형이 실제 시계열의 상-하 변동은 전반적으로 잘 포착하는 것으로 보인다.

Ⅱ장의 VAR 분석에 비해 본 장의 DSGE 모형 분석이 가지는 장점 가운데 하나는 모형의 구조적 모수(structural parameter)를 식별함으로써, 정책실험이 가능하다는 것이다. 특히 본고의 DSGE 모형 추정 결과 가운데 주목할 점은 2000년대 이후 우리나라 정책금리 결정 시 가계신용비율을 반영하였다는 측면이다. 이러한 통화정책 운영체계에 대한 평가를 위해 위 Figure 11에 제시된 모형으로부터 도출된 시계열을 이용한다. 구체적으로 다음과 같은 반사실적(counterfactual) 가정을 통해 가계신용비율에 반응해 온 정책운영을 평가하기로 한다: "샘플기간 동안 만약 통화정책이 가계신용비율에 반응하지 않았다면 과거의 거시경제 및 가계부채 동학은 어떻게 바뀌었을 것인가?" 이를 위해 $\phi_s = 0$라는 조건을 통해 구한 모형의 해(solution)와 위 Figure 11을 도출하는 과정에서 시산된 외생적 충격들의 시퀀스를 결합함으로써 모형에 입각한 반사실적 시계열을 도출하고, 이를 Figure 11에 제시된 모형으로부터 도출되는 실제 시계열과 비교한다.

이와 같이 시산한 실제 및 반사실적 시계열 비교 결과는 Figure 12에 제시되어 있다. 만약 통화정책이 가계신용비율에 반응하지 않았다면 2002~03년경 및 2020년 이후 기간에 대해

(Unit: %)

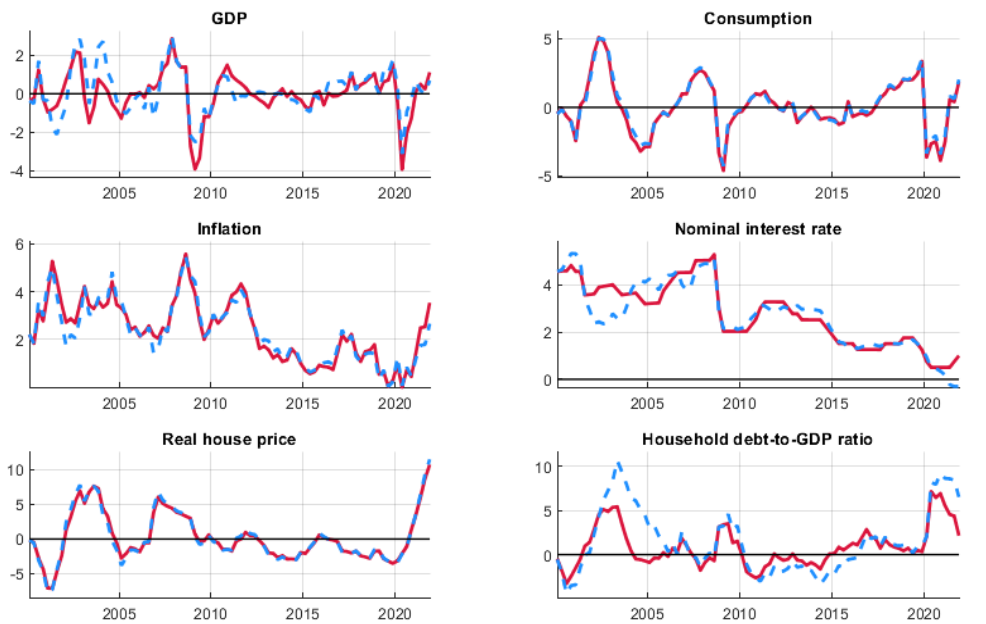

Figure 12. The Model-implied Actual and Counterfactual Time Series

Note: 1) In each graph, the solid line (red) represents the actual time series derived from the model, while the dashed line (blue) represents the counterfactual experimental results assuming monetary policy does not respond to the household credit-to-GDP ratio ($\phi_s = 0$); 2) The model-implied time series represent the mean values of the posterior distribution at each point in time.

정책금리가 실제보다 낮았을 것이라는 결과를 얻었다. 특히 2020년 중반 이후 기간에 대해서는 반사실적 정책금리가 명목금리의 제로 하한(zero lower bound) 밑으로 내려가는 것으로 나타났다. 이러한 금리 경로의 변화에 따라 성장 및 물가의 경로도 실제보다 더 변동성이 커졌을 것임을 알 수 있다. 반사실적 시나리오하의 가계신용비율도 2002~03년경 및 2020년 이후 기간에 대해 실제보다 더욱 높았을 것임을 실험 결과는 보여주고 있다. 다만, 반사실적 실험에도 불구하고 실질주택가격 경로는 크게 바뀌지 않았는데, 이는 허준영(2022)에서 밝힌 바 있듯이 통화정책이 주택가격에 미치는 영향이 제한적인 Iacoviello (2005) 모형의 특성에서 기인하는 것으로 보인다.

6. 중앙은행의 손실함수 분석 및 최적 금리준칙: 조건부 분석

본 연구의 주요 목적 중 하나는 물가안정과 금융안정을 책무로 가지는 중앙은행의 최적 금리준칙을 도출하는 것이다. 이를 위해 먼저 Benigno and Woodford(2012)에서 제안된 바 있으며 Bernanke *et al.*(2019) 및 Kiley and Roberts(2017) 등의 기존 미국 문헌에 원용된 손실함수를 확장하여, 중앙은행이 최소화하고자 하는 2차 손실함수(quadratic loss function)를 다음과 같이 정의한다.

$$QL(\lambda,\gamma) = Var(\pi_t) + \lambda\, Var(y_t) + \gamma\, Var(s_t) \tag{9}$$

위 식에서 λ 및 γ는 각각 손실함수 내에서 성장과 가계신용비율 분산에 대한 가중치를 의미하며, 물가 분산에 대한 가중치가 1로 주어져 있는 상황에서 이 값들은 물가 분산 대비 성장과 가계신용비율 분산의 상대적 가중치를 나타낸다.

Gali and Monacelli(2005)와 같은 기존의 문헌에서는 성장 분산의 가중치인 λ에 0.5나 1의 값을 부여한다. 예를 들어 $\lambda=1$인 경우 중앙은행이 물가와 성장 분산에 동일한 가중치를 두는 이중책무(dual mandate) 형태의 손실함수가 된다. 이러한 문헌을 따라 본고에서도 $\lambda=0.5$인 경우와 $\lambda=1$인 경우를 분석한다.

그러나 성장 분산에 대한 가중치와 달리, 가계신용비율 분산에 대한 가중치와 관련하여 기존 문헌 간 일치된 합의는 없는 상태이다. 한편, Figure 11에서 나타난 바와 같이 데이터상 가계신용비율의 변동성은 성장 및 물가 변동성에 비해 상당히 큰 값을 가진다. 따라서 성장과 마찬가지로 가계신용비율 분산에 0.5나 1의 가중치를 부여할 경우 손실함수 값이 가계신용비율 변동성에 의해 결정될 가능성이 크다. 이러한 문제점을 보완하기 위해 본고에서는 γ 값을 물가와 성장 분산의 평균치와 가계신용비율 분산 사이 비율의 역수로 설정하였다($\gamma=0.138$).

이러한 손실함수를 가정하고 먼저 실제 및 반사실적 시나리오에 대한 조건부(conditional) 분석을 시행한다. 즉, Figure 12에 제시된 실제 및 반사실적 실험하에서 물가, 성장 및 가계신용비율의 분산이 어떻게 달라지며, 나아가 이를 통해 시산된 식 (9)의 2차 손실함수가 어떤 경우에 더 작아지는지를 시산하는 것이다. 해당 실험의 결과는 Table 4에 요약되어

있다. $\phi_s = 0$을 가정하는 반사실적 실험의 경우 Figure 12에 나타나듯이 실제보다 성장과 가계신용비율의 분산을 크게 한다. 한편, 반사실적 실험하에서 물가의 분산은 실제 경우와 크게 차이가 없다. 그 결과 2차 손실함수에서 성장 분산에 어떤 가중치를 주더라도 실제 경우보다 반사실적 실험하에서 2차 손실함수 값이 커지는 현상이 발생한다. 이와 같은 결과는 과거 한국 거시경제 및 금융안정 시계열을 가장 잘 설명하는 충격들의 시퀀스에 근거(conditioning) 했을 때, 가계신용비율에 반응해 왔던 통화정책이 그렇지 않은 정책에 비해 중앙은행의 손실함수 값을 줄여주는 우월한 정책임을 시사한다.

위에서 언급한 조건부 실험은 금리준칙의 가계신용비율 반응 계수만을 조정하여 시산하였다. 이러한 실험을 확장하여 금리준칙상 모든 계수를 조정함으로써 식 (9)에 나타난 중앙은행의 2차 손실함수를 극소화하는 금리준칙 계수들의 조합을 구할 수 있다. 해당 실험 시행 시 각 금리준칙의 계숫값들이 기존 문헌이나 경제이론과 합당하지 않은 값으로 발산하는 것을 막기 위해 각 계숫값에 대한 하한과 상한을 설정하여 분석하였다. 먼저 통화정책의 자기회귀(autoregressive) 부분을 반영하는 ρ_r는 해당 모수의 특성상 [0, 1]의 하한과 상한을 부여하였다. 통화정책의 물가 반응도(ϕ_π)는 물가안정목표제를 시행하였던 샘플기간의 특성을 고려하여 1보다 크고 2.5보다 작도록 설정하였다. 성장 및 가계신용비율 계수에는 [0, 1]의 상·하한 값을 가정하였는데, 이는 물가안정목표제의 특성상 이들 변수에 대한 통화정책의 반응도가 물가보다는 작아야 함을 반영한 결과이다. 이와 같은 실험을 각 모수 사후분포 평균값에서 시산하여 Table 5에 결과를 제시하였다.

시산 결과, 조건부 실험에서 2차 손실함수를 극소화하는 최적 금리준칙 계수들은 다음과

Table 4. Variance of Each Variable and Quadratic Loss Function Values: Conditional Experiment

	분산			2차 손실함수(λ, γ)	
	물가	성장	가계신용비율	(0.5, 0.138)	(1, 0.138)
실제	0.08	1.34	4.59	1.39	2.06
($\phi_s > 0$)	[0.09, 0.09]	[1.33, 1.35]	[4.27, 5.04]	[1.34, 1.44]	[2.01, 2.11]
반사실적	0.08	2.00	14.11	3.02	4.02
($\phi_s = 0$)	[0.07, 0.08]	[1.56, 2.81]	[6.40, 32.20]	[1.76, 5.84]	[2.56, 7.21]

Note: Mean and [5%, 95%] estimates are reported.

Table 5. Optimal Interest Rate Rule Coefficients in Conditional Experiments

모수	추정치 (평균값)	[하한, 상한]	2차 손실함수 ($\lambda = 0.5$, $\gamma = 0.138$)	2차 손실함수 ($\lambda = 1$, $\gamma = 0.138$)
ρ_r	0.92	[0, 1]	0.79	0.72
ϕ_π	1.38	[1, 2.5]	1.00	1.00
ϕ_y	0.89	[0, 1]	1.00	1.00
ϕ_s	0.18	[0, 1]	0.29	0.39

Note: Values evaluated at the mean of posterior parameter estimates are reported.

같은 특성을 가지는 것을 확인하였다. 먼저 금리준칙의 AR(1) 계수는 추정치보다 작은 0.72~0.79로 분석되어 최적 금리준칙은 실제 통화정책보다 정책금리의 자기상관성이 낮은, 즉 한국은행이 금융・경제 여건 변화에 대응하여 기준금리를 보다 적극적으로 조정하는 정책이 바람직하다는 것을 시사한다. 한편, 물가와 성장 계수의 최적값은 각 계수의 하한 및 상한에서 나타났으며, 이는 최적 금리준칙이 물가에의 반응도가 실제보다 낮고 성장에의 반응도는 실제보다 높아야 한다는 것을 의미한다. 이러한 결과는 2000년 이후 물가는 이전 시기에 비해 상대적으로 낮았으며, GDP 증가율이 지속적으로 하락했던 최근의 거시경제 환경과 밀접한 관련을 가지는 것으로 보인다. 마지막으로 최적 금리준칙상의 ϕ_s는 0.29~0.39로 실제 추정치보다 높게 시산되어, 금융안정을 고려한 통화정책은 과거 실제 정책운영 패턴보다 더욱 적극적으로 가계신용비율 변화에 반응해야 함을 나타낸다.[13]

이와 같은 최적 금리준칙 도출 시 가계신용비율의 시차에 관한 이슈가 있을 수 있다. 성장(GDP)과 물가(CPI)의 경우 해당 분기 다음 월에 실제 통계가 공개되는 반면, 가계신용에 활용되는 자금순환 통계의 경우 약 3개월(1분기)의 시차를 두고 늦게 발표되는 특성을 가진다. 예를 들면 4월 초에 전년도 4/4분기 자금순환 통계가 발표가 이루어지는 것이다. 이에 따라 성장갭과 물가갭 도출에 비해 가계신용비율갭 도출 시에는 약 1분기 정도의 시차가 존재하게 된다. 여기에 더해 성장과 물가의 경우에는 실제 발표 통계 이전에 전망치를 활용할 수 있다는 중요한 차이도 존재한다. 이와 같은 이유로 Table 5에 나타난 실험 시산 시 성장갭 및 물가갭, 가계신용비율갭에 다양한 시차를 고려하는 것이 의미 있을 것이다. 이러한 특성을 반영하여 최적 금리준칙을 도출하는 실험을 Table 6에 제시된 바와 같이 해당 변수들의 다양한 시차를 고려하여 시산하였다. Case 1의 경우 성장갭, 물가갭, 가계신용비율갭 모두 현재 시차를, Case 2~4는 가계신용비율갭 발표 시점을 고려하여 과거 1분기 시차를 적용하였으며, Case 3과 Case 4에서는 물가갭과 성장갭에 각각 미래 시차를 적용하여 실험을 진행하였다.

실험 결과는 Table 7에 제시되어 있는데, 2차 손실함수에서 성장에의 반응도와 관계없이 일관된 결과가 도출되었다. 가장 작은 손실함수를 나타내는 금리준칙은 본고에서 벤치

Table 6. Alternative Time Lags in Obtaining Optimal Interest Rate Rule, Lag in Inflation and Household Credit-to-GDP Ratio

	금리준칙 반응변수		
Case	성장갭	물가갭	가계신용비율갭
Case 1	$\hat{y}_t$	$\hat{\pi}_t$	$\hat{s}_t$
Case 2	$\hat{y}_t$	$\hat{\pi}_t$	$\hat{s}_{t-1}$
Case 3	$\hat{y}_t$	$E_t(\hat{\pi}_{t+1})$	$\hat{s}_{t-1}$
Case 4	$E_t(\hat{y}_{t+1})$	$E_t(\hat{\pi}_{t+2})$	$\hat{s}_{t-1}$

[13]통화정책이 금융안정을 달성하는 과정을 명확히 보이기 위해서는 추정된 DSGE 모형과 최적 통화준칙 계수를 사용한 각각의 모형에 대해서 통화정책 충격의 충격반응함수를 살펴보는 것이 필요할 것이다. 해당 충격반응함수는 부록 4에 제시되어 있다.

Table 7. Optimal Monetary Policy Rule Coefficients in Conditional Experiments Considering Alternative Lags

	2차 손실함수 ($\lambda=0.5$, $\gamma=0.138$)				2차 손실함수 ($\lambda=1$, $\gamma=0.138$)			
	Case 1	Case 2	Case 3	Case 4	Case 1	Case 2	Case 3	Case 4
ρ_r	0.79	0.84	0.84	0.75	0.72	0.80	0.79	0.52
ϕ_π	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ϕ_y	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
ϕ_s	0.39	0.45	0.43	0.36	0.29	0.34	0.32	0.23
Quad. loss	0.89	0.91	0.90	1.19	1.26	1.30	1.28	1.85

Note: Values evaluated at the mean of posterior parameter estimates are reported.

마크로 상정한 바 있는, 통화정책이 모두 현재 기의 변수에 대응하는 준칙(Case 1)으로 분석되었다. 한편, 가계신용비율 통계 산출 시점을 고려하여 동 변수에 과거 1분기 시차를 적용한 실험에서는 Case 3 〉 Case 2 〉 Case 4 順으로 손실함수가 작은 것으로 나타났다. 여기서 Case 3과 2의 경우에는 손실함수 값의 차이가 그리 크지 않았으나, Case 4의 경우에는 손실함수 값이 상대적으로 높은 수치를 기록하였다. 이 같은 실험 결과를 고려할 때 실제 통화정책 운영에 참고하기 위한 금리준칙 산출 시 가계신용비율갭을 과거 1분기 시차 통계로 활용할 경우에는 성장갭과 물가갭은 현재의 정보를 이용(Case 2)하거나, 물가갭의 경우 1분기 후 전망치를 활용(Case 3)하는 것도 대안이 될 수 있을 것으로 판단된다.

7. 중앙은행의 손실함수 분석: 무조건부 분석

앞 절의 조건부 분석이 과거 한국 데이터를 가장 잘 설명하는 특수한 충격의 시퀀스에 근거하는 것이었다면, 비슷한 분석을 보다 일반적인 상황에 적용할 수 있다. 즉, 충격 시퀀스를 무작위(random)로 시산하여 동일한 실험을 하는 것이다. 이를 통해 일반적인 경우 통화정책이 가계신용비율에 반응해야 하는가에 대한 해답을 찾을 수 있을 것이다.

이러한 무조건부(unconditional) 2차 손실함수 분석을 위해 Kiley and Roberts(2017)의 시뮬레이션 방법을 원용하였는데, 그 구체적인 절차는 다음과 같다.

[1] 먼저 추정된 모형 모수 사후분포의 평균값을 바탕으로 모형의 충격을 200기(50년) 동안 시뮬레이션하여 실제 및 반사실적 시나리오하에서 각 변수의 경로를 구한다.
[2] 이렇게 생성된 경로 가운데 결과가 시뮬레이션 초기 값에 의해 영향받지 않도록 처음 100기 동안은 번인 기간(burn-in period)으로 설정하여 이 기간 동안 생성된 경로는 무시한다.
[3] 나머지 100기 동안의 경로를 바탕으로 각 변수의 분산을 구한다.
[4] 이를 통해 식 (9)의 손실함수 값을 계산한다.
[5] [1]~[4]의 과정을 10,000번 반복해서 얻은 손실함수의 평균값 및 [5%, 95%] 추정치를 구한다.

Table 8. Variance of Each Variable and Quadratic Loss Function Values: Unconditional Experiment

	분산			2차 손실함수(λ, γ)	
	물가	성장	가계신용비율	(0.5, 0.138)	(1, 0.138)
실제	0.10	5.80	155.85	24.44	27.34
($\phi_s > 0$)	[0.06, 0.14]	[3.29, 9.35]	[73.04, 276.27]	[11.95, 42.65]	[13.74, 47.09]
반사실적	0.14	3.08	332.91	47.48	49.02
($\phi_s = 0$)	[0.09, 0.21]	[2.21, 4.14]	[130.50, 648.21]	[19.50, 91.02]	[20.92, 92.70]

Note: Mean and [5%, 95%] estimates are reported.

이러한 방식으로 구한 무조건부 실험 결과는 Table 8에 요약되어 있다. 시뮬레이션 결과 가계신용비율에 반응하는 통화정책은 그렇지 않은 정책에 비해 물가와 가계신용비율의 분산을 감소시키나, 성장의 분산은 증가시키는 것으로 나타났다. 이러한 분산 추정치를 바탕으로 시산한 2차 손실함수 값은 성장 분산에 어떠한 가중치가 주어지더라도 통화정책이 가계신용비율에 반응할 때 더 작아지는 결과가 도출되었다. 이러한 결과를 통해, 가계신용비율로 대표되는 금융안정 요인을 통화정책의 책무 가운데 하나로 가지는 중앙은행의 경우 가계신용비율에 반응하는 통화정책을 운영하는 것이 전체 금융·경제 변동성을 축소시켜 중앙은행의 손실함수를 줄일 수 있다는 정책적 함의를 얻을 수 있다.

Ⅳ. 요약 및 시사점

글로벌 금융위기 이후 민간신용 급증, 자산가격 거품 등 과도한 금융불균형 누증이 위기 발생 가능성을 증대시키는 등 거시경제에 상당한 부정적 파급효과를 장기간 미칠 수 있다는 점이 확인되면서 물가안정을 전통적인 책무로 부여받은 주요국 중앙은행들의 통화정책 목표에 금융안정이 추가되었다. 이를 계기로 최종대부자 기능을 주로 강조하던 중앙은행들의 책무로 민간신용 급증과 자산가격 거품을 사전에 예방하는 정책대응(Leaning Against Wind: LAW) 역할이 강조되기 시작하였다. 이와 같은 국제적 공감대하에서 우리나라에서도 2011년 법 개정을 통해 한국은행의 주요 설립목적에 금융안정이 추가되었다.

그런데 동 법 개정 이후 한국은행의 통화정책 운용 시 금융안정을 어떠한 방식으로 고려하고 대응할 것인지에 대한 체계적인 연구가 활발하지 않은 실정이다. 이 같은 상황에서 국내 가계신용은 금융위기 이후 디레버리징을 경험했던 미국 등 주요 선진국과 달리 장기간 증가세를 지속하면서 최근의 가계부채비율은 주요국과 비교해 매우 높은 수준까지 상승하였다. 특히 코로나19 발생 이후에는 극심한 경제위기에도 불구하고 주택가격 상승을 배경으로 가계부채가 빠른 속도로 증가하였는데, 최근의 국내 가계부채 규모는 경제의 기초 여건(fundamental)을 크게 벗어난 것으로 평가되고 있으며, 성장을 제약하고 대내외 부정적 충격 시 위기 발생 가능성을 증대시키는 등의 부작용을 초래할 가능성이 높은 것으로 평가

되고 있다.

한편, BIS는 지난 2019년 중장기 시계에서 거시경제 안정과 금융안정을 효율적으로 도모할 수 있는 통합적 물가안정목표제(IIT)를 제안하였다. 동 정책체계에서는 중앙은행의 금융안정 책무를 더욱 강화하고, 통화정책 운영 시 성장과 물가 외에도 금융안정 요인을 명시적으로 고려할 것을 권고하고 있다. 이에 따라 BIS는 금리준칙 설계 시 전통적인 물가와 성장 이외에 신용 변수 추가를 제안하고 있다.

본 연구에서는 국내 금융불균형 누증 상황을 고려하여 BIS가 제안한 통합적 물가안정목표제의 도입 가능성을 다각도로 점검해 보았다. 이를 위해 VAR 모형과 DSGE 모형 분석을 병행하였다. 우선 VAR 분석을 통해서는 주요 충격 발생 시의 경제변수 반응을 살펴보았는데, 금융위기 이후 기준금리 인하에 따른 주택가격과 가계신용의 파급효과가 상당폭 증대되면서 통화정책의 위험선호 경로(risk-taking channel)가 강화된 것으로 분석되었다. 또한 DSGE 모형 구축을 통해 2000년 이후 2021년까지 약 20여 년간 한국은행의 통화정책 운영방식을 추정해 본 결과, 약한 형태의 통합적 물가안정목표제(IIT)를 운영해 온 것으로 나타났다. 이는 한국은행이 통화정책 운영 시 물가상승 압력에 적극 대응하는 가운데 경기상황을 종합적으로 고려하였으며, 가계신용 증대에 대해서도 기준금리 조정으로 일부 대응해 왔음을 의미한다. 다만, 금리평활화 계수가 상당폭 높게 추정되어 금융・경제 여건 변화에 대응한 기준금리 조정에는 매우 신중했던 것으로 분석되었다. 한편, 중앙은행의 손실함수 분석을 통해 최적 금리준칙을 도출해 본 결과, 물가와 성장 등 거시경제 상황을 균형적으로 고려하면서도 가계신용 등 금융안정 요인을 더욱 비중 있게 고려하여 통화정책을 운영하는 방안이 중장기 금융・경제 안정화 도모에 가장 우월한 것으로 분석되었다. 또한 최적 금리평활화 계수가 실증적 금리준칙 추정계수에 비해 낮게 추정됨에 따라 한국은행이 금융・경제 여건 변화에 대응해 기준금리를 보다 적극적으로 조정할 필요가 있다는 시사점도 도출되었다.

국내 가계부채는 전술한 바와 같이 금융위기 이후 지속적으로 증가하여 최근에는 소득 대비 가계부채 비율이 주요국과 비교해 상당히 높은 수준까지 상승하였다. 이 같은 금융불균형 누증은 향후 중장기 시계에 있어 안정적인 성장 흐름을 제약하고 위기 발생 가능성을 높일 수 있다는 점에서 매우 유의해야 할 것으로 판단된다. 이에 따라 향후 국내 가계부채 수준은 소득 증가 범위 내에서 관리될 필요성이 높은 것으로 판단된다. 이를 위해 과도한 가계부채 부담이 우리 경제의 건전한 발전에 저해가 되지 않도록 정책적 노력을 경주할 필요가 있으며, 가계부채 문제 해소를 위해 정부와 중앙은행의 정책공조가 효율적이고 긴밀하게 이루어져야 할 것으로 판단된다.

한편, 국내외 경제 여건 변화에 대응하여 중장기 경제안정을 도모하기 위한 중앙은행의 최적 정책체계에 대한 연구가 계속 진행될 필요가 있다. 미국 등 기축통화국과는 달리 우리나라의 금융시장과 거시경제는 대외여건 변화에 상당한 영향을 받고 있는 점을 종합적으로 고려하여 거시・금융안정(macro-financial stability) 체계를 설계할 필요가 있다. 특히 코로나19 이후 높은 물가 오름세에 대응한 미 연준의 가파른 정책금리 인상이 외국인 자금유출입, 환율 변동 등을 통해 국내 금융・경제의 다방면에 상당한 영향을 미치는 점 등을 고

려할 때, 우리나라와 같은 개방소국(small open economy)의 정책 여건을 고려한 심도 있는 정책체계 연구가 지속되어야 할 것으로 보인다.

부 록

1. BIS가 제안한 IIT의 주요 내용(요약)

금융위기 이후 글로벌 유동성이 크게 증가하면서 신흥국에 대한 외국인 자금유출입 규모가 증대되고, 저물가 지속에 따른 저금리 정책 등의 영향으로 가계부채 증가, 주택가격 상승이 이어지면서 대내외 금융부문뿐만 아니라 이로 인한 실물경제의 변동성도 확대될 가능성이 있다는 우려들이 제기되고 있다. 이에 BIS는 중앙은행이 전통적 물가안정 책무와 함께 금융안정을 포괄적으로 고려할 수 있는 통합적 물가안정목표제도(Integrated Inflation Targeting, 이하 IIT) 도입이 금융・경제 전반의 안정에 보다 효과적일 수 있다는 견해를 제시하였다. 이는 과거 선진국을 중심으로 물가안정목표제(IT)를 도입할 당시에는 중앙은행이 통화정책 운용을 통해 성장과 물가 등 거시경제의 균형을 도모할 경우 금융과 자산시장 등에도 불균형이 발생하지 않을 것으로 전제하였으나, 금융위기를 계기로 중앙은행의 물가안정 도모 정책이 금융부문의 안정을 담보할 수 없으며, 민간부채 누증 등에 따라 금융위기가 발생할 경우 실물경제에 막대하고도 장기적인 피해를 유발한다는 역사적 경험과 실증적 분석 등에 기반한 것이었다.

BIS는 이를 위해 다음과 같은 사항을 권고하였다. 첫째, 금융불균형 누증이 금융・경제에 미치는 부정적 파급효과를 완화하기 위하여 거시・금융정책 운용 시 금융안정이 더욱 강화될 필요가 있다. 가계신용 등 금융불균형 누적을 예방하기 위해 통화정책과 거시건전성 정책이 상호 보완적이고 유기적으로 운영될 필요가 있다. 둘째, 금융 불균형 누적 시 이를 적극 안정화시키기 위해서는 통화정책 결정 과정에서 거시경제 변수뿐만 아니라 민간신용 등 금융안정 요인을 균형 있게 고려하는 것이 효과적이다. 이를 위해 금리준칙에 민간신용 등 금융안정 변수를 명시적으로 반영(Augmented Taylor Rule)하는 것은 통화정책의 체계성과 투명성을 제고하고 금융안정을 균형적으로 도모하는 데 도움이 된다. 셋째, 중앙은행의 정책금리 조정만으로는 거시경제와 금융안정을 동시에 도모하는 데 한계가 있을 수 있으므로 거시건전성 정책의 유기적・상호 보완적 활용이 긴요하다. 예를 들면 실물경제 여건이 위축된 상황에서 가계부채 증가나 주택가격 상승세가 지속될 경우 금융안정 측면의 리스크만을 고려하여 정책금리를 인상하는 것은 어려울 수 있으므로, 금융・경제 전반의 안정을 도모하기 위해서는 중앙은행의 금리정책 외에 거시건전성 정책도 충분히 활용될 필요가 있다.

넷째, 금융위기 이후 선진국의 대규모 양적완화 등으로 글로벌 유동성이 크게 늘어나 신흥국으로의 외국인 투자자금 유출입 규모가 확대되고 이로 인해 외환시장의 변동성이 증대되면서 금융・경제 여건에 미치는 부정적 영향이 확대될 수 있는 만큼 이를 완화하기 위한 외환부문 거시건전성 정책수단의 활용이 필요하다. 다만, 이 과정에서 특정 환율 수준을 목표로 해서는 안 되며, 외환제도의 기본적 토대는 자유변동 환율제도임에 유의할 필요가 있다. 마지막으로 인구 고령화에 따른 연금부담 증대 등으로 재정 건전성에 대한 우려가 증대

될 경우 기대인플레이션이 높아지고 이에 따라 시장금리가 상승하면서 거시경제정책의 효과가 제약되고 경제 전반에 부정적 영향을 미칠 수 있는 만큼, 정부의 건전한 재정규율이 필요하다. 특히 신흥국은 재정건전성을 양호하게 유지할 경우 대외 신인도를 제고하고 자금조달 비용을 낮출 수 있으므로 금융·경제 안정에 크게 도움이 된다.

2. DSGE 분석모형

여기에서는 본고의 분석대상이 되는 DSGE 모형에 대한 자세한 설명을 제시하도록 한다.

가. 가계의 최적선택

본고의 모형에서는 저축가계와 차입가계의 두 유형의 가계가 존재하며, 각 가계는 무한기를 산다고 가정한다. 먼저 저축가계의 효용함수는 다음과 같이 주어진다.

$$\text{(A1)} \qquad E_0 \sum_{t=0}^{\infty} \beta^t \left[\log(c_t' - h_b c'_{t-1}) + u_t^j \log(h_t') - (L_t')^{\eta}/\eta \right]$$

여기에서 E_t는 t기까지의 모든 정보를 이용하여 형성한 조건부 기대를 나타낸다. β는 저축가계의 주관적 할인인자(discount factor)이며, c_t', h_t' 및 L_t'는 각각 저축가계의 t기 소비, 주택보유 및 노동공급을 의미한다. u_t^j는 AR(1)으로 주어지는 주택 선호충격이며, h_b는 소비습관을 반영하는 모수이다.

이러한 저축가계의 예산제약은 다음과 같다.

$$\text{(A2)} \qquad P_t c_t' + Q_t h_t' - B_t' + M_t = W_t' L_t' + Q_t h'_{t-1} - B'_{t-1} R_{t-1} + M'_{t-1} + P_t F_t + P_t T_t'$$

위 식에서 B_t'는 가계의 차입(borrowing)을 나타내며, Q_t와 W_t'는 각각 명목 주택가격과 명목임금을 의미한다. F_t는 추후 설명하게 될 소매기업으로부터의 실질 이익(profit)을 배당받는 부분이고, T_t'는 중앙은행으로부터의 이전지출을 의미한다. 이러한 식 (A2)의 예산제약은 다음과 같은 실질 단위로 나타낼 수 있다.

$$\text{(A3)} \quad c_t' + q_t h_t' - b_t' + \Delta M_t / P_t = w_t' L_t' + q_t h'_{t-1} - b'_{t-1} R_{t-1}/\pi_t + F_t + T_t'$$

위 식에서 q_t와 b_t'는 각각 실질 주택가격과 실질 차입을 의미하게 된다.

한편, 차입가계의 효용함수는 다음과 같이 주어진다.

$$\text{(A4)} \qquad E_0 \sum_{t=0}^{\infty} (\beta'')^t \left[\log(c_t'' - h_b c''_{t-1}) + j \log(h_t'') - (L_t'')^{\eta}/\eta \right]$$

동 모형에서 ″ 와 함께 나타나는 모수 및 변수는 차입가계의 변수를 나타낸다. 차입가계의 주관적 할인인자는 저축가계보다 작다($\beta'' < \beta$)고 가정하는데, 이러한 설정은 차입가계가 저축가계보다 미래를 더 많이 할인하여 현재 소비에 더 큰 비중을 두게 됨을 반영한다. 차입가계의 실질 예산제약은 다음과 같이 나타낼 수 있다.

(A5) $$c_t'' + q_t \Delta h_t'' - b_t'' R_{t-1}/\pi_t + \Delta M_t''/P_t = w_t'' L_t'' + b_t'' + T_t'' + u_t^b$$

위 식에서 u_t^b는 AR(1) 과정을 따르는 가계신용 충격이다.

차입가계의 효용극대화 문제는 저축가계와 동일하게 식 (A5)의 제약하에서 식 (A4)를 극대화함으로써 풀 수 있다.

나. 기업가와 소매기업의 최적선택

기업가는 가계로부터 구입한 부동산(real estate), 자본 및 노동을 이용하여 중간재를 생산하는 경제주체이며, 생산된 중간재는 단위당 도매가격 P_t^w에 소매기업에 판매된다. 기업가의 목적함수는 다음과 같다고 가정한다.

(A6) $$E_0 \sum_{t=0}^{\infty} \gamma^t [\log(c_t)]$$

여기에서 γ는 기업가의 주관적 할인인자를 나타내는데, $\gamma < \beta$라고 가정한다. 기업가는 아래 주어진 제약들하에서 위의 효용을 극대화한다.

(A7) $$Y_t = A_t K_{t-1}^{\mu} h_{t-1}^{\nu} (L_t')^{\alpha(1-\mu-\nu)} (L_t'')^{(1-\alpha)(1-\mu-\nu)}$$

(A8) $$Y_t P_t^w/P_t + b_t = w_t' L_t' + w_t'' L_t'' + q_t \Delta h_t + b_{t-1} R_{t-1}/\pi_t + c_t + I_t + \varepsilon_{K,t}$$

(A9) $$b_t R_t \leq m E_t (q_{t+1} h_t \pi_{t+1})$$

위에서 식 (A7)과 (A8)은 각각 기업가의 생산함수와 예산제약을 나타낸다. 그리고 식 (A9)는 실질 단위로 나타낸 기업가의 신용제약(credit constraint)을 의미한다. 식 (A7)의 K_t와 식 (A8)의 I_t는 각각 t기의 자본과 투자를 나타낸다. 식 (A8)의 $\varepsilon_{K,t}$는 $\varepsilon_{K,t} = \Psi_t (I_t/K_{t-1} - \delta)^2 K_{t-1}/(2\delta)$로 주어지는 자본 조정 비용(capital adjustment cost)을 의미한다.

소매기업 부문의 경우 z로 인덱스화되는 동질적인 소매기업이 경제 내에 무수히 많이 존재한다고 가정한다. 각 소매기업은 기업가로부터 중간재를 단위당 P_t^w의 가격에 구입하여 단위가격 $P_t(z)$인 최종재 $Y_t(z)$를 생산한다. 소매기업들은 매 기 $1-\theta$ 비율의 소매기업만이 자신이 생산하는 상품 가격을 바꿀 수 있는 Calvo 형태의 독점적 경쟁과 가격경직성에 직면한다. 구체적으로 최종재의 수량과 가격은 다음과 같이 집계화(aggregation)된다.

(A10) $$Y_t^f = \left[\int_0^1 Y_t(z)^{(\epsilon-1)/\epsilon} dz\right]^{\epsilon/(\epsilon-1)}, \ \epsilon > 1$$

(A11) $$P_t = \left[\int_0^1 P_t(z)^{\epsilon-1} dz\right]^{1/(\epsilon-1)}, \ \epsilon > 1$$

따라서 개별기업의 수요곡선은 다음과 같이 주어진다.

(A12) $$Y_t(z) = \left[P_t(z)/P_t\right]^{-\epsilon} Y_t^f, \ \epsilon > 1$$

소매기업의 극대화 문제는 식 (A12)에 주어진 우하향하는 수요곡선이 제약조건으로 주어진 상황에서 할인된 기대수익(expected discounted profit)을 극대화하는 것으로 표현된다. 이러한 문제의 최적 가격 $P_t^*(z)$는 다음과 같은 방정식을 풀어서 구할 수 있다.

(A13) $$\sum_{k=0}^{\infty} \theta^k \left[\beta \frac{c_t'}{c'_{t+k}} \frac{P_t^*(z)}{P_{t+k}} Y_{t+k}^*(z)\right] = \sum_{k=0}^{\infty} \theta^k \left[\beta \frac{c_t'}{c'_{t+k}} \frac{X}{X_{t+k}} Y_{t+k}^*(z)\right]$$

여기에서 X_t는 $X_t = P_t/P_t^w$로 정의된 마크업(markup)이며, X는 정상상태의 마크업이 되어 $X = \epsilon/(\epsilon-1)$이 된다. Y_t^*는 기대수요(expected demand)를 나타내며 $Y_{t+k}^* = \left[P_t^*(z)/P_{t+k}\right]^{-\epsilon} Y_{t+k}$로 정의된다. 위 식 (A13)의 좌변은 할인된 한계 기대수익이며 우변은 할인된 한계 기대비용이 되어, 양변이 같아질 때 할인된 기대수익이 극대화된다는 것을 의미한다.

이러한 문제의 해를 구하면 총가격(aggregate price)은 다음과 같은 형태로 나타난다.

(A14) $$P_t = \left[\theta P_{t-1}^{1-\epsilon} + (1-\theta)(P_t^*)^{1-\epsilon}\right]^{1/(1-\epsilon)}$$

마지막으로 식 (A13)과 (A14)를 연립하면 해당 모형에 대한 필립스 곡선(Phillips curve)이 다음과 같이 도출된다.

(A15) $$\widehat{\pi_t} = \beta E_t \widehat{\pi_{t+1}} - \kappa \widehat{X_t}$$

다. 통화당국

로그-선형화한 통화정책은 본문의 식 (3)~(8) 가운데 하나를 따른다고 가정한다.

라. 시장청산

모형에는 네 개의 시장이 존재하는데, 노동시장, 부동산시장, 재화시장 및 신용시장이 바로 그것들이다. 각 시장의 청산조건은 다음과 같이 주어진다.

(A16) $$[\text{노동시장}] \quad L_t = L_t' + L_t''$$

(A17) $$[\text{부동산시장}] \quad h_t = h_t' + h_t''$$

(A18) $$[\text{재화시장}] \quad Y_t = c_t' + c_t'' + I_t$$

(A19) $$[\text{신용시장}] \quad b_t' + b_t'' = 0$$

3. 데이터

본고의 VAR 및 DSGE 모형은 2000년 1/4분기부터 2021년 4/4분기까지의 한국 자료를 사용하여 분석하였다. 추정에 사용된 데이터의 구체적인 설명은 다음과 같다.

$$GDP(y_t) = \log(\text{실질}GDP/\text{인구수})$$

$$\text{소비}(c_t) = \log(\text{실질소비}/\text{인구수})$$

$$\text{명목정책금리}(r_t) = \text{한국은행기준금리}$$

$$\text{물가}(p_t) = \text{소비자물가지수}$$

$$\text{실질주택가격}(hp_t) = \text{실질주택가격지수}$$

$$\text{가계신용비율}(hc_t) = \text{가계신용}/GDP$$

실질 주택가격지수는 명목 주택가격지수를 CPI로 나눠서 구한다. 각 데이터의 출처는 다음과 같다.

- 실질 GDP: 국내총생산 (시장가격, GDP) (한국은행 경제통계시스템)
- 실질소비: 가계 최종소비지출 (한국은행 경제통계시스템)
- 명목 정책금리: 한국은행 기준금리, 연% (한국은행 경제통계시스템)
- 물가: 소비자물가지수 (2010$=$10)(전국), 총지수 (한국은행 경제통계시스템)
- 명목 주택가격지수: 주택종합 매매가격지수 (KB)
- 가계신용: Total credit to households (BIS)

마지막으로 VAR 모형 추정 시 외생변수로 사용된 변수들은 다음과 같이 구축하였다.

- US GDP = log(US real per capita GDP)
- US 10-year interest rate = Market yield on U.S. treasury securities at 10-year constant maturity
- Oil Price = log(Global price of Dubai Crude)
- Real effective exchange rate = log(Real broad effective exchange rate for Korea)

4. 통화준칙별 통화정책 충격의 충격반응함수

Figure A1에는 추정된 DSGE 모형 중 데이터 적합도가 가장 높은 모형(금리준칙 식 (8)을 포함한 모형)에서의 통화정책 충격에 대한 충격반응함수가 보고되어 있다. 해당 충격반응함수는 추정된 모수의 사후분포 평균값 추정치에서 시산된 것이다. 긴축적 통화정책 충격은 GDP, 소비 및 투자를 단기적으로 감소시키는 동시에 인플레이션도 떨어뜨려 음(-)의 수요충격으로서 기능하는 것으로 나타났다. 이러한 반응은 통상적인 경제학 이론과 부합한다. 해당 충격이 주택시장에 미치는 영향 또한 긴축적이어서 단기적으로 실질주택가격, GDP 대비 가계부채 비율 및 가계부채 수준을 감소시키는 것으로 도출되었다.

한편, 통화정책이 가계부채비율에 반응하는 것의 거시경제적 함의를 도출하기 위해 Figure A2는 Figure A1에 나타난 실제 충격반응함수와 해당 모형의 모수 가운데 통화정책이 가계부채비율에 반응하는 부분을 0으로 상정한($\phi_s = 0$) 상황에서의 충격반응함수를 비교하고 있다. 통화정책이 가계부채비율에 반응하지 않을 때에는 실제 모형보다 통화정책 충격에 대한 GDP 및 인플레이션의 단기 반응이 커지게 된다. 또한 가계부채비율이나 가계부채 수준 자체의 변동도 커지는 결과가 도출된다. 이러한 결과는 본고의 모형에서 통화정책이 가계부채비율에 반응하는 것이 거시변수 및 가계부채 변수 변동을 줄임으로써 후생상의 개선을 가져올 수 있음을 방증한다.

마지막으로 Figure A3와 Figure A4는 본문의 Table 5에 제시된 최적 금리준칙 계수하에서 시산된 충격반응함수를 Figure A1의 실제 충격반응함수와 비교한다. 두 그림에서 나타나듯이 전반적으로 최적 금리준칙 계수하에서의 통화정책 충격에 대한 반응이 실제 추정치에서의 그것보다 변동성이 작다. 이러한 경향성은 GDP, 인플레이션 및 가계부채 관련 변수들 모두에서 관측된다. 2차 손실함수 분석을 통한 최적 통화준칙 도출은 결국 이러한 변수들의 변동성을 줄임으로써 얻을 수 있으므로, Figure A3와 Figure A4의 결과는 이러한 직관과 부합한다고 할 수 있다.

(Unit: %)

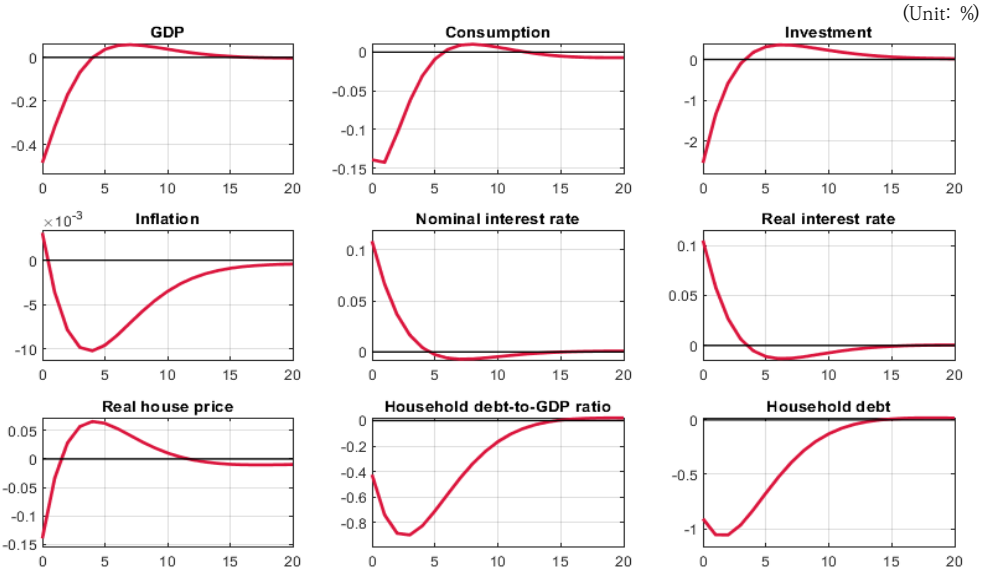

Figure A1. Impulse Response Functions to Monetary Policy Shocks in DSGE Models

Note: 1) The impulse response functions in each graph are simulated using the mean estimates of the posterior distribution of the parameters; 2) In each graph, the x-axis represents the period in quarters after the shocks.

(Unit: %)

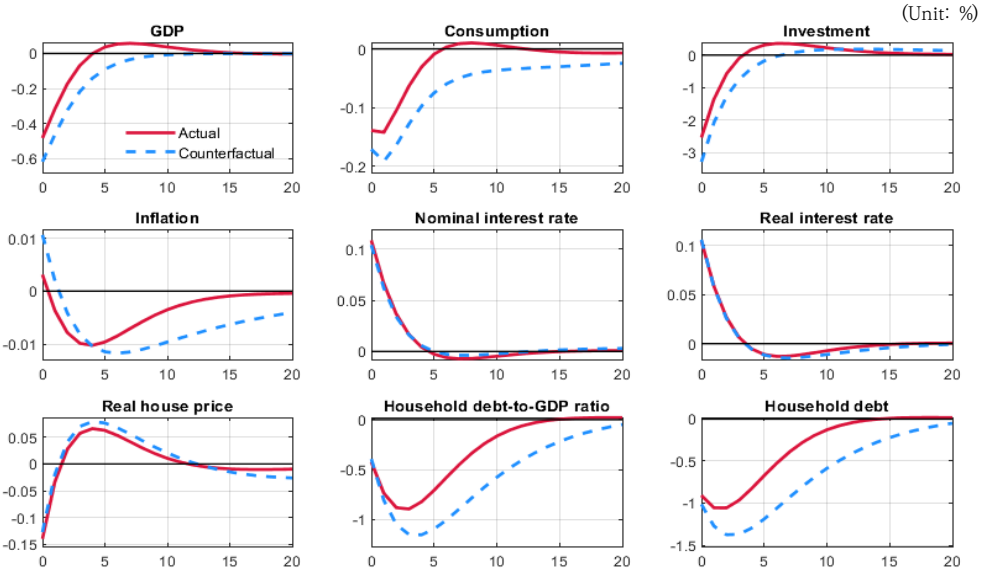

Figure A2. Impulse Response Functions to Monetary Policy Shocks in DSGE Models, Actual vs. Counterfactual

Note: 1) In each graph, the solid line represents the impulse response function based on the actual parameter estimates, while the dashed line represents the counterfactual impulse response function assuming monetary policy does not respond to the household debt-to-GDP ratio; 2) In each graph, the x-axis represents the period in quarters after the shocks.

(Unit: %)

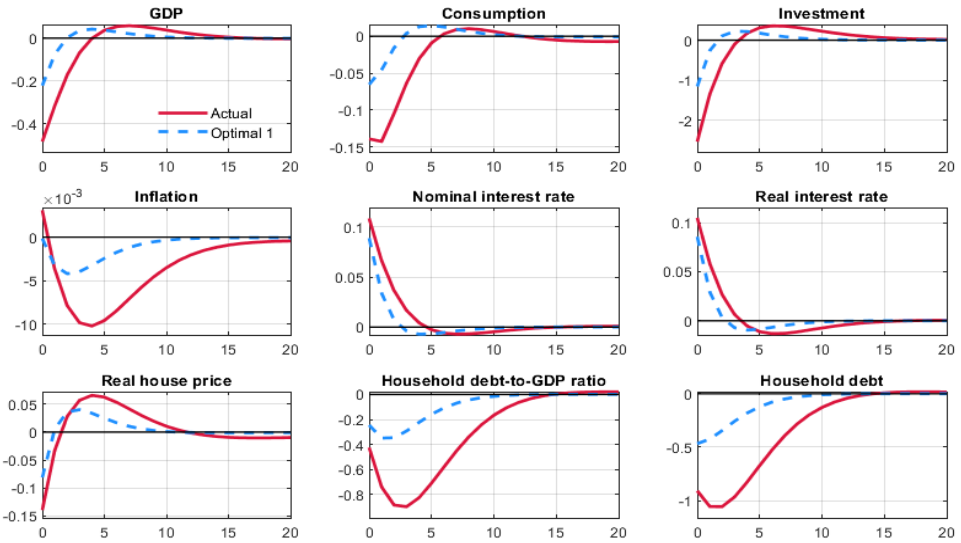

Figure A3. Impulse Response Functions to Monetary Policy Shocks in DSGE Models, Actual vs. Optimal 1

Note: 1) In each graph, the solid line represents the impulse response function based on the actual parameter estimates, while the dashed line represents the impulse response function assuming optimal interest rate rule coefficient 1; 2) In each graph, the x-axis represents the period in quarters after the shocks.

(Unit: %)

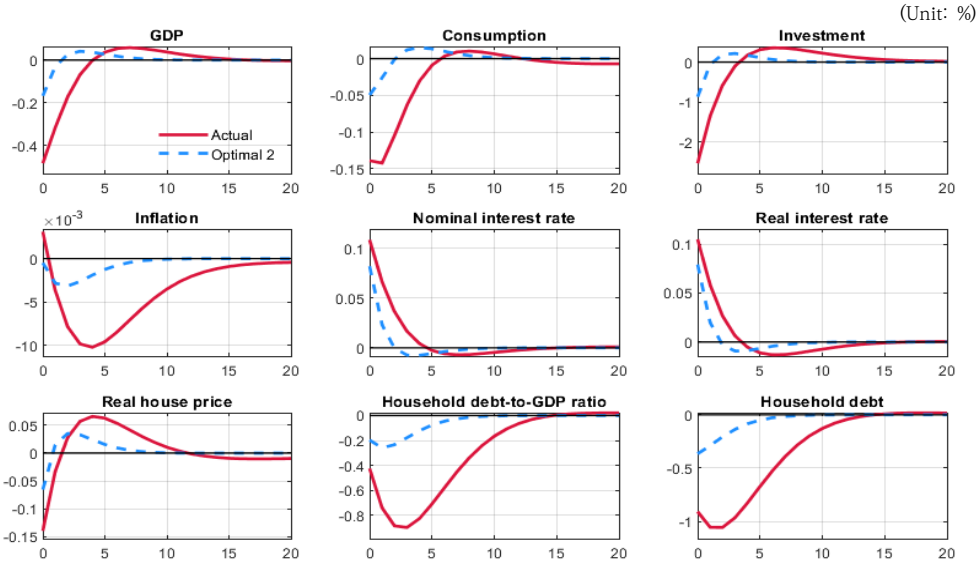

Figure A4. Impulse Response Functions to Monetary Policy Shocks in DSGE Models, Actual vs. Optimal 2

Note: 1) In each graph, the solid line represents the impulse response function based on the actual parameter estimates, while the dashed line represents the impulse response function assuming optimal interest rate rule coefficient 2; 2) In each graph, the x-axis represents the period in quarters after the shocks.

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Optimal Monetary Policy System for Both Macroeconomics and Financial Stability†

By Joonyoung Hur and Hyoung Seok Oh*

The Bank of Korea, through a legal amendment in 2011 following the financial crisis, was entrusted with the additional responsibility of financial stability beyond its existing mandate of price stability. Since then, concerns have been raised about the prolonged increase in household debt compared to income conditions, which could constrain consumption and growth and increase the possibility of a crisis in the event of negative economic shocks. The current accumulation of financial imbalances suggests a critical period for the government and central bank to be more vigilant, ensuring it does not impede the stable flow of our financial and economic systems. This study examines the applicability of the Integrated Inflation Targeting (IIT) framework proposed by the Bank for International Settlements (BIS) for macro-financial stability in promoting long-term economic stability. Using VAR models, the study reveals a clear increase in risk appetite following interest rate cuts after the financial crisis, leading to a rise in household debt. Additionally, analyzing the central bank's conduct of monetary policy from 2000 to 2021 through DSGE models indicates that the Bank of Korea has operated with a form of IIT,

Key Word: Macroeconomy · Financial stability, Monetary policy system, Interest rate rules, Household debt

JEL Code: E52, E58, E44

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considering both inflation and growth in its policy decisions, with some responsiveness to the increase in household debt. However, the estimation of a high interest rate smoothing coefficient suggests a cautious approach to interest rate adjustments. Furthermore, estimating the optimal interest rate rule to minimize the central bank's loss function reveals that a policy considering inflation, growth, and being mindful of household credit conditions is superior. It suggests that the policy of actively adjusting the benchmark interest rate in response to changes in economic conditions and being attentive to household credit situations when household debt is increasing rapidly compared to income conditions has been analyzed as a desirable policy approach. Based on these findings, we conclude that the integrated inflation targeting framework proposed by the BIS could be considered as an alternative policy system that supports the stable growth of the economy in the medium to long term.

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