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Speeches from Global Leaders

Monetary Policy Normalization and the Road Ahead*

By JEROME H. POWELL*

Thank you for the opportunity to speak here today at the Stanford Institute for Economic Policy Research, a place dedicated to scholarship supporting policies to better peoples' lives. As today is International Women's Day, I would like to preface my remarks by commending the American Economic Association for highlighting the diversity challenges of the economics profession and charting a way forward. Diversity is also a priority at the Fed: I want the Fed to be known within the economics profession as a great place for women, minorities, and others of diverse backgrounds to be respected, listened to, and happy.

Just over 10 years ago, the Federal Open Market Committee (FOMC, or the Committee) lowered the federal funds rate close to zero, which we refer to as the effective lower bound, or ELB. Unable to lower rates further, the Committee turned to two novel tools to promote the recovery. The first was forward guidance, which is communication about the future path of interest rates. The second was large-scale purchases of longer-term securities, which became known as quantitative easing, or QE. There is a range of views, but most studies have found that these tools provided significant support for the recovery. From the outset, the Committee viewed them as extraordinary measures to be unwound, or "normalized," when conditions ultimately warranted.

Today I will explore some important features of normalization and then turn to what comes after. In some ways, we are returning to the pre-crisis normal. In other ways, things will be different. The world has moved on in the last decade, and attempting to re-create the past would be neither practical nor wise. As normalization moves into its later stages, my colleagues and I also believe that this is an important moment to take stock of issues raised by the remarkable experiences of the past decade. We are therefore conducting a review of the Fed's monetary policy strategy, tools, and communications practices. I will conclude with some thoughts on the review.

Balance Sheet Normalization

Between December 2008 and October 2014, the Federal Reserve purchased $3.7 trillion in longer-term Treasury and agency securities in order to support the economy both by easing dislocations in market functioning and by driving down longer-term interest rates. Consistent with the Committee's long-stated intention, in October 2017 we started the process of balance sheet normalization. We began gradually reducing the reinvestment of payments received as

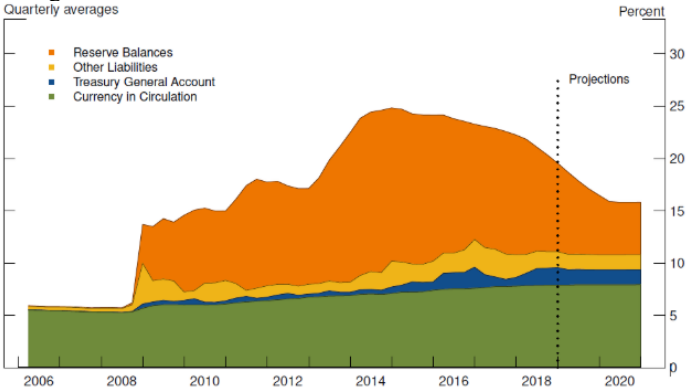
*This speech was given at the 2019 SIEPR Economic Summit.
*Jerome H. Powell, Chair of the Federal Reserve

assets matured or were prepaid, allowing our holdings to shrink. The process of reducing the size of the portfolio is now well along.

To frame the discussion of the final stages of normalization of the size of the balance sheet, it is useful to consider what the phrase "normal balance sheet" meant in the decades before the crisis. During that period, the main monetary policy decision for the FOMC was choosing a target value for the federal funds rate. Subject to that choice, the Fed allowed the demand for its liabilities to determine the size of the balance sheet. This is a feature of "normal" that we are returning to: After normalization, the size of the Fed's balance sheet will once again be driven by the demand for our liabilities.

To see what this means, consider figure 1, which shows the size of the Fed's balance sheet through time, as measured by total liabilities. The values are stated as a percentage of the dollar value of GDP, or gross domestic product.[1] Liabilities began to grow sharply at the end of 2008 and continued to increase until the end of 2014. Since that time, liabilities relative to GDP have fallen appreciably. To understand these changes, it is useful to focus on a snapshot of the balance sheet at three points in time: before the crisis, when the balance sheet was at its largest, and a rough projection for the end of this year (table 1).

Figure 1 Federal Reserve Liabilities as a Share of GDP



Note: Key identifies regions in order from top to bottom. In this figure, currency in circulation is Federal Reserve notes outstanding. Projections of liabilities are based on responses to surveys of primary dealers and market participants conducted by the Federal Reserve Bank of New York. Nominal GDP projections are from the Congressional Budget Office, *The Budget and Economic Outlook: 2019 to 2029*.

Source: Federal Reserve Board, Statistical Release H.4.1, "Factors Affecting Reserve Balances," https://www.federalreserve.gov/releases/h41; Federal Reserve Board staff calculations; Federal Reserve Bank of New York Primary Dealer Survey and Survey of Market Participants; Congressional Budget Office (2019), *The Budget and Economic Outlook: 2019 to 2029*. (Washington: CBO), https://www.cbo.gov/system/files?file=2019-03/54918-Outlook-2.pdf.

[1]The balance sheet had been steady at around 5 percent of GDP since about 1980, as currency slowly grew as a share of GDP, but the increase was offset by a decline in reserves.

Table 1. Federal Reserve Liabilities as a Share of GDP
(Percent)

	2006	2014	2019	2019 to 2006 Change
Reserve Balances	0.1	14.6	5.7	5.6
Currency in Circulation	5.5	7.1	7.9	2.4
Treasury General Account	0.0	0.6	1.4	1.4
Other Liabilities	0.3	2.5	1.4	1.1
Total Liabilities	5.9	24.8	16.5	10.6

Note: Values shown are averages for each liability item in Q4 of each year divided by Q4 nominal GDP in that year. Values for 2019 are based on projections (for details on projections, see the Figure 1 note). In this table, currency in circulation is Federal Reserve notes outstanding. Total liabilities may not equal the sum of the line items due to rounding.

Source: Federal Reserve Board, Statistical Release H.4.1, "Factors Affecting Reserve Balances," https://www.federalreserve.gov/releases/h41; Federal Reserve Board staff calculations; Federal Reserve Bank of New York Primary Dealer Survey and Survey of Market Participants; Congressional Budget Office (2019), *The Budget and Economic Outlook: 2019 to 2029* (Washington: CBO), https://www.cbo.gov/system/files?file=2019-03/54918-Outlook-2.pdf.

In 2006, the dominant liability was currency held by the public, and the dominant asset was Treasury securities. The Fed's asset purchase programs increased the balance sheet from just below 6 percent to nearly 25 percent of GDP by the end of 2014.[2] Balance sheets must balance, of course, and the Fed issued reserves as payment for the assets purchased. This action pushed reserves to nearly 15 percent of GDP.

The Committee has long said that the size of the balance sheet will be considered normalized when the balance sheet is once again at the smallest level consistent with conducting monetary policy efficiently and effectively. Just how large that will be is uncertain, because we do not yet have a clear sense of the normal level of demand for our liabilities. Current estimates suggest, however, that something in the ballpark of the 2019:Q4 projected values may be the new normal. The normalized balance sheet may be smaller or larger than that estimate and will grow gradually over time as demand for currency rises with the economy. In all plausible cases, the balance sheet will be considerably larger than before the crisis.

To understand the differences between the new and old normal, consider the final column in the table, which shows the change, measured in percentage points of GDP, between 2006:Q4 and the 2019:Q4 projection in the table. In this estimate, relative to before the crisis, the balance sheet will have grown as a share of GDP by about 10.6 percentage points. Bank reserves account for the biggest part of the growth, or about 5.6 percent of GDP. The crisis revealed that banks, especially the largest and most complex, faced much more liquidity risk than had previously been thought. Because of both new liquidity regulations and improved management, banks now hold much higher levels of high-quality liquid assets than before the crisis. Many banks choose to hold reserves as an important part of their strong liquidity positions.

The rest of the increase in liabilities is accounted for by three other categories. First, public currency holdings will have grown by 2.4 percentage points as a share of GDP. Second, the U.S. Treasury maintains an account at the Fed, which has been running 1.4 percentage points higher as a share of GDP. And, third, other liabilities, which are mainly associated with the mechanics of the national and international financial system, will have grown by 1.1 percentage points.

[2]This size is similar to that of the balance sheet relative to GDP in the wake of the Great Depression.

As was the case before the crisis, the FOMC's chosen operating regime for controlling short-term interest rates also plays a role in determining the appropriate quantity of reserves. In January, the Committee stated its intention to continue in our current regime in which our main policy rate, the federal funds rate or possibly some successor, is held within its target range by the interest rates we set on reserves and on the overnight reverse repo facility.[3] In this system, active management of the supply of reserves is not required. Thus, the supply of reserves must be "ample," in the sense of being sufficient to satisfy reserve demands even in the face of volatility in factors affecting the reserve market.[4] Put another way, the quantity of reserves will equal the typical reserve demands of depositories plus a buffer to allow for reserve market fluctuations.

While the precise level of reserves that will prove ample is uncertain, standard projections, such as those in the table, suggest we could be near that level later this year. As we feel our way cautiously to this goal, we will move transparently and predictably in order to minimize needless market disruption and risks to our dual-mandate objectives. The Committee is now well along in our discussions of a plan to conclude balance sheet runoff later this year. Once balance sheet runoff ends, we may, if appropriate, hold the size of the balance sheet constant for a time to allow reserves to very gradually decline to the desired level as other liabilities, such as currency, increase. We expect to announce further details of this plan reasonably soon.

There is no real precedent for the balance sheet normalization process, and we have adapted our approach along the way. In these final phases, we will adjust the details of our normalization plans if economic and financial conditions warrant. After decisions regarding the size of the balance sheet have been made, we will turn to remaining issues, such as the ultimate maturity composition of the portfolio. The Committee has long stated that it intends to return to a portfolio consisting primarily of Treasury securities.

Forward Guidance and the Normalization of Policy Communication

The Committee has also been normalizing communication about our policy after a decade of forward guidance. Since December 2008, the FOMC's postmeeting statement had contained ever-evolving forms of guidance about keeping the federal funds rate at the ELB or about the gradual pace at which that rate would return to more normal levels. We removed the last elements of this crisis-era guidance in January. [5]The federal funds rate is now within the broad range of estimates of the neutral rate--the interest rate that tends neither to stimulate nor to restrain the economy. Committee participants generally agree that this policy stance is appropriate to promote our dual mandate of maximum employment and price stability. Future adjustments will depend on what incoming data tell us about the baseline outlook and risks to that outlook.

Policy communication will not simply revert to the ways of the early 2000s, however, for transparency advances have continued apace since then. The most significant change from the standpoint of forward guidance is that, since January 2012, the FOMC's quarterly Summary of Economic Projections (SEP) has included federal funds rate projections reaching up to three years into the future--often referred to as the "dot plot." Returning to a world of little or no explicit forward guidance in the FOMC's postmeeting statement presents a challenge, for the dot

[3]As noted in the minutes of the November 2018 FOMC meeting (see https://www.federalreserve.gov/monetarypolicy/fomcminutes20181108.htm), participants discussed costs and benefits of various alternatives to the federal funds rate, such as the overnight bank funding rate, and recommended further study of the issue.

[4]Both supply and demand factors can show large fluctuations.

[5]Of course, "patience" as used in the January FOMC statement (see https://www.federalreserve.gov/newsevents/pressreleases/monetary20190130a.htm) might be seen as forward guidance. This type of guidance was used at times before the crisis and may play a role in the future. It is not, however, the explicit guidance about the medium-term level or direction of rates that distinguished the crisis-era guidance.

plot has, on occasion, been a source of confusion. Until now, forward guidance in the statement has been a main tool for communicating committee intentions and minimizing that confusion.

For example, in early 2014, the Committee's intentions were at odds with a common misreading of the dots, and Chair Yellen explained, "[O]ne should not look to the dot plot, so to speak, as the primary way in which the Committee wants to or is speaking about policy to the public at large. The FOMC statement is the device that the Committee as a policymaking group uses to express its opinions . . . about the likely path of rates."[6] If the Committee remains largely out of the business of explicit forward guidance, we will need to find other ways to address the collateral confusion that sometimes surrounds the dots.

As readers of the FOMC minutes will know, at our last meeting in January there was an impromptu discussion among some participants of general concerns about the dots. My own view is that, if properly understood, the dot plot can be a constructive element of comprehensive policy communication. Let me follow my two predecessors as Chair in attempting to advance that proper understanding.

Each participant's dots reflect that participant's view of the policy that would be appropriate in the scenario that he or she sees as most likely. As someone who has filled out an SEP projection 27 times over the last seven years, I can say that there are times when I feel that something like the "most likely" scenario I write down is, indeed, reasonably likely to happen. At other times, when uncertainty around the outlook is unusually high, I dutifully write down what I see as the appropriate funds rate path in the most likely scenario, but I do so aware that this projection may be easily misinterpreted, for what is "most likely" may not be particularly likely. Very different scenarios may be similarly likely. Further, at times downside risks may deserve significant weight in policy deliberations. In short, as Chairman Bernanke explained, the SEP projections are merely "inputs" to policy that do not convey "the risks, the uncertainties, all the things that inform our collective judgment."[7]

Effectively conveying our views about risks and their role in policy projections can be challenging at times, and we are always looking for ways to improve our communications. I have asked the communications subcommittee of the FOMC to explore ways in which we can more effectively communicate about the role of the rate projections. For now, let me leave you with a cautionary tale about focusing too much on dots. Here is a picture composed of different colored dots (figure 2). The meaning of it is not clear, although if you stare at it long enough you might see a pattern. But let's take a step back (figure 3). As you can see, if you are too focused on a few dots, you may miss the larger picture.

[6]See page 9 of Chair Yellen's March 2014 press conference transcript, available at https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20140319.pdf.
[7]See page 6 of Chairman Bernanke's April 2012 press conference transcript, available at https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20120425.pdf. Note that the SEP does provide some general information about the balance of risks, but this information is far less complete than the detail provided on the modal outlook.

Figure 2 Some Interesting Dots

Source: Steven Zucker. Seurat, A Sunday on La Grande Jatte—1884, detail with bouquet. https://www.flickr.com/photos/profzucker/8018209742/in/photostream/

Figure 3. Georges Seurat's *A Sunday Afternoon on the Island of La Grande Jatte*

Source: Wikimedia, https://upload.wikimedia.org/wikipedia/commons/6/67/A_Sunday_on_La_Grande_Jatte%2C_Georges_Seurat%2C_1884.png.

Delivering on the FOMC's intention to ultimately normalize policy continues to be a major priority at the Fed. Normalization is far along, and, considering the unprecedented nature of the exercise, it is proceeding smoothly. I am confident that we can effectively manage the remaining stages.

Beyond Normalization

We live in a time of intense scrutiny and declining trust in public institutions around the world. At the Fed, we are committed to working hard to build and sustain the public's trust. The Fed has special responsibilities in this regard. Our monetary policy independence allows us to serve the public without regard to short-term political considerations, which, as history has shown, is critical for sound monetary policymaking. But that precious grant of independence brings with it a special obligation to be open and transparent, welcoming scrutiny by the public and their elected representatives in Congress. Only in this way can the Fed maintain its legitimacy in our democratic system.

Among other initiatives, my colleagues and I on the FOMC are undertaking a year-long review of the Federal Reserve's monetary policy strategy, tools, and communication practices. The review will involve a series of "Fed Listens" events around the country. These will include town-hall-style meetings and a conference where academic and nonacademic experts will share their views. These events will inform staff work and FOMC discussions as we plan for the

future. While this is the first time the Fed has opened itself up in this way, many central banks around the world have conducted similar reviews, and our approach builds on their experiences.

We believe that our existing framework for conducting monetary policy has generally served the public well, and the review may or may not produce major changes. Consistent with the experience of other central banks with these reviews, the process is more likely to produce evolution rather than revolution. We seek no changes in law and we are not considering fundamental changes in the structure of the Fed, or in the 2 percent inflation objective. While there is a high bar for adopting fundamental change, it simply seems like good institutional practice to engage broadly with the public as part of a comprehensive approach to enhanced transparency and accountability.

Without ruling out other topics, we have highlighted three questions that seem particularly important at present:

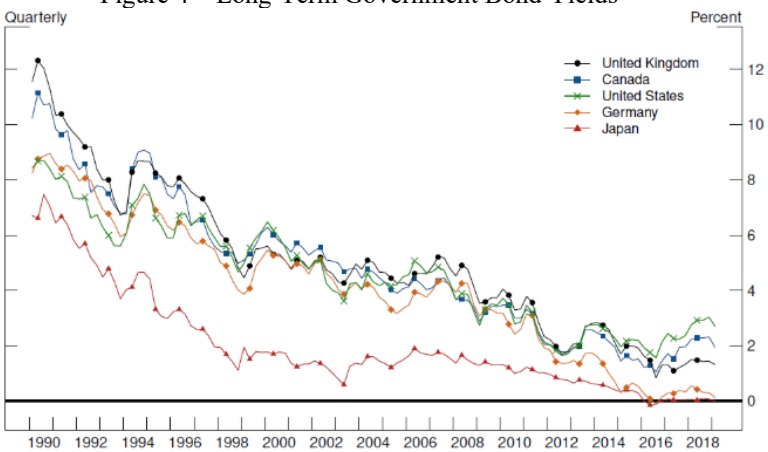
1. Can the Federal Reserve best meet its statutory objectives with its existing monetary policy strategy, or should it consider strategies that aim to reverse past misses of the inflation objective?

2. Are the existing monetary policy tools adequate to achieve and maintain maximum employment and price stability, or should the toolkit be expanded?

3. How can the FOMC's communication of its policy framework and implementation be improved?

I would like to spend a few minutes discussing the first topic. Because interest rates around the world have steadily declined for several decades, rates in normal times now tend to be much closer to zero than in the past (figure 4).[8] Thus, when a recession comes, the Fed is likely to have less capacity to cut interest rates to stimulate the economy than in the past, suggesting that trips to the ELB may be more frequent. The post-crisis period has seen many economies around the world stuck for an extended period at the ELB, with slow growth and inflation well below target. Persistently weak inflation could lead inflation expectations to drift downward, which would imply still lower interest rates, leaving even less room for central banks to cut interest rates to support the economy during a downturn. It is therefore very important for central banks to find more effective ways to battle the low-inflation syndrome that seems to accompany proximity to the ELB.

Figure 4 Long-Term Government Bond Yields



Note: Series are 10-year nominal bond yields.
Source: Organisation for Economic Co-operation and Development, Main Economic Indicators (retrieved from Federal Reserve Bank of St. Louis, FRED).

[8]For evidence on the secular decline in interest rates in the United States and abroad, see King and Low (2014); Holston, Laubach, and Williams (2017); Rachel and Smith (2017); and Brand, Bielecki, and Penalver (2018).

In the late 1990s, motivated by the Japanese experience with deflation and sluggish economic performance, economists began developing the argument that a central bank might substantially reduce the economic costs of ELB spells by adopting a makeup strategy.[9] The simplest version goes like this: If a spell with interest rates near the ELB leads to a persistent shortfall of inflation relative to the central bank's goal, once the ELB spell ends, the central bank would deliberately make up for the lost inflation by stimulating the economy and temporarily pushing inflation modestly above the target. In standard macroeconomic models, if households and businesses are confident that this future inflationary stimulus will be coming, that prospect will promote anticipatory consumption and investment. This can substantially reduce the economic costs of ELB spells.[10]Researchers have suggested many variations on makeup strategies.[11] For example, the central bank could target average inflation over time, implying that misses on either side of the target would be offset.

By the time of the crisis, there was a well-established body of model-based research suggesting that some kind of makeup policy could be beneficial.[12] In light of this research, one might ask why the Fed and other major central banks chose not to pursue such a policy.[13]The answer lies in the uncertain distance between models and reality. For makeup strategies to achieve their stabilizing benefits, households and businesses must be quite confident that the "makeup stimulus" is really coming. This confidence is what prompts them to raise spending and investment in the midst of a downturn. In models, confidence in the policy is merely an assumption. In practice, when policymakers considered these policies in the wake of the crisis, they had major questions about whether a central bank's promise of good times to come would have moved the hearts, minds, and pocketbooks of the public. Part of the problem is that when the time comes to deliver the inflationary stimulus, that policy is likely to be unpopular--what is known as the time consistency problem in economics.[14]

Experience in the United States and around the world suggests that more frequent ELB episodes could prove quite costly in the future. My FOMC colleagues and I believe that we have a responsibility to the American people to consider policies that might promote significantly better economic outcomes. Makeup strategies are probably the most prominent idea and deserve serious attention. They are largely untried, however, and we have reason to question how they would perform in practice. Before they could be successfully implemented, there would have to be widespread societal understanding and acceptance--as I suggested, a high bar for any fundamental change. In this review, we seek to start a discussion about makeup strategies and other policies that might broadly benefit the American people.

[9]See Reifschneider and Williams (2000) and references therein.

[10]Eggertsson and Woodford (2003), for example, show that optimal policy at the ELB entails a commitment to reflate the price level during subsequent economic expansions. See also Wolman (2005) for a discussion of the effectiveness of price-level targeting at the ELB. For a discussion of the relationship between price-level targeting and average-inflation targeting, see Nessén and Vestin (2005).

[11]The strategy in Reifschneider and Williams (2000), for instance, involves a central bank following a Taylor rule modified to make up for shortfalls in policy accommodation during ELB episodes. Kiley and Roberts (2017) study a strategy in which policymakers aim for inflation higher than 2 percent during normal times to compensate for below-target inflation during ELB episodes. See also Bernanke (2017) for a strategy in which low inflation is made up if it occurs when the federal funds rate is at or near the ELB.

[12]See, for example, English, López-Salido, and Tetlow (2015); Hebden and López-Salido (2018); Bernanke, Kiley, and Roberts (2019); and Mertens and Williams (2019).

[13]The Bank of Japan (2016) came closest, announcing in September 2016 an "inflation-overshooting commitment" (p. 1). The commitment did not, however, come with any explicit goal for a degree or duration of overshoot.

[14]Transcripts of FOMC discussions (see, for example, 2011 transcripts, available at https://www.federalreserve.gov/monetarypolicy/fomchistorical2011.htm reveal that some policymakers were dubious about whether it would be appropriate or even feasible for a current FOMC to bind a future FOMC to a policy that it might find objectionable, which contributed to more general doubts over whether the policy would be credible.

Conclusion

Tonight I have focused on policy normalization and our efforts to engage the public in what may come after. Before concluding, I will say a few words on current conditions and the outlook.

Right now, most measures of the health and strength of the labor market look as favorable as they have in many decades. Inflation will probably run a bit below our objective for a time due to declines in energy prices, but those effects are likely to prove transitory. Core inflation, which is often a reliable indicator of where inflation is headed over time, is quite close to 2 percent. Despite this favorable picture, we have seen some cross-currents in recent months. With nothing in the outlook demanding an immediate policy response and particularly given muted inflation pressures, the Committee has adopted a patient, wait-and-see approach to considering any alteration in the stance of policy.

Considering monetary policy more broadly, we are inviting thorough public scrutiny and are hoping to foster conversation regarding how the Fed can best exercise the precious monetary policy independence we have been granted. Our goal is to enhance the public's trust in the Federal Reserve--our most valuable asset.

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April 2019
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The Financial Sector: Redefining a Broader Sense of Purpose*

By CHRISTINE LAGARDE*

Master, Wardens, Sir David, my Lords, Governor, Aldermen, Sheriff, Chief Commoner, Ladies and Gentlemen.

I am honored to have been invited to deliver the Tacitus lecture in this magnificent Guildhall. I am also fortunate to be among so many friends, including former colleagues, who know that I have a weakness for good stories.

So let me start with a Hollywood story. As you may know, Disney was recently faced with the challenge of creating a sequel to the original Mary Poppins movie, which has delighted children and adults for more than half a century.

The producers of the new film recreated the magical nanny from P.L. Travers's books, but they also featured a new cast of characters—including a villain who could give everybody a good scare. That villain—yes, you guessed it—is a slick banker who is cheating his way to fortune. In the end, of course, the villain is defeated with a touch of magic.

So here is the question: why is the banker the villain? After all, a healthy economy requires a healthy financial sector that is at the service of people as they pursue better lives for themselves and their children.

You might call it the "everyday magic" of finance: helping families buy a home or save for retirement; helping businesses raise capital to support growth and employment; and helping ordinary people manage risks and prepare for a rainy day. That is what most financial professionals do every day, with dedication and a sense of pride.

And yet, despite these good aspects, the caricature of the "bad banker" has resonated with audiences since the dawn of civilization. And its latest version—seen by millions of children around the world—is telling us something about the deeply felt sense of unease about the role of finance in today's world.

It does not take magic to trace much of this most recent frustration back to the global financial crisis, which has left painful economic and psychological scars on millions of people. We know also that many people are angry about the steady drip-drip of financial scandals and misconduct that have occurred all over the world.

Indeed, financial globalization has been one of the key drivers of what Theodore Roosevelt called the "swollen fortunes for the few". It seems we may now be in a new Gilded Age, with high economic inequality and low social mobility. On Wall Street, for example, overall compensation levels have been reaching record highs, and there is a similar trend of moving back to pre-crisis pay levels in other financial centers.

No wonder that growing concerns about finance can be heard across the political spectrum—and not just about the issues of the day, but about the fundamental purpose of this industry. In too many cases, the financial sector has strayed from its original, noble purpose. And too often, it has worked hard to serve itself rather than serve people and the economy at large.

Surely, there must be a better way forward—which brings me to my theme:

I believe that we can build a better financial sector—one that is safer, more sustainable, and ethically sound. A financial industry with a broader sense of purpose.

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*This speech was given at 32nd World Traders' Tacitus Lecture on February 28, 2019

*Christine Lagarde, Managing Director, International Monetary Fund

In this vein, the U.K. has launched a national conversation on how to enhance the social impact of investing—furthering the goal of doing good while making a return.

This goal is not just morally just; it is economically right. Why? Because a better financial sector is more important than ever to help deliver on what our 21st century so badly needs: higher employment, greener growth, and good living standards for all.

The key to achieving this goal is to reshape finance into something that is more aligned with societal values and more connected to the interests of all stakeholders: from customers, to workers, to shareholders, to local communities and future generations.

To do this, we will need more than just a touch of Mary's famous brolly. So let me propose two questions:

- First, how can we make the financial system safer—to encourage the good, not the bad, side of finance?
- Second, how can the financial sector support long-term growth that is more sustainable and more inclusive?

1. How can we make the system safer?

Let me begin with a simple observation: if finance is to become safer and more trustworthy, it will need to harness good innovation, better regulation, and a broader sense of responsibility.

a) Good innovation

Students of history will tell us that these issues have resonated through the ages. For one, it is remarkable just how much influence financial innovation has had on human progress. Think of its instrumental role in the development of writing, mathematics, accounting, and probability theory.

Consider Chinese paper money introduced in the 9th century, or the 13th century Venetians who eagerly bought prestiti, the first true government bonds. And think of how we can draw a line from the first stock exchanges—in Antwerp and Amsterdam—to our modern investment apps that put the global financial markets at our fingertips.

At the same time, history tells us about unsustainable credit booms and speculative bubbles that were driven by bright new financial ideas.

In ancient Rome—in the year 33 AD—land prices crashed after noble families took out loans to bet on ever rising land prices. Ultimately the government of Emperor Tiberius bailed out the investors by extending three-year, interest-free budgetary loans. How do we know this? Tacitus himself briefly described this financial crisis in his final works.

But this is only one of many examples. In the 17th century Tulip Mania, it was a new market for futures contracts. In the 18th century South Sea Bubble, it was the promise of a mythical new land. In the 19th and 20th century, it was often new technology, from the Railway Mania to the dot.com bubble.

And of course, in the run-up to the global financial crisis, it was financial engineering that helped drive a frenzy of reckless risk taking. So, when Lehman Brothers collapsed, policymakers were facing what I once referred to as a "holy cow" moment".

The most striking thing for all of us back then was the incredible fragility of so many advanced economy banks. At their very core, these firms had been weakened by inadequate equity capital, flawed business models, and the blindness of powerful men—a toxic combination that left taxpayers on the hook for massive bank bailouts.

Fast-forward to the present, and the question is whether financial systems are safer today. The short answer is that they are safer, but not safe enough.

b) Better regulation

The good news is that, over the past decade, countries have worked together to reform global financial regulations to help rebuild trust and restore financial health. This ambitious effort—in which the IMF, the FSB, the G20 and many others have been involved—has made a substantial difference.

Banks have much higher capital and liquidity positions. Big banks face tighter regulation, and their leverage is lower. Winding down failing banks has become much easier in all major jurisdictions and in many emerging economies. And a big chunk of the derivatives market has become significantly more transparent.

This is all good, but still not good enough.

We need further efforts to address the potential dangers of "too-big-to-fail" as banks become even bigger and more complex. In the United States, for example, the top five banks now hold about 45 percent of total banking assets, compared with about 40 percent in 2007.

Meanwhile, leading economists and industry experts have been calling for further increases in equity funding—beyond the current capital requirements—to ensure that banks can withstand a potential storm.

Others are not so sure—because further increases in equity funding might come with negative side-effects, such as reduced lending. So far, the evidence points to relatively small costs of higher capital.

Above all, we must be concerned about increasing efforts to roll back some post-crisis regulations. Countries need to resist these pressures. Indeed, they need to push on because more work and political will are required to fully implement the existing reforms.

And even as policymakers are still internalizing the lessons from the last crisis, they need to be vigilant about new risks. For example, the IMF has recently estimated that cyber-attacks could potentially lead to net income losses in the global banking system of up to $350 billion.

Or think of a sharp adjustment in asset prices that could affect the fast-growing shadow banking sector. That part of the financial world comes with many regulatory blind spots that should be addressed. For instance, we believe that countries need to regulate underwriting standards in high-risk debt markets, including leveraged loans.

Of course, making finance safer and more trustworthy is not just about good innovation and better regulation. It is also about a broader sense of individual and collective responsibility.

c) Broader responsibility

Responsible behavior has a lot to do with incentives, especially monetary incentives. There is no question that remuneration policies in the banking sector were driving reckless risk-taking before the financial crisis.

As one analysts put it: "Employ as little equity as one can; promise a high return on equity; link bonuses to the achievement of this return target in the short term; and ensure that as few as possible of those rewards are clawed back in the event of catastrophe."

We know how that story ended. And we know that there is a widely-shared perception that those who caused the crisis did not face the consequences, while ordinary people paid a heavy price. Many people actually saw this as the ultimate breach of public trust.

So what has changed since then? For one, post-crisis reforms have significantly moved the needle by better aligning individual pay with the health of the firm.

If you are a senior banker here in the City, 40 to 60 percent of your variable remuneration is deferred over 3-7 years. And it can be reduced, cancelled, or clawed back in case of poor performance and misconduct.

In other words, bankers have more skin in the game. In the U.K., senior bankers and traders also have to comply with the so-called Senior Manager and Certification Regime, which has increased accountability and is helping firms to set a better "tone at the top".

Here I would like to commend my former IMF colleague, Minouche Shafik, who in her role as deputy governor of the Bank of England did so much to promote codes of conduct for financial markets.

Certainly, more can be done: from making claw-backs more consistent across countries, to enhancing the disclosure of disciplinary actions within firms, to creating a global code of conduct.

And let us not forget the power of criminal and civil liability. In major financial centers, we see a more forceful pursuit of individual wrongdoing. But the brunt of legal action—amounting to billions of dollars in fines—is borne by financial firms, where it is too often perceived simply as a cost of doing business.

Values and ethics

The reality is that even the toughest legal sanctions, and the smartest compensation and governance rules, cannot be substitutes for a strong individual responsibility that is grounded in values and ethics. For it is not just the "tone at the top" but the"response from the bottom" that creates a better and more trusted corporate culture.

That is why the financial industry needs what I call an "ethics upgrade". What do I mean? For financial professionals, it simply means doing the right thing—even when nobody is watching. It sounds so simple, and yet it is perhaps the hardest thing to do.

Remember: the word "credit" comes from the Latin word for "trust", which is the lifeblood of the financial system. But trust itself cannot be manufactured or mandated. It must be earned through virtuous behavior that is intrinsically motivated—again, done even when nobody is watching.

Here one could draw inspiration from Aristotle, who argued that we are all driven by a sense of purpose. We can achieve our purpose by developing virtues, such as justice, courage, self-control, prudence, generosity, and honesty. Aristotle believed that this was the key to genuine happiness.

That spirit can also help achieve a purposeful banking career and a safer and more trusted financial system. But this is not the whole story. Aristotle also believed that individual purpose must always be linked to social purpose, to the common good.

This applies to all aspects of our life—including corporations and financial firms. The "goal" of a corporation cannot be just about its own narrow financial interest. It must also encompass a broader common responsibility.

It is not surprising, therefore, to see growing debates about the nature of modern corporations and the concept of maximizing shareholder value.

As the British economist Colin Mayer put it: "For nearly all of its 2,000-year history, the corporation has combined a public purpose with its commercial activities. It is only over the last 60 years that the idea that profit is the only purpose of business has emerged."

I believe that encouraging a broader common responsibility is now more important than ever—not just for today's stakeholders, but for future generations.

Which brings me to my second question: how can the financial sector support long-term growth that is more sustainable and more inclusive?

2. How can finance support sustainable and inclusive growth?

Let me start with a data point. Over the next 15 years, $24 trillion of wealth will be inherited by millennials—and they are more than twice as likely as other generations to invest in companies or funds that target social or environmental outcomes.

The financial industry has seized this opportunity by offering various forms of impact investing, green bonds, and a panoply of fund products that take account of "ESG"—environmental, social, and governance issues.

Clearly, sustainable investing is booming. But it also points to a deeper issue: whether you are a banker, fund manager, or fintech entrepreneur, you are probably wondering how to take a more sustainable approach that is both economically and ethically right.

This offers us a huge opportunity to redefine the magic of finance, to pursue a broader sense of purpose.

a) Fintech

The immediate priority should be to foster cutting-edge financial technology. This means creating fintech products that are substantially cheaper and more accessible. It means serving customers and communities in new and better ways. It also means rethinking the economics of the financial industry itself.

In the United States, for example, the unit cost of financial intermediation has remained largely unchanged over the past century, while income from finance has risen and fallen with the value of financial assets. That suggests a significant amount of rent extraction.

The fintech response is to increase competition, reduce inefficiencies, and provide better value for money to individuals and small businesses. In doing so, fintech can help drive an "inclusion revolution".

In Kenya and China, mobile payment systems have brought millions of previously "unbanked" people into the financial system. In Latvia, Brazil, and elsewhere, peer-to-peer lending has opened up new sources of credit for small businesses. Around the world, blockchain enables faster and cheaper transactions—from trading securities to sending money to relatives abroad. And this is just the beginning.

Let us not forget that 1.5 million adults in the U.K. still have no bank accounts, and about 33 million U.S. households are under-or unbanked—and those numbers are multiplied in emerging and developing countries.

So there is a huge opportunity to boost financial inclusion which—as we know—leads to stronger growth and higher employment. This in turn requires vibrant digital ecosystems, such as London—which is home to the biggest cluster of fintech startups in Europe.

But fintech cannot do it alone. We also need better regulation and smarter supervision to ensure that fresh sources of credit do not encourage people to overborrow and that personal data is protected against prying eyes and criminals.

In other words, banking-type fintech services should be subject to banking regulations, especially when it comes to consumer protection. For new firms, this means working with regulators to unlock the immense potential of fintech, while managing the risks.

That is the goal of the Bali Fintech Agenda launched by the IMF and World Bank last October. It provides key principles—including on promoting competition and consumer choice, and fighting money laundering—which can help guide our joint endeavors in the period ahead.

b) Female leadership

Of course, the inclusion revolution goes beyond fintech. It also encompasses the need for more diverse leadership in finance.

I say this for two reasons. First, greater diversity always sharpens thinking, while reducing the potential for groupthink. And second, diversity also leads to more prudence and better decision-making.

Our own research bears this out: a higher share of women on the boards of banks and financial supervision agencies is associated with greater financial stability—which underpins stronger and more durable growth.

There is a long way to go here. Across the globe, only two percent of bank CEOs are women; and less than a fifth of bank board members are women. Here in the U.K., the Hampton-Alexander review has been urging the largest listed companies to increase the proportion of women on boards to at least one-third by 2020.

Would quotas make a difference? The answer is 'yes', so long as they are properly designed and implemented. A good example is Norway where, over five years, mandatory quotas supported a fourfold increase in the proportion of women on corporate boards.

Clearly, more female leadership is critical—and not just at the top, but as consumers of financial services. Women all over the world are making their voices increasingly heard when it comes to investing their own money.

For example, recent surveys show that women are far more likely to engage in sustainable investing than men. And they are driving demand for new products, such as funds targeting gender equality in corporations.

That spirit is beautifully captured by the "Fearless Girl" statue on Wall Street—which brings me to my final point.

c) Investing for the global public good

I believe that fearless action and fresh ideas are needed more than ever to invest for the global common good.

Think about it: trillions of dollars in private-sector investments will need to be mobilized to tackle climate change and to achieve the Sustainable Development Goals (SDGs)—which are aimed at eliminating poverty by 2030 and, more than this, making the planet a better place for our children and grand-children.

These goals—endorsed by the global community—constitute a daunting challenge. But they are also a huge opportunity—especially for the financial sector.

Only a few years ago, the financial industry perceived climate risk as a distant threat. Governor Mark Carney famously called it the "tragedy of the horizon".

That time horizon has since shifted much closer to the present.

Major hurricanes in the Caribbean, wildfires in California, severe flooding in parts of the U.K: these are but a few of the powerful reminders of an economic threat that is already affecting the livelihoods of too many individuals and communities.

And there are now growing economic debates over the likely effects of climate change on productivity, incomes, financial stability—even monetary policy, not to mention migration pressures.

What does it mean for the financial sector? It means shifting to a more sustainable form of finance that is grounded in better risk management and longer-term thinking. It also means mobilizing more finance for investment opportunities in people and infrastructure.

For example, the IMF recently estimated that the additional spending needed by low-income countries to achieve the SDGs—in key sectors such as health, education, and low-carbon infrastructure—is about $520 billion per year in 2030.

That gap can only be filled through a combination of public and private resources: from bank lending, to project finance, to so-called "blended finance"—which brings together grants, concessional financing, and commercial funding.

The key is for public and private investments to be complements, not substitutes. They must go hand-in-hand to create the right conditions for investment. This includes sound economic policies, strong legal frameworks, good governance, and zero tolerance for corruption—whether in the public or private sector.

And remember: the SDGs are not just about developing economies. They are designed to promote global growth that is stronger, fairer, and environmentally friendly.

If the SDGs are to deliver on that promise, we will also need to harness the momentum of the sustainable investing sector—which already accounts for $23 trillion, or 26 percent of global assets under management.

How might this be done? Fund managers could, for example, launch new investment products that encourage corporations to align their business model with the SDGs. They could also work with policymakers to create global standards for sustainability accounting and reporting—this would boost transparency and strengthen the credibility of sustainable investing.

As I said: this is the moment when fearless action is absolutely critical; when fresh ideas can help us break the mold; when we join hands to foster the global common good.

Conclusion

Let me conclude by returning to Mary Poppins. Remember the scene where the "good banker" teaches his children a lesson about purpose. He argues that they should follow in his footsteps, and he sings the following lines […don't worry, I won't sing]:

"A British bank is run with precision. A British home requires nothing less! Tradition, discipline, and rules must be the tools. Without them—disorder! Chaos! Moral disintegration! In short, you have a ghastly mess!"

Well, that is one way of putting it. But the question is whether young people today should consider joining the financial industry. For many of them, the answer comes down to finding a broader sense of purpose—much like Mary Poppins.

The genius of her character is that she is serving others—with dignity, with a kind heart, with honesty, and with a wicked sense of humor. I think this is a good description of what the financial industry should be all about.

Serving others, not yourself—that is the real magic of finance.

Thank you.

IMI International Monetary Review

The Euro Area Economy and Our Monetary Policy Stance*

By LUIS DE GUINDOS*

Recent economic developments

In recent months, incoming euro area data have continued to be weak and the economy has grown below expectations.

That is, euro area real GDP increased by 0.2% quarter-on-quarter in the fourth quarter of 2018 (according to preliminary estimates), which was slightly up from 0.1% in the quarter before, but well below the 0.4% growth observed in the first half of 2018.

The continued weakness, particularly in the manufacturing sector, reflects the slowdown in external demand, compounded by some country and sector-specific factors.

The global economy is expanding at a more modest pace. According to IMF estimates, global growth has moderated to 3.7% in 2018 (from 3.8% in the previous year), and is expected to slow to 3.5% in 2019. Important euro area trading partners, such as China, show signs of a maturing economic cycle, and this has affected euro area exports. Net exports recovered in the fourth quarter of 2018 (according to preliminary estimates), but weaker exports were the main factor behind the steep growth slowdown observed in the third quarter.

In the euro area, the slowdown in growth has been particularly visible in the manufacturing sector. Euro area industrial production, excluding construction, declined by 1.4% quarter-on-quarter in the fourth quarter of 2018, with the slowdown being widespread across sectors and most major economies. Purchasing managers' survey data on manufacturing production also moved into contractionary territory last month. Growth in services, in contrast, proved to be more resilient.

Country and sector-specific factors have been playing a role as well. Temporary issues in the automotive sector due to new regulation, for example, caused industrial production to fall particularly strongly in some euro area countries. These idiosyncratic factors are only fading slowly, and have been weighing on growth for longer than anticipated.

Meanwhile, persistent uncertainties have left their mark on business and consumer confidence. These uncertainties relate to geopolitical factors, such as the state of play of the Brexit negotiations, the continued threat of trade protectionism and vulnerabilities in emerging markets. By denting confidence, uncertainty might affect real economic variables, such as capital goods production, which declined strongly last quarter, possibly as a result of this reduced confidence.

All these elements indicate that the moderation in the pace of the euro area economic expansion will likely extend into the current year. This is also reflected in our staff macroeconomic projections. In fact, growth for this year has been revised downwards to 1.1%, which is 0.6% lower than anticipated in the December forecast.

The fundamental factors supporting the euro area expansion remain broadly in place, however.

Looking ahead, the effects of the idiosyncratic factors currently weighing on economic growth are expected to unwind, albeit at a slower pace than initially foreseen. For instance, recent data on motor vehicle production show signs of normalisation, and consumer confidence recently edged up again.

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*This speech was given at Asociación para el Progreso de la Dirección (APD) on March 18, 2019.

*Luis de Guindos, Vice-President of the ECB

Beyond more temporary fluctuations, the euro area expansion will continue to be supported by favourable financing conditions, further gains in employment and rising wages. Also, the ongoing yet somewhat more modest expansion in global activity should continue to support euro area growth.

In fact, bank lending rates to euro area firms and households remain close to their historical lows. The euro area unemployment rate currently stands at its lowest level in more than a decade, and the wage increases that result from tightening labour markets should continue to underpin household income and private consumption. On the external side, preliminary estimates for the fourth quarter of 2018 point to a pickup in net exports after a very weak third quarter.

For these reasons, GDP growth in the euro area is expected to remain sound in the medium term. Accordingly, our staff projections expect euro area GDP growth to reach 1.6% in 2020 and 1.5% in 2021, which is largely unchanged from the December forecast round.

The risks surrounding euro area growth are still considered to be tilted to the downside, on account of the persistence of the uncertainties related to geopolitical factors, the threat of protectionism and vulnerabilities in emerging markets.

Turning to inflation, HICP inflation increased to 1.5% in February, from 1.4% in January (according to preliminary estimates). This slight increase was mostly driven by higher energy and food price inflation, while measures of underlying inflation remain generally muted. Headline inflation is likely to remain around current levels in the coming months, before declining towards the end of year on the basis of the financial market's outlook for oil prices.

In line with this, our latest projections foresee annual HICP inflation declining to 1.2% in 2019, before recovering to 1.5% in 2020 and 1.6% in 2021.

Compared with the December forecast round, the outlook for HICP inflation has been revised downwards across the projection horizon. This downward revision reflects, in particular, the more subdued near-term growth outlook, which is delaying the adjustment of inflation to our aim.

Also for inflation, supportive factors continue to be in place that will lift inflation above this year's muted levels in the more medium term. Labour cost pressures have strengthened and broadened amid high levels of capacity utilisation and tightening labour markets. Together with the economic expansion, these forces are expected to trickle through to wage growth and support underlying inflation.

Finally, in addition to the factors mentioned, the monetary policy measures we announced at the last Governing Council meeting will add to our already accommodative stance, which will continue to underpin the economic expansion and the convergence of inflation to our medium-term aim.

The monetary policy stance

The sizeable moderation in the euro area's expansion and the downward revisions to the near-term growth outlook and inflation projections have led the Governing Council to take a number of decisions in pursuit of its price stability objective.

One decision was to adjust our forward guidance on the key ECB interest rates. We now expect these to remain at their present levels at least through the end of 2019, and in any case for as long as necessary to ensure the continued sustained convergence of inflation to levels that are below, but close to, 2% over the medium term.

This formulation consists of two parts. There is a date-based element – that interest rates are expected to remain at their present levels "at least through the end of 2019". And there is a state-contingent element – that rates will remain unchanged "in any case for as long as necessary

to ensure the continued sustained convergence of inflation to levels that are below, but close to, 2% over the medium term".

By shifting the date-based part of our rate guidance further into the future, from "at least through the summer" to "at least through the end" of 2019, we ensure that our accommodation is not weakened by premature expectations of a rate hike. Market participants who were factoring in the probability that our rates could increase before this date should no longer do so.

On top of that, the state-contingent element ensures that the stance will continue to evolve gradually and in a data-dependent manner.

Second, the ongoing full reinvestment of the stock of assets purchased under the asset purchase programme will continue to provide a significant degree of stimulus. And this will hold true for an extended period of time past the date when we start raising the key ECB interest rates, and in any case for as long as necessary to maintain favourable liquidity conditions and an ample degree of monetary accommodation.

By linking the reinvestment horizon to the date when we start raising the key ECB interest rates, we are reinforcing the stimulative effects of our forward guidance, as market expectations for the reinvestment horizon should evolve in line with expectations for the date on which we start raising rates.

Third, we decided to launch a new series of quarterly targeted longer-term refinancing operations, namely TLTRO-III, starting in September 2019 and ending in March 2021, each with a maturity of two years.

Although bank funding conditions remain favourable, the moderation in the growth momentum and the persistence of several uncertainties could affect these conditions in the future. We need to remain vigilant.

By offering long-term funding at attractive conditions to banks, the new series of TLTROs will help to preserve favourable bank lending conditions and support the smooth and efficient bank-based transmission of monetary policy.

More specifically, under TLTRO-III, counterparties will be entitled to borrow up to 30% of the stock of eligible loans as at 28 February 2019 at a rate indexed to the interest rate on the main refinancing operations over the life of each operation.

Similar to the outstanding TLTRO programme, the "targeting" feature of the operations will offer built-in incentives for credit conditions to remain favourable. We will communicate the precise terms of these operations in due course.

A fourth decision was to continue conducting all our lending operations as fixed rate tender procedures with full allotment for as long as necessary, and at least until the end of the reserve maintenance period starting in March 2021. This measure ensures that we continue providing banks with a liquidity backstop against sufficient and adequate collateral.

Finally, as always we stand ready to adjust all of our instruments, as appropriate, to ensure that inflation continues to move towards the Governing Council's inflation aim in a sustained manner.

Taken together, this set of decisions should ensure that inflation remains on a sustained convergence path towards our medium-term aim, while also preserving favourable bank lending conditions and supporting the smooth transmission of our monetary policy.

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The New Role of Central Banks*

By AGUSTÍN CARSTENS*

Introduction

Ladies and gentlemen, good morning.

It is a pleasure to open this conference celebrating the 20th anniversary of the FSI. Over those 20 years, the FSI has been a key instrument for the BIS to accomplish its goal of promoting financial stability through international cooperation. In particular, the FSI has contributed significantly to capacity-building in central banks and supervisory authorities worldwide, helping them strengthen their financial systems.

The establishment of the FSI in 1999 was the result of a joint proposal made by the BIS and the Basel Committee on Banking Supervision in response to G7 leaders' call to strengthen financial stability worldwide after several crises that took place earlier that decade. At the time, the initial idea was for the FSI to assist countries with the implementation of the Core Principles for Effective Banking Supervision and to gradually broaden the scope of its activities with time, but always with a focus on helping jurisdictions in their pursuit of financial stability.

Twenty years later, much has happened that has affected the landscape of the global financial system and shaped the FSI that we have today. For example, the institutional architecture for financial sector oversight has changed markedly. We have seen a pendular movement in which supervisory authorities in some jurisdictions have been separated from the central bank, and then reunited with it after the crisis. In some cases, this was accompanied by an expansion of the roles played by the central bank to include, in addition to microprudential supervision, macroprudential and resolution functions. More recently, central banks and supervisory agencies have also been asked to contribute to other policy objectives such as financial innovation, financial inclusion or even environmental protection.

This trend shows how potential synergies across policy objectives have gained relevance in the design of the institutional architecture. Yet a plurality of objectives within a single agency could generate policy conflicts that may not always be solved in a socially optimal way. Moreover, the accumulation of power within a single agency may be used as the basis for challenging the independence of central banks vis-à-vis elected officials.

Let me touch upon those issues in the rest of this talk. In particular, I would like to discuss the additional complexity currently faced by central banks in their decision-making process and how their independence remains crucial for their actions to fully serve the public interest. I will start by discussing some of the challenges arising from the assumption of financial stability responsibilities by central banks, and then I will address the issue of how recent technological developments could affect the relevant policy framework and the role of financial sector authorities. Finally, I want to talk about how the BIS can help shed light on this relevant policy debate and support its stakeholders in addressing the challenges posed by the current institutional and technological environment.

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*This speech is given at the Financial Stability Institute's 20th anniversary conference "A cross-sectoral reflection on the past, and looking ahead to the future" on March 12, 2019.

*Agustín Carstens, General Manager, Bank for International Settlements

Central banks and financial stability

The crisis did not offer conclusive evidence on the general superiority of specific models for the organisation of financial supervision. Yet in recent years, central banks have tended to assume more financial stability-related responsibilities. According to a recent FSI publication,[1]about two thirds of central banks (out of a sample of 82) are currently the leading authority for the microprudential or macroprudential function in their respective jurisdiction.

Of course, the main rationale for allocating prudential responsibilities to central banks is the existence of important synergies between the pursuit of macroeconomic stability and the preservation of financial stability. Not only are economic and financial stability deeply interrelated concepts, but most relevant policy instruments (such as interest rates, capital requirements and maximum loan-to-value ratios) do affect both real and financial sector developments.

From a conceptual point of view, if we think of the set of interrelations between policy objectives and instruments as a system of equations, the view that the macroeconomic and financial stability objectives could be pursued separately would imply that equations in that system could be solved recursively one by one. However, it is now clear that the system is composed of correlated equations with common variables which must be solved simultaneously. In other words, to deliver both financial and economic stability on a sustainable basis, the interactions across policy domains should be fully considered in the decisions taken by responsible authorities. Arguably, that is easier to achieve if both responsibilities lie with the same agency than by ensuring the required coordination across different agencies.

Yet the addition of financial stability responsibilities to central banks' mandates significantly complicates decision-making. In monetary policy, the goal is for inflation to be stable and close enough to the target. Thus, the assessment of whether the goal has been achieved is relatively straightforward. The same kind of evaluation with respect to financial stability objectives is significantly more complex. First, there is no unique number or metric to define the target. Second, the number of prudential policy instruments that could eventually be used to preserve financial stability is large, each of them having different characteristics but also a variety of potential side effects.

More importantly, the addition of prudential policy to central banks' mission makes them more exposed to public scrutiny and political debate. In particular, financial stability responsibilities imply taking actions on sensitive matters with consequences along several dimensions, such as credit availability and the structure and degree of competition of the financial system. Moreover, actions and possible mistakes in this domain may directly affect customers and investors of financial institutions and have budgetary and distributive repercussions. The latter adds to the differentiated impact of monetary policy actions on different segments of the population.

As a consequence, the enlargement of central banks' functions has helped ignite the debate on their independence in different parts of the world. The argument is always that the accumulation of powers in agencies which are not subject to public control via the electoral system can make their policies deviate from the social interest.

Yet central banks' independence is, if anything, needed now more than ever before. Everybody in this room is familiar with the strong historical and theoretical underpinnings of the independence of monetary authorities.2 Indeed, independence helps mitigate the time-inconsistency problem for monetary policy that typically translates in the long term into higher average inflation without achieving higher employment.

[1]Calvo et al (2018).

Equally solid arguments support regulatory and supervisory independence.3 Supervisory authorities which are not sufficiently independent from governments are bound to give more weight to the short-term benefits of lax regulation – in terms, for example, of credit availability – than to the long-term costs of a higher risk of a systemic crisis. This myopic behaviour on the part of authorities affected by the electoral cycle can have only adverse social welfare implications. That is precisely why supervisory operational independence is one of the Core Principles.

Therefore, independence is just as important for financial stability as it is for price stability. As a consequence, the assumption of financial stability objectives by a central bank strengthens the case for independence, and not the other way around. To be sure, enlarging central banks' powers while at the same time constraining their independence is likely to generate severely suboptimal social outcomes.

That said, it is clear that the broader the mission of central banks, the stronger the case to enhance transparency and accountability. Moreover, the increased complexity of central banks' mission obliges them to strengthen their efforts to develop the required technical and human capacity to address the relevant challenges.

Technological developments

Recent technological developments further complicate the framework in which central banks and supervisory authorities should perform their responsibilities. This is typically the case because accelerated innovation in the market for financial services does generate new, complex trade-offs for policy actions.

In principle, innovation could contribute to financial inclusion, increased competition, enlarged savings and investment opportunities, and to the provision of more affordable services and products. While these are very relevant benefits, there are also important risks.

First, the reliance on automated systems and external providers of technological services raises the risk of cyber-incidents with a potential systemic impact. In addition, the extensive use of personal data by a possibly large number of players may affect the protection of sensitive information. Moreover, the supply of new products and services can attract customers who may not have the proper understanding of their characteristics and risks, thus raising consumer protection issues. Furthermore, some of these products, such as crypto assets, can be used for the remittance of funds of illicit origin and, therefore, for money laundering, thus compromising market integrity. Lastly, a disorderly interaction of market forces may end up creating socially undesirable distortions if the competitive advantage of new (fintech or big tech) entrants vis-à-vis incumbent financial institutions relies solely on regulatory gaps.

The challenging trade-offs suggest that authorities need to act prudently, but they can hardly remain passive given the rapid and potentially disruptive developments. The challenge for policymakers is, naturally, to maximise the benefits of fintech while minimising risks to the financial system.

In order to move forward, authorities need to consider at least four important aspects:

- First, they must develop a comprehensive understanding of the fintech businesses in their jurisdiction. A useful mapping of new innovative activities could be developed by characterising the nature of each of the new the services provided (which may be new or just reformatted), the enabling technologies for those services – such as distributed ledger technology, cloud computing or artificial intelligence – and the underpinning regulatory framework, if any, which may be specific to that activity, entity-based or a combination of the two.
- Second, careful consideration should be given to the need to adjust the regulatory perimeter to accommodate new entities or activities in order to ensure adequate control of risks and a level

playing field. As a minimum, regulation on aspects such as anti-money laundering, consumer and data protection, and possibly also operational resilience should, as a rule, be applied to all professional providers of financial services and payment platforms. Yet the same activity may entail different risks depending on the nature of the entities performing it and, in particular, whether or not they are deposit-takers. Therefore, activity-based regulation seems to be more a complement than a substitute for the traditional entity-based regulation.

- Third, regulatory actions should be coordinated at the global level to the extent possible. Financial innovations are a worldwide phenomenon given that providers of these new services and products often act on a cross-border basis, taking advantage of the new virtual distribution channels. It is therefore essential to guarantee appropriate coordination and cooperation among relevant authorities worldwide and, once sufficient experience is accumulated, to start developing new global regulatory standards to address the relevant policy issues.
- Fourth, regulators should also embrace technology. In recent years, advances in artificial intelligence and its practical application in machine learning, natural language processing and other advanced analytic capabilities have provided opportunities for developing tools that would enhance supervisory capacity. Here again, much is to be gained from international cooperation, not only to exchange experiences but potentially also to jointly develop applications that could then be adapted to the specific needs of each jurisdiction.

In sum, recent developments point to an emerging need for regulatory actions. Those actions should be proportionate, holistic and, ideally, internationally coordinated. Yet it is important for authorities not to lose sight of their policy objectives. In particular, while the benefits of the new technologies may be substantial, central banks and supervisory authorities could hardly take a leading role in promoting them by explicitly or implicitly embracing a pure industrial policy objective. Their focus should remain on their core functions relating to financial stability and adequate market functioning.

The (new) role of central banks

Indeed, despite the potential for disruption of new technologies, there seems to be no strong case to substantively modify supervisory authorities' key objectives. Moreover, the arguments for the involvement of central banks in financial stability – with the caveats that I expressed before – remain solid. Going back to my algebraic analogy, the inclusion of new (fintech) players might make the system of policy objectives and instruments more complex, with more relevant variables subject to non-linear interactions, but it is still a system of equations that, normally, need to be solved simultaneously.

By the same token, technological developments have, if anything, strengthened the case for the independence of central banks and supervisory authorities. Promoting technology may pay off in the short term, as it typically delivers clear benefits in the form of better and more affordable services, while its risks may only materialise after some time, and possibly with low probability, albeit with a great adverse impact. Accordingly, independent regulators could be in a better position to take time-consistent actions, and pay due attention to different scenarios – and not only to the most likely ones – to ensure that new technologies develop in an orderly way without undermining financial stability.

That said, in order to properly perform the functions that society has delegated to them, independent central banks – particularly if they hold financial stability responsibilities – need to develop sufficient capacity and to adapt their internal procedures and decision-making processes to cope with the new challenges. In particular, the ideas I developed before point to two clear tasks for central bankers: to develop a comprehensive and integrated analysis of economic and

financial stability, and to incorporate in the policy analysis and decision-making processes all relevant implications of technological innovation for the financial system.

The BIS is determined to contribute substantially to both objectives. In fact, the new BIS medium-term strategy, Innovation BIS 2025, has several elements that could support these endeavours:

•First, we will continue our efforts to develop as much as possible a conceptually integrated framework for monetary and financial stability policies. Future work in this area will cover both advanced economies and their challenge to normalise monetary policy, and emerging market economies and their challenge to respond to cross-border financial spillovers.

•Second, we will take several initiatives to better understand the implications of technological developments for the financial system and help our stakeholders to make effective use of them in their own policy formation. For example, we plan to establish a multidisciplinary Innovation Hub at the BIS in order to foster collaboration in innovation-related work, as well as a new unit which will undertake policy analysis and research on how key innovations and increased data availability should inform policy and shape central banks' responses.

•Third, we will strengthen our efforts to contribute to the dissemination of good policy practices, to support capacity-building and to facilitate interaction among regulators.

The FSI will play a key role in several of these initiatives. The new regulatory environment that emerged from the post-crisis reforms and recent technological developments have added much complexity to the financial oversight function. As such, financial sector authorities worldwide need to strengthen capacity-building to address these new challenges, and the FSI can contribute to those efforts by facilitating the dissemination of information and analysis on relevant topics and by fostering the exchange of practices and experiences among supervisors.

Moreover, the FSI will also play a prominent role in our pursuit of understanding the regulatory and supervisory implications of innovative technologies. In particular, the FSI will create a repository of technology-related regulatory developments. In addition, it will continue developing comparative studies on distinct regulatory and supervisory approaches followed in different jurisdictions. Finally, it will further develop a recently created informal network of technology specialists in supervisory organisations to exchange practices and experiences on technological developments.

As you can see, the FSI has come a long way over the last 20 years, but its goal remains the same: to assist supervisors around the world in improving and strengthening their financial systems. I have no doubt that the FSI will continue to rise to the challenge of meeting this goal in the years to come.

Congratulations, and keep taking this invaluable work forward. Thank you.

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IMI International Monetary Review

The NPC and CPPCC Sessions

Local Government Debt: Solved or Postponed?

By HERBERT POENISCH*

While the announcement by Premier Li Keqiang at the March CPPCC meeting that the bond issue quota for subnational governments in 2019 will be raised to RMB 2.15 tr, an increase of RMB 800 bn, some 30% over 2018 is good news for these government entities. The issue dealt with here is whether this helps solving the local government (LG) debt problem or just postpones the day of reckoning[1]. He also announced some help in maturity restructuring and lower interest rates on this borrowing.[2]

This article will give a summary on the current local government debt, the fundamentals of local government expenses and revenues, thus the projected need for incurring debt. It will be argued that a fundamental overhaul of government finances will have to address these issues. Otherwise a winding down of local government debt will not be possible. The LG bonds need to get a remake to make them marketable rather that a duty for captive investors. Finally, institutional investors need to be strengthened to allow them to invest in LG bonds, rather than commercial banks which are over-burdened with fiscal responsibilities. The banks would need additional capital if they continue to cover fiscal deficits.

1. Development of local government debt

For a decentralized country like China the government finances are mainly centralized, a contradiction which resulted in local government indebtedness over the years. As local governments were not allowed to go into debt until 2014, they had to rely on intergovernmental transfers, mostly revenue sharing and tax rebate transfers[3]. As their spending from joint and local mandates, such as education, pension insurance, social safety net, housing and investment among others increased significantly in recent years[4] they had to resort to borrowing to cover the gaping deficit. China was an outlier in comparison with other countries, as close to 90% of public expenditure amounting to some 20% of GDP were the responsibilities of local governments.[5] The assignment of responsibilities does not mean that LG have full autonomy in exercising them. They simply act as 'payment agent' with little or no decision-making power.[6]

This demand could only be financed by local governments resorting to the shadow banking system, through establishing Local Government Financing Vehicles (LGFV).By 2014 borrowing

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[1]SCMP (2019): China's 'two sessions': economic watershed or more of the same? 5 March 2019
[2]Li Keqiang (2019): Zhengfugongzuobaogaoquanwen. Published on Xinhuanet 5 March 2019.
[3]Lam, Raphael and Wang, Jingsen (2018): China's Local Government Bond Market. In: IMF WP/18/219, p3 www.imf.org/publications
[4]Wingender, Philippe (2018): Intergovernmental Fiscal Reform in China. In: IMF WP/18/88, www.imf.org
[5]OECD (2016): Subnational Governments Around the World. A first contribution to the global observatory on local finances, p20. www.oecd.org
[6]OECD (2016), ibid p19

from banks and capital markets through LGFV had increased to some 30% of GDP. Hence the Government decided in October 2014 to allow provincial governments to issue bonds, subject to approval of the NPC.[7]

The type of debt instruments was divided into general bonds and special bonds. Special bonds were supposed to be serviced and repaid from the return on investment in projects, however uncertain. Provincial governments were supposed to on-lend the proceeds from bond issues to lower-tier governments that may not report fully the use of funds. The purpose of these bond issues was not only to finance current spending but also to repay LGFV liabilities.

As a result, LG bond issuance increased to RMB 14.7tr by end 2017 and RMB 16tr by the end of 2018. By then, LG borrowing had reached the same level as central government borrowing. In total general government bond issues amounted to RMB 32tr (USD 4.8tr[8]), divided in equal shares between central and local government borrowing. In terms of GDP both had a share of 18% of GDP. If one adds the outstanding LGFV borrowing, the total LG borrowing would amount to 48% of GDP, much higher compared with other subnational governments[9]. Based on the official definition which does not include LGFV, China's local government borrowing is well placed among peers, although somewhat high as percent of total government debt.

The relationship between borrowing and debt is unorthodox in China as special bonds are non-debt creating. They are supposed to be served by special income from projects and thus do not count as government debt. Only general bonds count as debt. In Li Keqiang's proposal, out of a ceiling of RMB 2.15tr for 2019, RMB 810bn are special bonds and the rest, RMB 1.25tr are general bonds.[10]

While the poorer provinces, such as Guizhou, Liaoning and Yunan issued more debt as percentage of provincial fiscal resources than richer ones, such as Beijing, Shanghai and Guangdong, most of them borrowed up to the threshold stipulated by the NPC. Another feature is that interest rates on LG bonds do not vary much, thus not reflecting the credit risk of individual provinces. The assumption is that central government will bail out any province regardless of its credit rating.

2. Fundamentals of intergovernmental relations

A sound system of intergovernmental relations is crucial to China's continuing development and rebalancing progress. Appropriate allocation of spending responsibilities and funding will be necessary to improve public service delivery, reduce growing regional disparities and promote inclusive growth.[11]

The reform of the tax system in 1994 was successful in increasing overall revenues from 12% in 1993 to 22% in 2016. However, the reform also caused LG budgetary surpluses to turn into sustained and growing deficits.[12]

The last major reform was in 2014 with the adoption of a new budget law. The new law also allowed for the first time provincial governments to issue bonds for financing capital expenditure, subject to approval by the NPC. It thus closes off the 'back door' of opaque finance, such as LGFV and opening the 'front door' of transparent bond financing.[13]However, it does not address the fundamental misalignment of expenditure responsibilities and taxing powers, as a result of which the large vertical imbalance has prevailed since 1994.[14] The figures quoted here

[7]Lam, Raphael and Wang, Jingsen, ibid p 9
[8]BIS (2019): Securities statistics www.bis.org/statistics/securities
[9]Lam, Raphael and Wang, Jingsen, ibid figure 3.
[10]SCMP (2019): Six key takeways from Li Keqiang's speech.
[11]Wingender (2018), ibid p2.
[12]Wingender (2018), ibid p3.
[13]SCMP (2019): Can China walk out of economic difficulties by relying on its old playbook of debt? 5.January 2019
[14]Wingender (2018), ibid p4.

refer to 2017 (IMF) and 2013 (OECD).

China, which counts as a unitary state according to the constitution, mandates LG to finance close to 90 of general government spending. This ratio is higher than any other country in the world, both centralized or decentralized. Even decentralized ones like Switzerland and Russia are well behind China.[15] This reflects the strong involvement of LG in the economy and society. China lags far behind OECD countries and even EME in Asia on all major categories of spending, social assistance spending, health spending and education spending. In other areas such as economic affairs, transport and particularly investment[16] China is ahead of other countries.[17] For the sake of investment, LG, in particular cities have been allowed to issue urban construction investment bonds (UCIB) which have been popular with investors.[18]

Although LG collect 60% of total taxes, they can neither set the tax rates nor define the tax base, which is set by central legislation. China relies heavily on indirect taxes which have to be submitted to the central authorities. Shared taxes are corporate income tax and personal income tax. Sub-national taxes are mainly those on real estate, such as the land appreciation tax, house property tax etc.[19] It is not surprising that LG have relied mainly on taxes on the buoyant real estate market as well as on selling land. This allowed them to compete with prestige projects on a local level. However, slower fiscal growth and smaller land sales income add to LG worries during an economic slowdown.

For a centralized country the share of grants and subsidies is rather low, compared with other countries such as Japan and France[20]. Some transfers are linked with the successful launch of the UCIB. Other revenues such as tariffs, fees and property income are also lower than in peer countries. Tax revenue as share of LG revenue as well as share of GDP is highest in China.[21] This is particularly so for a country with lower per capita GDP than high income countries.

Plotting both, public expenditure of LG and tax revenue, China is the world champion with close to 90% share of expenditure and 60% of tax revenue share.[22] This is the key indicator for fiscal imbalances.

As a result of this unbalanced intergovernmental fiscal situation LG resorted to LGFV until 2014 to finance their escalating deficits. As a result, China's LG debt as share of public debt is highest in the world.[23] China's LG debt is the highest of unitary countries with 20% of GDP and 50% of public debt.[24] China is also the only middle-income country to run up LG debt, where only high-income countries such as Japan are found.

The financing sources are 54% bank loans, 24% LGFV bonds and trust loans. There are other sources for financing infrastructure investment, such as the policy banks, government funds and other resources. Among these are Government Guided Funds and Special Construction Funds. The activities of these funds are opaque, interact with other public sector units and have a strong public policy drive.[25] Every time central government adopts stimulus packages such as in 2008/9 but also recently, LG are given unfunded mandates. This is part of a 'proactive fiscal policy' to stimulate economic activities after growth dropped in 2018.[26]

As a result the main creditors of LGs are the central authorities, the policy banks and

[15]See figure 4 in Wingender (2018), ibid, p6. And figure 7 in OECD (2016)
[16]See figure 19 in OECD (2016)
[17]See figure 15 in OECD (2016)
[18]Lu, Ming and Zhong, Huiyong (2017): Euroisation of the Chinese economy. How do intergovernmental transfers affect local government debt in China? In: Asian Economic Papers, Vol 17/nr1 www.mitpressjournals.mit.edu
[19]See table 1 in Wingender (2018), ibid, p 10.
[20]See figure 34 in OECD (2016)
[21]See figure 36 in OECD (2016)
[22]See figure 41 in OECD (2016)
[23]See figure 42 in OECD (2016)
[24]Lam, Raphael and Wang, Jingsen (2018), ibid, figure 3, p8.
[25]Wingender (2018), ibid, p 14.
[26]SCMP (2019): Can China walk out of economic difficulties by relying on its old playbook of debt? 5.January 2019

commercial banks which financed LGFV and purchased the bulk of bonds issued by LG since 2014. Under these conditions it is easy to ask the creditors to extend the maturities as well as lower the interest rate on LG liabilities as Premier Li Keqiang has called for in his speech. In a market driven environment this would be very difficult to do.

This is only shifting the debt burden from one government-controlled entity to another, without resolving the fundamental flaws in the intergovernmental relations. Putting fiscal financing on a sound footing is a major precondition for opening up China's financial sector. Otherwise, foreign investors will do the cherry picking and leave their domestic competitors to bear the burden of unresolved fiscal imbalances.

3. Reform of the LG financing

In order to put LG financing on a sound footing, which will allow bond markets to consider investing in LG bonds the following three reforms need to be implemented. The first one is the reform of intergovernmental finance, the second one is the reform of LG issued bonds to reflect credit risk and third one is to strengthen institutional investors.

To address the misalignment of revenue and spending at the LG level, the State Council announced a major intergovernmental fiscal reform which should be complete by 2020. It has three overarching goals: (i) the clarification of expenditure responsibilities to minimize overlapping mandates, improve service delivery and increase accountability; (ii) a recentralization of key functions that are currently under LG control; and (iii) the consolidation and improvement of the transfer system, notably by increasing the fiscal resources of less-developed regions.

The major areas where the role of central authorities needs to be strengthened are spending on protection and management of the environment and natural resources, construction and management of the national transportation infrastructure. Social spending which should be addressed on a centralized level includes public pensions and unemployment insurance, but also national health insurance, basic education and social welfare policies to provide a safety net for all Chinese citizens across regions.[27]

Strengthening the national pension fund, unemployment fund as well as health fund for both, government as well as private sector workers, not only provides a safety net for the ordinary Chinese but allows these funds to grow into powerful institutional investors. A national provident fund such as in Singapore is also a successful model. Investments of this fund could include providing low cost housing for the low-income population.

Through all these proposed measures the population will be assured minimum standards in terms of benefit levels, eligibility requirements and targeting, with transfers used to complement local funds and to promote compliance with national objectives.[28] This could be linked with the social credit system.

In the transition to a fully funded system, from central and local revenues as well as from individual contributions, LG continue to issue bonds, but in a more market friendly way. At present there is no differentiation between rich provinces and less-developed ones, in the percentage quota as well as in the interest rate. The assumption is that all provinces, regardless of their economic prowess will be bailed out in case of financial difficulties. Monitoring the debt service capacity of provinces is an administrative tool rather than a risk assessment. With big data available, monitoring the revenue and spending patterns of LG should be available to potential investors. Harmonising regulation and taxation of LG bond markets will add to the

[27]Wingender (2018), ibid, p14.
[28]Wingender (2018), ibid, p21.

transparency.[29] However, the reform guidelines are largely silent on the reform of borrowing frameworks.

Strengthening potential investors, notably institutional investors should be a priority for financial market reform before opening to foreign investors. These include pension and health insurance funds but also possibly a national provident fund. In addition, allowing the market to set up various market-based funds, such as open and closed investment funds, would channel China's vast savings into orderly channels rather than leave it up to individuals to invest on their own in the capital markets or online platforms.

At present, 'a large pool of RMB denominated savings is held by residents, with M2 over 200% of GDP, and there are insufficient domestic assets in which to invest'[30]. These savings should be allocated into compulsory contributions to the national pension, unemployment, health and provident funds. Again, compliance with these contributions could be part of the social credit system for employers as well as individuals. The remaining savings can be invested in transparent, well supervised investment funds.

The task of the government is not only to strengthen these funds, supervise them to avoid fraud, but also inform the population about the need to invest there rather than in speculative funds. It is surprising that individuals are willing to invest in risky stock markets rather than in their personal welfare.

Conclusion

While the proposed raising of the borrowing ceiling for LG and easing of their servicing burden is a welcome step, it postpones the day of reckoning rather than solving the LG debt problem. A three pronged approach is suggested for putting LG intergovernmental finances on a solid footing, allow market assessment of LG debt and thus remove another obstacle to opening up the financial system.

[29]Fragmented regulatory framework. In: Lam, Raphael and Wang, Jingsen (2018): ibid, p12
[30]Das, Sonali (2019): China's evolving exchange rate regime. In: IMF WP/19/50 www.imf.org

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China and Its Western Critics*

By ANDREW SHENG AND XIAO GENG*

Contrary to popular belief in the West, China's trial-and-error approach to policymaking supports accountability. In fact, the evidence shows that Chinese policy is responsive to feedback from the Chinese people and the international community, with leaders correcting mistakes and updating policies as they gain new information.

In Washington, DC, a bipartisan consensus about China has emerged: the United States is facing a trade-manipulating, authoritarian intellectual-property thief that represents a strategic threat to the US and its allies and deserves to be punished. But the consensus is wrong. In fact, China deserves recognition, if not appreciation, for its achievements.

In recent decades, China has made unprecedented contributions to global economic growth and green innovation, lifting more than 800 million people out of poverty since it began its "reform and opening up" in the late 1970s. China – and the world – owes this success to the authorities' experimental approach to policymaking, characterized by trial and error and constant adaptation.

Contrary to popular belief in the West, where democratic elections are typically regarded as essential to holding governments responsible for their policies, China's approach supports accountability. Indeed, the evidence shows that policymaking is responsive to feedback from both the Chinese people and the international community, with leaders correcting mistakes and updating outdated measures as they gain new information.

Such adaptation is supported by two annual meetings that have been held in Beijing every March since 1998: the National People's Congress (NPC) and the Chinese People's Political Consultative Conference (CPPCC). At these gatherings, top officials from China's State Council, including key ministers and the premier, create detailed reports, identifying the challenges China faces, as well as a blueprint for continued reform and opening up.

The results are shared with delegates attending the meetings and broadcast live to thousands of official delegates and Chinese and foreign reporters. These gatherings thus represent an important window into evolving Chinese policymaking and governance.

At the most recent NPC and CPPCC, Chinese policymakers weighed the backlash against the standard neoliberal economic model, based on free movement of goods, capital, information, and sometimes labor. The advanced economies and the international institutions they lead have long assumed that expanding these freedoms naturally leads to better outcomes for all.

But the neoliberal model has had grave unintended consequences, such as environmental degradation, rising inequality, and the emergence of monopolies (especially in the tech sector). On a more emotional level, globalization and openness has fueled cultural insecurity. As frustration with the advanced economies' approach has grown, so has mistrust of the experts and elites who championed it.

In response to these anxieties, rational homo economicus has morphed into emotional homo politicus – an agent susceptible to the sirens of nationalism, tribalism, protectionism, and

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populism. The result is escalating trade conflicts, rising isolationism, surging anti-immigrant sentiment, and calls for massive increases in social spending, based on concepts like modern monetary theory.

For China, these developments imply a more hostile external environment. With the growth already slowing, policymakers at the NPC and CPPCC focused on how to ensure economic, financial, and social stability while reviving dynamism.

Despite the challenges China faces – including a high debt-to-GDP ratio and volatile stock markets – the country's leaders have proved adept at securing progress toward these goals. Consumer price index inflation stands at 2.1%. Last year, 13.6 million urban jobs were added, underpinning an unemployment rate of just 5%, and over 18,000 new businesses were launched every day, on average. China's international trade and payment position is largely balanced.

This is the result of a comprehensive and ever-evolving strategy aimed at improving the quality of life and work, reducing poverty, lowering the tax and regulatory burden for small private businesses, and championing green, innovative, open, and sustainable growth. For example, last year, China reduced its average tariff rate from 9.8% in 2017 to 7.5%; opened another 4,100 kilometers (2,550 miles) of high-speed railways; granted permanent urban residency to 14 million workers from rural areas; and implemented tax and fee cuts that reduced business costs by some CN¥1.3 trillion ($193 billion).

The Chinese authorities have now announced their intention to reduce the tax and social-security burden for business by another CN¥2 trillion, and to increase the fiscal deficit by 0.2 percentage points of GDP, to 2.8%, in order to counter the threat of protectionism-driven global deflation. Moreover, the NPC adopted a new foreign investment law that will reduce barriers to market entry by foreign entities and improve substantially the protection of intellectual property rights.

While many in the West sacrifice homo economicus to appease homo politicus, China's leaders are trying to satisfy both. They know that neglecting the needs of homo politicus could lead to social instability and fragmentation. But they also know that they must respond to internal pressures and rapidly evolving external conditions in ways that make good economic sense.

Not every decision will turn out to be the right one. But in China, when mistakes are made, adjustments follow. While this form of accountability is not perfect, it has produced a track record that is exceptional by any standard.

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China-US Trade Relation

Can Trump Make a Deal with China*

By ANDREW SHENG AND XIAO GENG*

In the ongoing US-China trade talks, considerable progress has been made on several key trade issues, such as intellectual-property rights protection. But to defuse tensions in any sustainable way will require a more comprehensive approach, based on a fundamental shift in mindset.

Trade negotiations between the United States and China are closing in on the March 1 deadline, after which the bilateral tariff war will resume – beginning with an increase from 10% to 25% on $200 billion worth of Chinese products. While global financial markets are fluctuating wildly, investors seem to assume that too much is at stake for the US and China to fail to reach a deal. Their optimism could prove short-lived.

To be sure, there has been considerable progress on several key issues, such as technology transfer, protection of intellectual-property rights, non-tariff barriers, and implementation mechanisms. But to defuse tensions between the US and China in any sustainable way will require a more comprehensive approach, based on a fundamental shift in mindset.

Over the last 40 years, Sino-US engagement has been largely cooperative, reflecting a holistic approach that takes into account the interests of the entire global system. US President Donald Trump's administration, however, does not seem to believe that engagement with China (or anyone else for that matter) can benefit both sides. As Trump's "America First" agenda shows, the US is now playing a zero-sum game – and it is playing to win.

For example, the US has threatened to punish or desert its closest allies unless they increase their defense spending. Under pressure from the Trump administration, South Korea just agreed to increase its contributions to US forces in Korea by 8.2%, to $923 million, in 2019.

Similarly, Trump has repeatedly disparaged fellow NATO members for insufficient defense spending. Most recently, Trump has criticized Germany for spending only 1% of GDP for defense, compared to America's 4.3%. German Chancellor Angela Merkel responded by condemning US isolationism at the Munich Security Conference, and calling for the revival of multilateral cooperation.

The Trump administration's myopic approach is also apparent in its preoccupation with bilateral trade imbalances. Any US deficit with another economy is, from Trump's perspective, a loss. Given this, if China agrees to cut its bilateral trade deficit with the US, other economies with bilateral surpluses vis-à-vis the US – including close allies, such as the European Union and Japan – may find themselves facing intensifying pressure to do the same.

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The weakening of trade that could result in this scenario would compound existing negative pressure on global growth, hurting everyone. A global economic downturn is the last thing the world needs at a time when it is already beset with risks, including a possible no-deal Brexit and populist gains in the European Parliament election in May.

Of course, while Trump does not spare his allies, his primary target remains China. After all, the competition between the US and China extends far beyond trade. Although the US maintains military, technological, financial, and soft-power superiority, China has been steadily catching up, leading to bipartisan support in the US for a more confrontational approach.

Last October, US Vice President Mike Pence bluntly accused China of technology theft, predatory economic expansion, and military aggression. Pence's stance echoed the fears of the US national security community. As former US Defense Secretary Ashton Carter put it, "Because it is a Communist dictatorship, China is able to bring to bear on US companies and our trading partners a combination of political, military, and economic tools that a government such as ours cannot match. This puts us at an inherent disadvantage."

And yet America's tools are hardly useless. The US authorities have mobilized a broad range of domestic and international resources – from law and diplomacy to national security measures – to stop the overseas expansion of the Chinese telecommunications giant Huawei. If Western countries allow Huawei to build their 5G infrastructure, America's hawks and their allies argue, they will be vulnerable to cyber attacks from China in some future war.

All of this has shaken business and market confidence to the core, wiping out trillions of dollars in market capitalization. And the Trump administration's apparent insistence that countries choose sides in its dispute with China is further heightening fears. As the rest of the world's trading countries understand, Trump's approach will fragment business and reverse the globalization-enabled economies of scale that have fueled growth for decades.

More broadly, the Trump administration's rejection of multilateralism undermines the global cooperation needed to confront a range of issues, including migration, poverty and inequality, climate change, and the challenges raised by new technologies. Trump's focus on geopolitical rivalry – and the associated rise in security and defense spending – will dramatically reduce resources available for global public goods, such as infrastructure investment and poverty-reduction programs.

Ending the Sino-US trade war will require considerable statesmanship on the part of Trump and Chinese President Xi Jinping. But, beyond that, both sides need to recognize that supporting global peace and prosperity requires less ideology and more respect for diversity of political, social, and cultural systems. Failing that, the fault lines will continue to deepen – much as they did in the 1930s – potentially setting the stage for full-blown war.

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Gauging the Impact of US Tech War on China*

By DONG JINYUE AND XIA LE*

China-US tariff war likely comes to an end while a tech war looms large

After the outbreak of a tariff war between the US and China in mid-2018, global investors have been nervously watching for the trade relation between the two economic clouts and attempting to gauge the impact on global economy. At last, the two countries have successfully narrowed their difference in the aftermath of the Buenos Aires meeting between President Trump and Xi. Over the past couple of weeks, some positive signals emerged which lifted investors' hope that the US and China might end the ongoing tariff war soon. If materialized, the solution of the US-China tariff war will add impetus to the sluggish international trade.

However, the US is now waging a tech war against China on top of those punitive tariffs. As China has successfully become a competitive player in many high-tech areas, the US wants to ensure that its leading position at the tech frontier will not be challenged by China. Towards this end, the US has deployed a number of tactics on different fronts.

We could summarize the potential US tech war measures on China in the following aspects: (i) to selectively file lawsuits, on the basis of its long arm jurisdiction, against Chinese high-tech enterprises (ZTE, Huawei etc.) in a bid to thwart their efforts to climb on the global supply chain; (ii) to bind some requests together with the trade talks in attempt to halt China's grand plan of enhancing technical progress, for example the "Made in China 2025"; (iii) to press China to enhance domestic protection for intellectual property and allow the US companies to open their subsidies of full-ownership in China; (iv) in some cases, to directly ban American companies from exporting essential components to Chinese high tech companies; (v) to restrict Chinese firms from investing in the high tech sector of the US; (vi) to tightening the screening for Chinese students to study in science and technology disciplines in the US etc.

All in all, we deem that the US tech war, including the above stated various forms of US efforts to suppress the development of China's enterprises, is unlikely to come to a halt even after the two sides reach a deal to solve other trade disputes and lift punitive tariffs imposed on each other's exports.

It begs the question that to what extent the US tech war will hinder China's pace of climbing on global supply chain and drag down its growth. To answer this question, we employ an analytical framework of input-output table to explore the inter-sector linkage of high-tech sector on other sectors thus gauge the influence of China-US tech war on China's economic growth.

Headline figures show the increasing importance of the high tech sector in China…

Since China's accession to the World Trade Organization (WTO), its economy has witnessed a fast expansion of almost two decades. Notably, the growth in China is not only based on the accumulation in capital and labour input, but also based on the general gain on productivity. The productivity gain particularly reflects on the fast rise of China's high-tech sector. Nowadays, China-produced high-speed railway systems are sold globally. Even the advanced countries are considering importing China-invented 5G system to be used in their mobile networks. All these must seem unimaginable back to twenty years ago when China was still in the run-up of joining the WTO.

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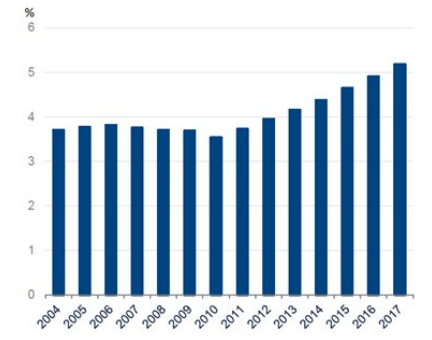
A straightforward way to measure the importance of China's high-tech sector to its economy is to calculate this sector's output relative to the total GDP. In China, this ratio has been rising steadily over time, from 3.7% in 2004 to 5.2% in 2017. (Figure 1) Moreover, China's high-tech exports also experienced a solid growth over the past decade. More importantly, the share of high-tech products to total exports steadily increased from 26.6% in 2010 to 28.5% in 2018. (Figure 2)

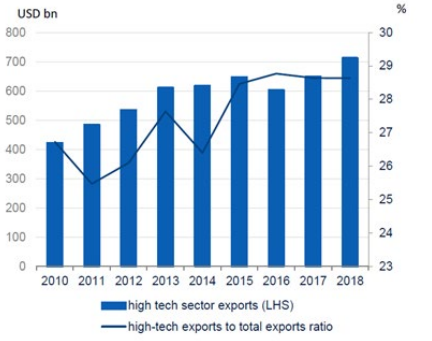
On top of the increasing high tech sector's GDP ratio and its export share, the employees in high tech sector have also increased over time (Figure 3), mainly due to the improvement in higher education domestically and the favourable policies to attract the talents with foreign educational background in high-tech related disciplines. In addition, the number of patents applied in China also has rocketed significantly, with its number significantly surpassing that of some other developed countries such as US, Japan, and Germany, although the quality of Chinese filed patents might not be very high for the moment. (Figure 4)

Figure 1 The ratio of high tech sector's GDP to total GDP has been rising over time



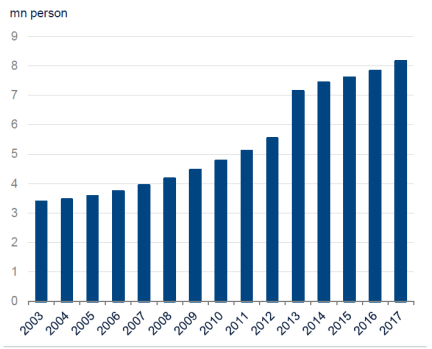
Source: BBVA Research and CEIC

Figure 2 China's high tech sector exports have increased for the past decade, so has its ratio to total exports



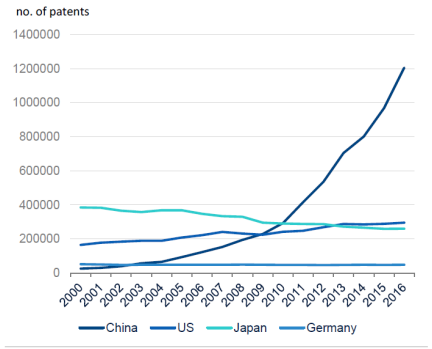
Source: BBVA Research and CEIC

Figure 3 Number of employees in high tech sector has also increased over time…



Source: BBVA Research and CEIC

Figure 4 …so has the number of patent applications in China, outnumbering many advanced countries



Source: BBVA Research and CEIC

··· while they are subject to bias

Although the figures shown in above charts are very informative, they are subject to bias. First, the export data only reflects the final products for shipment which includes contents not produced in the country. It is especially relevant since China has been famous for its processing exports. For many high-tech products, Chinese enterprises might just import the key elements from other countries and then use Chinese cheap labours to assemble them for export. Therefore,

we cannot jump to the conclusion of China becoming more competitive in their high-tech exports by just comparing its shipment figures.

Second, the figure of high-tech sector's contribution to total GDP is based on the final output of the sector, which tends to ignore the important inter-sector linkages. As such, this ratio could underestimate the importance of a sector to the entire economy if its linkage with other sectors is strong.

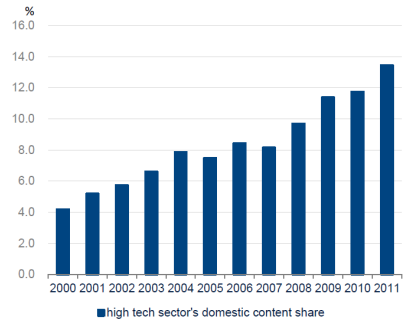
Analysis based on input-output table

Fortunately, based on the OECD TiVA database, we are able to derive important information with respect to the adding value of different sectors, which enables us to further gauge the relative importance of the high tech sector to the aggregate economic activities as well as the potential impact of China-US trade war on Chinese growth.

Indeed, the OECD TiVA database provides a Chinese input-output table of 35 sub-sectors. To define our high-tech sector for China, we combine 4 sub-sectors in the OECD TiVA database, namely sector D26--- computer, electronic and optical products; sector D27--- Electrical equipment; sector D 61---Telecommunications and sector D62T63--- IT and other information services. Based on this, we restructure the input-output table to form a new one of 32 sub-sectors including a self-defined high-tech sector.

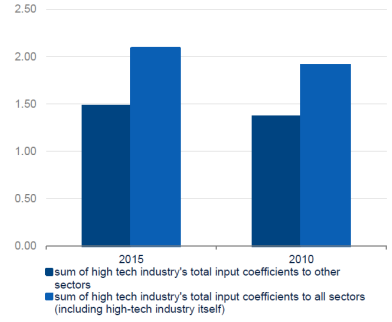
The OECD TiVA database directly provides an indicator of domestic content of China's high-tech exports, which rose swiftly during the period of 2000-2011. (Figure 5) We believe that such an uptrend continues until now. This indicator provides more reliable evidence that China is climbing on the global value chain by advancing their technologies. It also explains why the US, as well as other advanced economies albeit to a less extent, have become more concerned about China and are pushing China to play a fairer game in the global competition of the high tech sector.

Figure 5 The ratio of high tech sector exports' domestic content rose over time based on OECD TiVA database



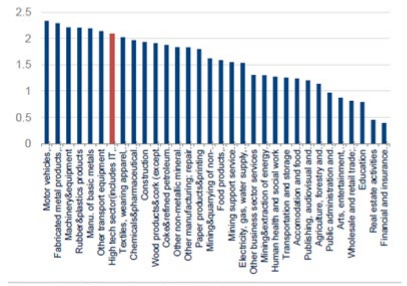
Source: BBVA Research and OECD TiVA

Figure 6 Comparison of high tech sector's importance to other sectors: 2010 vs. 2015



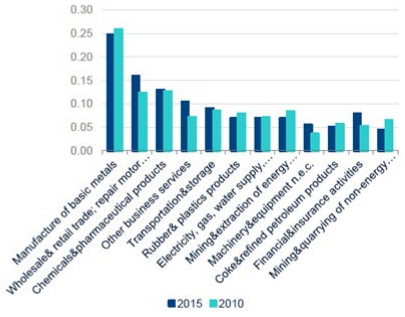
Source: BBVA Research and CEIC

Figure 7 Sum of each sector's total input coefficients: high tech sector ranks 7th, among the highest ones



Source: BBVA Research and OECD TiVA database

Figure 8 High tech's total coefficients to other sectors based on input-output table analysis



Source: BBVA Research and OECD TiVA database

Moreover, through the typical input-output table matrix calculations (see Technical APPENDIX in a separate pdf file), our input-output table analysis yields more interesting findings about China's high tech sector. Specifically, we calculate the total input coefficient, a typical concept in input-output analysis, which illustrates how much output from each sector is used as intermediate inputs to meet one unit of increase in the final demand of the high tech sector, with both direct and indirect effects considered. This is indeed a good summary of inter-sector linkages which captures not only the final demand linkage but also the linkages through intermediate demand.

Our findings from this input-output table analysis can be summarized in the following three aspects:

First, high tech sector's linkage with other sectors has been strengthening over time. (Figure 6) In particular, the sum of high tech sector's total input coefficients to other sectors (both including and not including high sector itself) have increased from 2010 to 2015. In particular, the 2010 total input coefficient is 1.8, indicating that one USD increase of the final demand of high tech sector results in a change in the economy's total output by 1.8 USD. This includes the initial dollar change (1 USD) in high tech sector's final demand (direct effect) and changes in the outputs of other related sectors to support the initial dollar change in high tech sector output (indirect effect) (0.8 USD). By 2015 this figure rose to 2.2, indicating that the high tech sector will consume more intermediate inputs from other sectors. It shows that the importance of China's high tech sector has been on the rise in terms of its stronger derived demand on other sectors.

Moreover, we observe that high tech sector ranks the 7th, among all of 32 sectors. This indicates the importance of the high tech sector to the economy in terms of its spill-over effect to other sectors. (Figure 7)

Second, we find that the spill-over effects of the high tech sector are in particular strong in a number of other sectors, including: manufacturing of basic metals, wholesale and retail trade, chemicals and pharmaceutical products, other business service and transportation and storage. In addition, for most of the sectors, the linkage with the high tech sector has been strengthening over time, corroborating our first result. (Figure 8)

Last, we also explore the relative importance of high tech sector by estimating the loss in the economy's total gross output caused by a hypothetical elimination of the linkage of high-tech sector with other sectors. (See details in Technical APPENDIX) Our result shows that the Chinese economy's total gross output would be around 10.8% less if we shut down high-tech sector's linkage with other sectors, based on the input-output table of 2015.

A scenario analysis: how will the tech war affect China's growth?

With the results of input-output table analysis at hand, we are able to gauge the impact of the US-initiated tech war on China's growth. Towards this end, we employ a scenario analysis approach, in which we defined three scenarios corresponding to different growth rates of China's high tech sector.

In the first scenario we assume a growth rate of 13.4% in China's high tech sector, which is the average annual growth during the period of 2010-2015. In our analysis, scenario 1 is treated as a benchmark without tech war risk.

In the second scenario, we assume the growth rate of the high tech sector decrease to 6.2%, the historical low of 2010-2015 due to the US tech war against China.

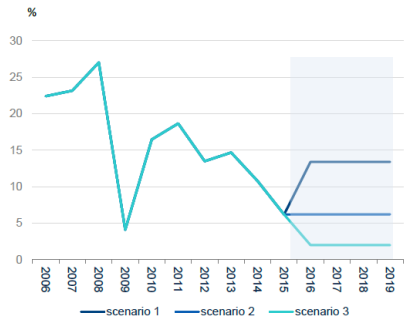
In the third scenario, the growth rate is assumed to decelerate to 2%, reflecting more adverse environment stemming from the tech war. (Figure 9)

Based on our total input coefficient result as displayed in the previous section (Figure 6), we assume that this coefficient is constant throughout 2015 to 2019. It indicates that one dollar increasing in final demand of high tech sector will lead to an increase of 2.2 dollars in total gross output of the economy.

In Figure 10 we display the size of total gross output increase with respect to the growth of high tech sector under three scenarios. Indeed, what we concern here is not the size but rather the gaps of gross output increase between different scenarios. If we treat scenario 1 as the one without the disturbance of the tech war, the gaps of scenario 2 and 3 relative to scenario 1 can reflect to what extent the tech war affects the total gross output of Chinese economy.

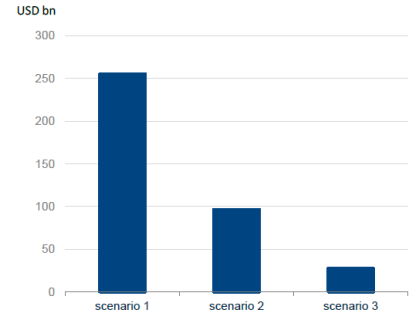
We estimate that a tech war risk will decrease the total gross output in China by 0.54%, or USD 158.6 billion if it slows the growth of high tech sector to 6.2% from 13.4% (scenario 2). In a worse case (scenario 3), China's total gross output could be slashed by 0.78%, or USD 227.7 billion if its growth of high tech sector decelerated to 2% due to the escalation of the trade war.

Figure 9 The assumptions of three scenarios of high-tech sector growth rate



Source: BBVA Research and OECD TiVA database

Figure 10 The comparison of the three scenarios of 2019: impact on total gross output



Source: BBVA Research and OECD TiVA database

Conclusion

Although the US-China tariff war is likely to come to an end soon, a tech war between these two economic and tech clouts are looming large. In this report, we try to quantify to what extent that China-US tech war will drag on Chinese economic growth based on input-output table analysis.

By use of data provided by OECD TiVA database, we find that the high tech sector has become increasingly important to the Chinese economy due to its strengthening linkage with other sectors, also suggesting that Chinese enterprises are climbing up the global supply chain.

In particular, the total input coefficients, which gauge how much output from each sector is used as intermediate inputs to meet one unit of increase in the final demand of the high tech sector, have steadily risen over time from 2005 to 2015.

We further set up three scenarios to analyse to what extent the risk of China-US tech war weighs on China's aggregate output. Our results suggest that a tech war risk will decrease China's annual total gross output by 0.54% and 0.78% respectively if its high tech sector growth slows to 6.2% and 2.0% from the previous normal level of around 13.4%.

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Monetary Policy

Questions over Fed Dovishness*

By MARK SOBEL*

The Federal Open Market Committee's decision to pause rate increases was long telegraphed and widely expected. But the highly dovish messaging in the Federal Reserve statement and press conference by Chair Jerome Powell surprised markets. The reasoning for the sharp shift in Fed rhetoric between December and January remains elusive. Fed speakers will have an opportunity in coming weeks to shed greater light on the extent of the pivot.

The Fed is a hallowed US institution. The staff is uniformly excellent and first rate. The board is extraordinarily strong. Pause, patience, flexibility and data dependence had already appropriately become the Fed's watchwords. The late January 'pause' was a done deal. But the board statement and press conference were perceived as going much further. The Fed's tightening bias was dropped by removing language about the risks being roughly balanced and the indication that the next rate move could be just as well up or down. The Fed suggested its balance sheet will remain large and could be more proactively adjusted in the future.

Juxtaposed against this background, the FOMC statement reaffirmed its baseline economic outlook, noting sustained expansion of economic activity, strong labour market conditions and inflation near the symmetric 2% objective were the most probable outcomes. From the standpoint of the Fed's dual mandate, labour markets are quite strong, but price pressures remain muted, providing ample space for a 'pause'.

To reconcile an unchanged baseline view with highly dovish messages, the Fed pointed to increased downside risks.

Many of these are external – China, Europe and Brexit. China's slowdown may be more severe than thought, but Beijing is injecting significant stimulus, which should help stabilise conditions. The European forecast has only been marked down a few tenths of a percentage point, and Brexit remains a longstanding, though still unfinished, saga.

The greater attention seemingly being paid by the Fed to global developments in recent years in its monetary policy reaction function is welcome. Nevertheless, given the still positive US baseline outlook, the relatively closed nature of the US economy and the modest markdowns in global growth, it is hard to see that the slightly weaker global economic outlook, absent associated financial stress or shock, provides sufficient rationale for the sharp change in rhetoric.

Uncertainties from President Donald Trump's trade wars and protectionist rhetoric are another downside factor, but the mood around discussions with China has brightened. The US government shutdown was extraordinarily unwise, but its macroeconomic impact will be short-lived and recouped.

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*This article appeared on OMFIF Commentary on February 13, 2019.
*Mark Sobel is US Chairman of OMFIF.

Volatility in financial markets and conditions could explain increased downside risks. Stock markets were hammered in December amid the president's unwarranted attacks on the Fed, public rebukes of Chinese trade practices, and shutdown politics. But stocks had rebounded quite nicely by the time of the January FOMC meeting and yields (Treasury 10-year) had also come down to 2.7% from around 3.2% in November. Moreover, the fed funds rate in the Fed's view still remains at the bottom of the neutral range. Overall US financial conditions are still not tight.

As the end to balance sheet normalisation appears on the horizon, it will behove the Fed to provide greater clarity to markets. But it is not clear that time is currently approaching, as opposed to later in 2019. Further, a larger future Fed balance sheet, certainly in contrast with pre-2008 crisis days, was widely expected given bank demands for high quality liquid assets and the Fed's need to control short-term interest rates. But here too, it is difficult to reconcile balance sheet normalisation as a factor contributing to financial market volatility, when new issuance emanating from the massive and unfortunate increase in the US fiscal deficit swamps the impact of normalisation.

On balance, the messaging at the end-January FOMC meeting was very dovish and stood in stark contrast to that in mid-December. The Fed stood behind its baseline US economic outlook. The downside risks it pointed to provide a firm basis for the 'pause' and more generally the shift towards 'patience', 'flexibility' and 'data dependence'. But these risks together do not yet seemingly add up to an adequate explanation for the extent of the shift. Hopefully the Fed will in the coming weeks provide a more fulsome explanation.

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Missing Out on Monetary Normalisation*

By DAVID MARSH*

It wasn't supposed to turn out like this. Thursday's European Central Bank announcement of more stimulus for euro area bank lending and postponement until at least 2020 of its first post-financial crisis interest rate increase could mean the ECB will miss out a cycle of monetary normalisation.

Mario Draghi, the ECB president, will bow out at the end of October, after eight years, as the first head of a German-based central bank for 20 years to leave office without raising interest rates. His earlier plan, looking decreasingly likely in the past two years, had been to depart after launching a gradual rise in interest rates to help his successor weather what will be a difficult transition.

Draghi is following, to many observers, what is a surprising precedent. Hans Tietmeyer, the Bundesbank president otherwise known for monetary orthodoxy, in charge in 1993-99, never raised interest rates, reflecting a steady alleviation of monetary pressures in Europe on the path to monetary union in 1999.

The governing council's unanimous decision exposes the ECB to three sets of pressures which will further weigh on the man (it is highly unlikely to be a woman) taking over from Draghi. The one helpful factor for ECB continuity is that the governors who agreed another round of long-term refinancing operations, as well as the delayed tightening, included the four heads of the German, French, Dutch and Finnish central banks, who are all contenders for Draghi's job.

The biggest risk is that the ECB will be bereft of monetary ammunition when and if the US Federal Reserve starts to ease interest rates in response to a further slowing of the US economy – or even a recession – later in 2019 or next year.

ECB watchers have long worried that, unless the central bank can raise interest rates before the next downturn, Europe will have no more conventional monetary instruments to fight a recession. This will raise pressure for further quantitative easing in Europe, despite heavy opposition in Germany – all the more intense because massive government bond purchases since 2015 have failed to raise inflation back towards the ECB's medium-tern target of close to 2%.

The second source of problems is that Draghi, may end up being blamed for making a bad situation worse. The apparent reversal from the ECB's avowed intent to shrink its balance sheet after ending QE in December may be a sensible adjustment. Yet Draghi's reference to the 'persistence of uncertainties' over geopolitics, protectionism and emerging markets may heighten gloom. The downbeat December statement about 'angst' by Jay Powell, Fed chairman, had a similar effect.

The third issue is political. The International Monetary Fund, the French government and the ECB have been joining forces – so far to little avail – to persuade Germany to adopt more Europe-orientated economic measures to help longer-term euro area stabilisation.

Benoît Coeuré, an ECB board member, warned last year that Germany would have to increase efforts for risk-sharing to prevent the bank having to take more extraordinary action when the next crisis strikes. Euro area reform, including setting up a European Monetary Fund, adopting a significant pro-growth euro area budget and pooling instruments for bank deposit insurance, has

*This article first appeared in OMFIF Commentary on March 13, 2019.
*David Marsh is Member of IMI International Committee and Chairman of OMFIF..

lost nearly all traction in the past 12 months.

However, particularly if the German economic picture worsens and Italian tensions intensify, the German government will face further calls for affirmative European action in the next few months.

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Global Economy

Proper Perspective on Emerging Risks*

By CHRISTOPHER SMART *

You can hear the bearishness in everyone's voices. They don't trust a cycle this old. They won't fight the Federal Reserve. They fear a market swoon in a world of unstable politics.

Risks are mounting, as indicated by recent data signalling slight economic contractions in Germany and Japan. But for now, monetary, fiscal and political headwinds hardly seem strong enough to induce a global recession.

If the biggest market worry centres on the Fed, that should begin to dissipate early this year. Rates are rising and debt service is growing more expensive, but how probable is it that US monetary policy is really 'behind the curve'? Wages and tariffs may be nudging some prices higher, but energy and technology prices are falling.

Most forecasts have core inflation hovering just above 2%, which suggests the end of the current tightening cycle is in sight. The Federal Open Market Committee seems to be heading slowly and tentatively towards a 3% fed funds rate at the end of next year if the 'dot plots' hold, but futures markets are pricing in lower rates.

Meanwhile, monetary accommodation reigns in Europe, Japan, China and beyond. And long-term demographic trends and new technologies seem likely to keep any inflationary spikes in check.

The second major cyclical worry comes from the US federal budget, which seems less predictable than ever. There is a lot of talk about the budget deficit that is set to reach $1tn this year, but there is also little determination from either political party to raise taxes or cut spending as they prepare for the 2020 presidential election.

This means US firms should not expect fresh tax cuts to boost their earnings. That being said, they probably did not pass the full 2017 cuts through to earnings in 2018, and may therefore enjoy reserves to support 2019's results. More importantly, they should expect steady domestic demand supported by continued low unemployment and strong household balance sheets.

One key trend to watch will be the prospect for rising productivity that should come from higher business investment. Recent US investment figures have been weak, and further weakness could undermine earnings beyond next year. But that, too, is probably a longer-term concern.

Meanwhile, fiscal policy globally has been generally supportive in large economies like China, Japan and even Germany. It may not be enough to accelerate global growth, but it is hardly contractionary.

Even if you are comfortable with the growth and inflation outlook, a long list of political risks looms. The trick in these polarised times is to disaggregate political preferences from economic

*This article first appeared in OMFIF Commentary on January 22, 2019.
*Christopher Smart is Head of Macroeconomic and Political Research at Barings.

analysis. Democrats tend to magnify risks to the economy that might undermine President Donald Trump's re-election campaign. Republicans tend to pin outsized hopes on tax cuts and deregulation.

For the current cycle, the most important political theatre to watch in Washington involves the standoffs over the debt limit and government funding. These may trigger market gyrations, but the disruptions shouldn't be enough to tip the US economy into recession.

In Europe, Britain's new relationship with the European Union will (we hope) become clearer well before the official Brexit date of March 29, though this may require an extension of negotiations. Italy is Europe's biggest challenge; there is not enough money to bail out the Italian economy if the government loses the confidence of bond markets. But the country's debts are long-term and mainly held domestically. The budget standoff is real, but likely to subside as politicians turn their attention to European parliamentary elections that carry few direct market consequences.

The largest political risk for the global economy could be the deepening trade frictions between the US and China. Following the G20 summit at the end of November 2018, both Washington and Beijing gave bullish reports on the negotiations. Still, nagging issues around China's economic subsidies and protection of intellectual property will not be resolved quickly.

But the greatest damage from tariffs is likely to come over the very long term, as companies reassess their investment priorities amid rising trade barriers. The near-term impact of tariffs on global growth should remain limited, as both the Chinese and US economies depend overwhelmingly on internal demand.

There is plenty of room for unpleasant surprises, especially from higher debt servicing costs and continuing pressures on some emerging markets. Still, it is important to keep these risks in proper perspective against a global economy that is slowing, but still very strong, and political tensions that are distracting, but unlikely to trigger recession.

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Determinants of Capital Flows to Emerging Market Economies*

By KYUNGHUN KIM*

Theoretically, capital market integration allows people to share the country-specific risks by holding foreign assets, and contributes to economic growth especially for emerging market economies (hereafter EMEs) at their early stages of development. At the same time, there are also some problems caused by capital market integration. As we experienced during the global financial crisis (GFC), financial shocks originating from the center country can be rapidly transmitted to peripheral countries through the integrated financial market. Volatile cross-border capital inflows and outflows impede efforts to maintain financial stability, which eventually stunts economic growth by incurring financial crises.

Though some monetary authorities in EMEs implemented capital controls or macroprudential policy measures after the GFC to mitigate the procyclicality of credit cycles, the common factors in the global financial market still play a crucial role in determining capital flows to EMEs. In academia, the relationship between common factors in the global financial market and their impact on capital flows to EMEs has been a long-debated issue. This is mainly concerned with the major determinant of capital flows between push and pull factors.

The push factor represents common factors which exist in the global financial market. These are interest rates and GDP growth rates of advanced economies (hereafter AEs), global risk factors such as measured by the S&P 500 Volatility Index (VIX), and commodity price index. The pull factor denotes domestic factors that attract funds from the global financial market to domestic financial markets. These are domestic interest rates, domestic GDP growth rates, and other country-specific characteristics.

Kang and Kim (2018) revisited this issue regarding the push and pull factors of capital inflows. They consider the heterogeneity existing in EMEs by dividing them into four subgroups and then investigate the main driver of capital inflows between push and pull factors across country groups. According to their empirical results, the push and pull factors play a different role in determining capital flows to AEs and EMEs. The major drivers of capital flows to AEs are both push and pull factors, but the push factor turns out to be the main determinant of capital flows to EMEs. When EMEs are divided into four subgroups, there is a sizable heterogeneity across subgroups.

Two policy implications may be derived based on the empirical results in Kang and Kim (2018).

First, it might lead to unexpected results if EMEs simply follow uniform policy recommendations suggested by international organizations such as the IMF, because the capital market heterogeneity between EMEs is substantial. Therefore, individual countries need to find effective policy instruments appropriate to the financial market environment of their country.

Second, Korea is classified as an advanced economy by the IMF and a number of other international organizations. However, it should not be overlooked that Korea has the characteristics of a small open economy. Therefore, it is necessary to make efforts to secure the

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most effective policy instruments while complying with the obligations and agreements required of developed countries. The OECD has opposed to the use of capital flow management measures by its member states. G20 platform needs to discuss ways to activate alternative policy instruments such as macroprudential policy measures to cope with the financial crisis.

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Hyperinflation: a Kaleidoscope of Uses and Abuses *

By STEVE H. HANKE*

The word "hyperinflation" is sprinkled throughout the press each day. We read that Iran is hyperinflating. The same is written about Zimbabwe and Venezuela, as well as a potpourri of other countries that are experiencing inflation flare ups. While Iran came close to a hyperinflation in the fall of 2012, it has never experienced an episode of hyperinflation. And, while Zimbabwe experienced hyperinflation episodes in 2007-2008 and 2017, it is not hyperinflating now. At present, Venezuela is the only country experiencing a hyperinflation. It's clear that journalists and those they interview tend to play fast and loose with the word "hyperinflation."

To clean up the hyperinflation landscape, we must heed the words of the great Eugen von Böhm-Bawerk, one of the founders of the Austrian School of Economics, who, in 1891, wrote "…We too must bring into our science a strict order and discipline, which we are still far from having. [B]y a disorderly and ambiguous terminology we are led into the most palpable mistakes and misunderstandings — all these failings are of so frequent occurrence in our science that they almost seem to be characteristic of its style."

Yes. Nothing cleans up ambiguity and disorder better than clear definitions. So, just what is the definition of the oft-misused word "hyperinflation?" The convention adopted in the scientific literature is to classify an inflation as a hyperinflation if the monthly inflation rate exceeds 50%. This definition was adopted in 1956, after Phillip Cagan published his seminal analysis of hyperinflation, which appeared in a book edited by Milton Friedman, *Studies in the Quantity Theory of Money*.

Since I use high-frequency data to measure inflation in countries where inflation is elevated, I have been able to refine Cagan's 50% per month hyperinflation hurdle. With improved measurement techniques, I now define a hyperinflation as an inflation in which the inflation rate exceeds 50% per month for at least thirty consecutive days.

After years of research with the help of many assistants, I have documented, with primary data, 58 episodes of hyperinflation. Those episodes are listed in the "Hanke-Krus World Hyperinflation Table" (2013, Amended 2017) below.

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The Hanke-Krus World Hyperinflation Table
(2013, Amended 10/2017)

Location	Month with Highest Inflation Rate	Highest Monthly Inflation Rate	Time Required for Prices to Double
Hungary	Jul. 1946	4.19×10^{16}%	15.0 hours
Zimbabwe	Mid-Nov. 2008	7.96×10^{10}%	24.7 hours
Yugoslavia	Jan. 1994	313000000%	1.41 days
Republika Srpska	Jan. 1994	297000000%	1.41 days
Germany	Oct. 1923	29500%	3.70 days
Greece	Oct. 1944	13800%	4.27 days
China	Apr. 1949	5070%	5.34 days
Free City of Danzig	Sep-23	2440%	6.52 days
Armenia	Nov. 1993	438%	12.5 days
Turkmenistan	Nov. 1993	429%	12.7 days
Taiwan	Aug. 1945	399%	13.1 days
Peru	Aug. 1990	397%	13.1 days
Bosnia and Herzegovina	Jun. 1992	322%	14.6 days
France	Mid-Aug 1796	304%	15.1 days
China	Jun. 1945	302%	15.2 days
Ukraine	Jan. 1992	285%	15.6 days
Poland	Oct. 1923	275%	16.0 days
Nicaragua	Mar. 1991	261%	16.4 days
Congo (Zaire)	Nov. 1993	250%	16.8 days
Russia	Jan. 1992	245%	17.0 days
Bulgaria	Feb. 1997	242%	17.1 days
Moldova	Jan. 1992	240%	17.2 days
Venezuela	Nov. 2016	219%	17.9 days
Russia / USSR	Feb. 1924	212%	18.5 days
Georgia	Sep. 1994	211%	18.6 days
Tajikistan	Jan. 1992	201%	19.1 days
Georgia	Mar. 1992	198%	19.3 days
Argentina	Jul. 1989	197%	19.4 days
Zimbabwe	Oct. 2017	185%	20.1 days
Bolivia	Feb. 1985	183%	20.3 days
Belarus	Jan. 1992	159%	22.2 days
Kyrgyzstan	Jan. 1992	157%	22.3 days
Kazakhstan	Jan. 1992	141%	24.0 days
Austria	Aug. 1922	129%	25.5 days
Bulgaria	Feb. 1991	123%	26.3 days
Uzbekistan	Jan. 1992	118%	27.0 days
Azerbaijan	Jan. 1992	118%	27.0 days
Congo (Zaire)	Nov. 1991	114%	27.7 days
Peru	Sep. 1988	114%	27.7 days
Taiwan	Oct. 1948	108%	28.9 days
Hungary	Jul. 1923	97.90%	30.9 days
Chile	Oct. 1973	87.60%	33.5 days
Estonia	Jan. 1992	87.20%	33.6 days
Angola	May-96	84.10%	34.5 days
Brazil	Mar. 1990	82.40%	35.1 days
Democratic Republic of Congo	Aug. 1998	78.50%	36.4 days
Poland	Jan. 1990	77.30%	36.8 days
Armenia	Jan. 1992	73.10%	38.4 days
Tajikistan	Nov. 1995	65.20%	42.0 days
Latvia	Jan. 1992	64.40%	42.4 days
Turkmenistan	Jan. 1996	62.50%	43.4 days
Phillipines	Jan. 1944	60.00%	44.9 days
Yugoslavia	Dec. 1989	59.70%	45.1 days
Germany	Jan. 1920	56.90%	46.8 days
Kazakhstan	Nov. 1993	55.50%	47.8 days
Lithuania	Jan. 1992	54.00%	48.8 days
Belarus	Aug. 1994	53.40%	49.3 days
Taiwan	Feb. 1947	50.80%	51.4 days

Source: Hanke, Steve H., and Erik Bostrom. "Zimbabwe Hyperinflates, Again: The 58th Episode of Hyperinflation in History." Studies in Applied Economics, no. 90(2017). Johns Hopkins Institute for Applied Economics, Global Health, and the Study of Business Enterprise, 19 Oct. 2018. Web. https://sites.krieger.jhu.edu/iae/files/2018/07/Zimbabwe-Hyperinflates-Again-Hanke-Bostrom-.pdf

Hungary holds down the top spot. Its peak hyperinflation occurred in July 1946, when prices were doubling every 15 hours. Zimbabwe's November 2008 hyperinflation peak is second highest, but way behind Hungary's. Indeed, at their peaks, the daily inflation rates were 207% in Hungary and 98% in Zimbabwe. The most memorable hyperinflation was Germany's. But, it only ranks as the fifth highest, with a peak daily rate of inflation of 20.9% — way lower than the top four rates.

Now, let's turn to the world's only current hyperinflation: Venezuela. It ranks as the 23rd most severe. Today, the annual rate of inflation is 120,810%/yr. While this rate is modest by hyperinflation standards, the duration of Venezuela's hyperinflation episode, as of today, is long: 27 months. Only four episodes of hyperinflation have been more long-lived.

So, how do we accurately measure hyperinflations? Well, let's take a look at Venezuela's case. There is only one reliable way to measure. The most important price in an economy is the exchange rate between the local currency — in this case, the bolivar — and the world's reserve currency, the U.S. dollar. As long as there is an active black market (read: free market) for currency and the data are available, changes in the black-market exchange rate can be reliably transformed into accurate measurements of countrywide inflation rates. The economic principle of purchasing power parity (PPP) allows for this transformation. And, the application of PPP to measure elevated inflation rates is rather simple.

Evidence from Germany's 1920-1923 hyperinflation episode — as reported by Jacob Frenkel in the July 1976 issue of the Scandinavian Journal of Economics — confirms the accuracy of PPP during hyperinflations. Frenkel plotted the Deutschmark/U.S. dollar exchange rate against both the German wholesale price index and the consumer price index (CPI). The correlations between Germany's exchange rate and the two price indices were very close to unity throughout the period, with the correlations moving to unity as the inflation rate increased.

Beyond the theory of PPP, the intuition of why PPP represents the 'gold standard' for measuring inflation during hyperinflation episodes is clear. All items in an economy that is hyperinflating are either priced in a stable foreign currency (the U.S. dollar) or a local currency (the bolivar). If goods are priced in terms of bolivars, those prices are determined by referring to the dollar prices of goods, and then converting them to local bolivar prices after checking with the spot black-market exchange rate. Indeed, when the price level is increasing rapidly and erratically on a day-by-day, hour-by-hour, or even minute by-minute basis, exchange rate quotations are the only source of information on how fast inflation is actually proceeding. That is why PPP holds, and why we can use high-frequency (daily) data to calculate Venezuela's inflation rate, even during episodes of hyperinflation.

Even though we can measure hyperinflation very accurately using PPP, no one has ever been able to forecast the magnitude or direction of hyperinflations. But, that hasn't stopped the International Monetary Fund (IMF) from producing forecasts for hyperinflation in Venezuela. Even though the IMF does not measure Venezuela's hyperinflation, something that can be reliably done, the IMF does forecast hyperinflation, something that cannot be reliably done. Indeed, forecasts for hyperinflation can't be found in the scientific literature.

That impossibility hasn't stopped the IMF from throwing economic science to the winds. Yes, the IMF has regularly been reporting what are, in fact, absurd inflation forecasts for Venezuela. These forecasts have been issued under the watchful eye of Alejandro Werner, the head of the IMF's Western Hemisphere Department. The chart below presents the IMF's finger-in-the-wind forecasts (read: nonsensical folly).

The IMF's 2018 Year-End Inflation Projections for Venezuela

Date of Projection	IMF Inflation Projection[1]
October, 2018	2,500,000%
July, 2018[2]	1,000,000%
April, 2018	12,874.6%
October, 2017	2,529.6%
April, 2017	2,529.6%

[1] These are the International Monetary Fund's year-end inflation projections for 2018 found in the biannual World Economic Outlook reports for 2017 and 2018.
[2] On July 23, 2018, in the IMF Blog, "Outlook for the Americas: A Tougher Recovery," Alejandro Werner, Director of the Western Hemisphere Department of the IMF, revised Venezuela's projection.

Surprisingly, the press dutifully reported the IMF's forecasts that Venezuela's annual inflation rate would hit a whopping 2,500,000% by the end of 2018. In some cases, this figure was reported as a forecast, which it was. By some, it was even reported as an actual measurement, which it was not. In any case, the IMF's 'guestimation' was a bit off. I measured Venezuela's annual inflation rate on December 31, 2018, and it was 80,000%/yr. When it comes to hyperinflation and its abuses, there is no one more guilty of malfeasance than the IMF. It repeatedly produces what no one can produce: reliable forecasts of hyperinflation.

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Financing Emerging Asia Infrastructure*

By JANG PING THIA*

The private sector must redouble efforts to finance infrastructure projects in emerging Asia. Multilateral development banks are critical to mobilising this capital. Beyond co-financing, they can help improve project preparation and reduce project risks, a valid concern for investors when dealing with perceived geopolitical or policy uncertainty. Greater risk-sharing between financiers can cushion the impact from higher borrowing costs.

Despite much discussion and effort, private capital is still not playing the role it can or should. Structural issues around bankability, coupled with short-term challenges, threaten to hold back private sector participation.

In the light of macroeconomic uncertainty, multilateral institutions such as the Asian Infrastructure Investment Bank can bolster fiscally-sustainable public investment, given their ability to lend counter-cyclically and take longer-term exposures.

Cross-border infrastructure can support trade and development that fosters income growth. Increased rail connectivity in central Asia could enable further Europe-China trade and integrate central Asia with other regions. It is estimated that $38bn in investment is required between now and 2030 for rail upgrades and new lines. Better infrastructure, together with investments in productive sectors, can also promote a more sustainable trade structure between Latin America and Asia.

Information and communication technology can facilitate integration. However, some Asian economies are at risk of falling behind in basic ICT to support trade. They require more investment support from the international community.

Tourism flows to and from Asia, as well as within the region, are rising quickly in line with incomes. This will require sustainable airport infrastructure and fuels to support industry growth. With improved aircraft technology, there will also be opportunities for more direct connections between Asia and Latin America, facilitating services trade such as tourism and activities involving face-to-face interactions.

Project financing is at an inflection point. Geopolitical tensions, rising nationalism and macroeconomic developments are adding uncertainty to the sourcing and continuity of infrastructure investment. Data show that private sector participation in project financing has stagnated or declined in recent years. Stakeholders in the infrastructure sector will face a markedly different situation in the coming years.

Interest rates will rise as central banks continue to normalise policy, propelling a flight to quality. The combination of remaining liquidity in the system, higher cost of capital and the potential impact from the implementation of Basel III and International Financial Reporting Standard 9, which may make banks more risk-averse in terms of long-term lending, could lead to a divergence in lending costs. There will be a widening credit spread between projects with strong contracts, government backing and multilateral development banks' involvement, and those without.

Trade frictions and market volatility have increased uncertainty around project pipelines. Sustained trade tensions will cause a shift in supply chains, potentially affecting long-term infrastructure and economic development plans. Currency volatility in some emerging markets

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will impact the transaction pipeline, as governments delay projects with a view to protecting their currencies or reducing government expenditure.

As major economic infrastructure is sometimes classified as a national strategic asset, sponsors and lenders are likely to be more prudent in building such assets. Increased geopolitical uncertainty and shifts in terms of sources of infrastructure financing, as well as broader trade and political partnerships, are also likely to accentuate such sensitivity. Many Asian economies will see national elections in 2019, which could induce investors to bide their time.

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China

China Needs to Overhaul Its Financial Sector to Ease Rebalancing*

By LIU JUN*

China's economy is slowing down. Both official statistics and people's daily experience appear to tell the same story. Disappointing retail sales figures for November spooked investors, deepening anxiety about the economy.

However, closer scrutiny reveals that the structure of Chinese output is actually improving, with consumption growing as a share of gross domestic product, while investment and exports fall. The trends show that China is on the right path, rebalancing its economy away from high-speed growth to high-quality development.

Recent research from the OECD also suggests that knowledge-intensive service sectors are growing faster than labour-intensive ones. Investment in science, technology and innovation has grown steadily, with China overtaking Japan and the EU in 2014 to become the world's second-largest spender on research and development.

The poor retail sales figures can partly be attributed to the effects of technological progress. The new digital economy is substantially reshaping traditional notions of product and service. Intermediate products and services that were once indispensable are now cut off from the value chain, and end users no longer need to pay for the considerable cost of those mediating links.

China is at the forefront of the so-called sharing economy and digital transformation more broadly, leading the way in the development of Big Data and artificial intelligence. It is a pioneer in technologies that allow customers' needs to be identified more precisely and satisfied more quickly, without them necessarily having to pay any more.

There is a cultural aspect to this, too. A do-it-yourself ethos and an emphasis on self-sufficiency run deep in the Chinese national character. This is one reason why the sharing economy, peer-to-peer models of market exchange and ecommerce platforms have already been so successful in China, and why they are set to go from strength to strength in the future. It is clear that Chinese consumers will continue to play the roles of producers and service providers themselves quite happily.

While slowing retail growth should not be a big concern, the real issue for policymakers in Beijing is to maintain the momentum of consumption and of the economy as a whole.

Classical economic theory stresses the importance of credit creation and money supply. Given that China's real economy currently relies heavily for financing on commercial bank lending, credit expansion and the injection of liquidity ought to benefit both the retail sector and the wider economy.

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*This article first appeared on FT March 18, 2019.

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Hence proposals from policymakers, including a stimulus package of active fiscal policy and neutral-to-loose monetary policy. However, it is important to see the bigger picture. Substantial improvements to China's financing structure are essential.

First, reducing the overdependence on commercial bank lending is central. Commercial banking was a product of the industrial revolution and was the major engine of financing throughout the industrial age. But it is clearly less relevant in the digital era, which is characterised by increasing "disintermediation", in which investors and borrowers bypass banks to tap capital markets directly.

In China, bank loans account for a substantial proportion of corporate funding. Most bank liabilities are individual savings and corporate deposits. But tech-oriented start-ups tend to fund themselves using equity investment, meaning they are not a good match for commercial banks.

While commercial banks should continue to service basic financial needs, they must also seek to develop capabilities in trading, investment banking and digital banking. Equipping banks to offer comprehensive financial solutions should be a priority.

Furthermore, the recent decline in equity funding for Chinese corporates highlights the urgent need for a well-functioning capital market. Although China has set up several stock exchanges to optimise the funding mix, equity is still not a significant source of capital. Investors tend to focus almost entirely on the ups and downs of the indices. Fundamental issues such as the quality of listed companies, the need for a streamlined process for initial public offerings, effective information disclosure and a well-defined regulatory framework are neglected.

Reshaping the structure of corporate financing and reforming the banking system are essential if the rebalancing of the economy towards consumption is to be achieved without too much disruption.

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When Will China Achieve Quality Growth?*

By ANDREW SHENG AND XIAO GENG*

China has not yet realized President Xi Jinping's vision of an inclusive, green, innovation-driven economy. But if policymakers continue to strengthen property rights and work to improve market confidence and foster fair competition, a breakthrough should not be far off.

Even before the 2008 global financial crisis laid bare the limits of China's export-oriented growth model, the country's leaders were stressing the need for quality growth. In 2007, then-Premier Wen Jiabao argued that Chinese economic growth had become "unstable, unbalanced, uncoordinated, and unsustainable." More than a decade later, how close is China to overcoming Wen's "Four Uns"?

Significant progress has been achieved, particularly since 2013, when President Xi Jinping and his team articulated a comprehensive reform plan that would put China onto a path of inclusive, green, innovation-driven growth. Since then, China has taken major steps forward, especially in rooting out corruption, alleviating poverty, and implementing supply-side reforms.

But China has not quite reached the authorities' goal that the market should become the "decisive" force in resource allocation. And the implementation of Xi's reform plan has been hampered by multiple internal and external shocks – including, in recent months, escalating trade tensions with the United States.

As the external environment becomes shakier and more hostile, China is facing a cyclical downturn at home. In 2018, China's GDP growth slowed to 6.6%, the lowest level since 2010, though unemployment and consumption have so far remained stable. Moreover, while trade grew by 9.7% for the whole year, it shrank by 4.8% in December, reflecting the uncertainty created by trade tensions with the US.

As market sentiment turned bearish, growth in fixed-capital investment in infrastructure and housing declined to only 5.9%. The Shanghai Composite Index fell about 25% – the largest drop in a decade – and the market capitalization of Chinese companies listed on the Shanghai and Shenzhen stock exchanges dropped by as much as $2.4 trillion.

The silver lining of the challenges – and, in particular, of protectionist pressure from the US – is that they have given Chinese policymakers added motivation to address structural imbalances and work toward leveling the playing field for private and foreign businesses. For example, the Ministry of Finance has launched a series of tax-cut programs, aimed at easing the burden on low-income households, the service sector, and small enterprises.

Moreover, financial, trade, and industrial regulations that previously hindered private business and innovation are being streamlined. And, on the monetary front, the People's Bank of China has cut the mandatory reserve ratio for banks four times over the last year, to maintain appropriate liquidity.

As part of its negotiations with the US, China is also moving to open its markets further. But there is a limit to the extent to which China can appease the US. As it stands, China has largely eliminated its trade surplus with the rest of the world. If it eliminates its trade surplus with the

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US, as President Donald Trump has repeatedly demanded, it may end up having to reduce imports from other countries to keep its overall trade balanced. This would disrupt global trade.

Another barrier impeding China's quest for quality growth relates to timing. While delivering sustainable development, raising living standards, and eliminating imbalances will yield massive long-term benefits, the policies needed to get there may weaken growth in the short term.

In order to offset this effect, China hopes that the private sector can deliver innovative, productivity-boosting breakthroughs in the near future. To help bring this about, Xi has met with various private business leaders to reassure them that they can count on the government to support fair competition and innovative activities.

But, if the private sector is to fulfill its potential, it needs financing. To this end, China must deepen its domestic capital markets, in order to support varied and efficient long-term investments by institutional players, such as social security and pension funds, that can convert savings from debt to long-term equity.

At the same time, the private sector needs stronger institutions to underpin fair competition. According to the late economist Harold Demsetz, institutions that define, protect, and refine private property rights will emerge only when the benefits of such a system exceed the costs of establishing it. China is in the midst of this transition.

The private sector also needs greater incentives to take risks. Here, clarifying the balance between local-government autonomy and central-government regulation is crucial. While excessive freedom for subnational governments can lead to instability, excessive control can choke off the local-level experimentation and competition that has long driven growth in China.

Indeed, though the central government provides essential infrastructure and policy coordination, only local (including municipal) governments can identify and implement "last-mile" public-infrastructure projects that create market potential for new growth. Such projects – and the public services they support – are crucial to creating an ecosystem that attracts entrepreneurs and innovators.

To enable local governments to fulfill this important role, innovative financing mechanisms are needed to reduce their debt and increase overall capital productivity. For example, public assets could be leased to private businesses capable of providing more efficient management.

This speaks to a broader need for China to dismantle bureaucratic roadblocks. As Demsetz observed, the decision not to lower barriers to market entry does more to undermine competition than, say, excessive market concentration. Though the Chinese digital giants Tencent and Alibaba have natural monopoly power in their domains, relatively low barriers to market entry have enabled them to provide low-cost services to vast numbers of consumers and businesses.

China has not achieved quality growth yet. But if the country's leaders continue to strengthen property rights and work to improve market confidence and foster fair competition, a breakthrough should not be far off.

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The Rise of China from a Network Perspective*

By JAICHUL HEO*

Hans J. Morgenthau, one of the founders of classical realism, captured the essence of international politics in the words, "As long as the world is politically organized into nations, the national interest is indeed the last word in world politics." He also believed that national interest could be realized through military and economic power, these being the most influential sources of power seen from a realistic perspective.

Joseph Nye, on the other hand, defines power as the ability to influence the behavior of others to realize the outcomes one desires, classifying the ways in which such influence is exercised into two categories: Command Power and Cooptive Power. Command Power is the ability to change what others do, which includes military and economic power, i.e. those valued from a realistic perspective. These forms of power are defined as Hard Power. Meanwhile, Cooptive Power is the ability to shape what others want, referring to non-material resources such as culture, ideology, and the ability to create an international system. These are defined as Soft Power. Based on this definition of Hard Power and Soft Power, Nye claimed a shift was taking place in international politics from Hard Power to Soft Power.

Nye has recently gone further to propose concepts such as Smart Power and Sharp Power. Smart Power refers to the ability to combine hard and soft power, depending on whether hard or soft power would be more effective in a given situation. And Sharp Power is the use of manipulative diplomatic policies by one country to influence and undermine the political system of a target country, which has also been utilized as a means of criticism against China.

The existing debate on power is significant in that it provides a concise and easy explanation for power shifts in international politics. However, current discourse lacks a proper understanding of the concept of power within the newly changing international politics of the 21st century. Thus, new ideas are needed to supplement the limitations of existing concepts of power, one of which is the idea of Network Power. Network Power refers to the power exercised by some social actors over others through rules of inclusion and coordination within networks, which can also be divided into Collective Power at the actors' level, Positional Power at the structure level, and Programming Power at the level of processes.

Now let us look at the rise of China based on these concepts of power. China overtook Japan in terms of GDP in 2010, and on a purchasing power basis its economy grew to 18.3 percent of the world's GDP in 2017. Meanwhile, following the launch of its first aircraft carrier Liaoning (遼寧) in 2012, the nation is currently conducting trial operations for its second aircraft

carrier, showing rapid growth in its military capabilities. Also, as of 2018, there are 525 Confucius Institutes in 146 countries around the world, serving as bases for spreading Chinese culture. In this way, China is showing remarkable growth in its Soft Power through cultural means, as well as its Hard Power represented by economic and military power.

However, seen from the perspective of Network Power, the rise of China is even more dynamic and significant. Since Chinese President Xi Jinping first proposed the Belt and Road Initiative (BRI) in 2013, it has been vigorously pushed forward as a national strategy project for expanding economic and trade cooperation between China and neighboring countries. As a result, as of 2018, 122 countries and 29 international organizations from over the world have

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joined hands with China under the vision of building BRI. In addition, 93 countries or organizations have joined as official members of the Asian Infrastructure Investment Bank (AIIB), which was established by China to push for the BRI.

Meanwhile, in September last year, China held the 2018 Beijing Summit Forum on China-Africa Cooperation (FOCAC), which was held as a large-scale international event with the participation of top officials from fifty-three African countries. In addition, China worked to forge closer economic relations with the world economy by hosting the first China International Import Expo (CIIE) in Shanghai in November last year, and held the Global Media Summit in Chongqing in October to establish closer relations with the international media as well. Also, China is holding the Boao Forum for Asia every year, an event which has come to be regarded as the Davos Forum of Asia, and is a leading member of the Shanghai Cooperation Organization (SCO), which plays an important security role in the region. In addition, China newly established diplomatic relations with Panama in 2017, followed by the Dominican Republic and El Salvador in Central America and Burkina Faso in Africa in 2018. In the process, China stressed the "One China principle" and induced the countries to sever ties with Taiwan.

As such, China is building a global network, creating more and more new platforms at the global level. This can be seen as the process of developing Collective Power and Programming Power by increasing the size of the existing network that China belongs to and creating new networks. In addition, China is trying to improve its Positional Power by occupying a central position in the diverse networks already existing, such as by actively hosting various international events and increasing the ratio of its contributions to international organizations.

On the other hand, the United States, which is considered the world's superpower, is removing itself from its existing networks one by one, unlike China. The Trump administration withdrew from the Trans-Pacific Partnership (TPP), the agreement of the Paris COP 21 and the UNESCO in 2017. The U.S. also officially declared last year that it would withdraw from the U.N. Human Rights Council and terminate the United States' participation in the Joint Comprehensive Plan of Action (JCPOA) with Iran. This diplomacy of withdrawal by the Trump administration is without doubt based on a calculation of U.S. interests, including domestic political circumstances, but from a network perspective they signify a weakening of the United States' global network power.

Of course, seen from the concept of "stock," China's network power still lags greatly behind the United States as its might in military and economic terms. From the concept of "flow," however, China's network power seems to be worthy of notice and an important driver of China's rise. Recently, the Malaysian government canceled its plans to build an eastern coastal railway with China in Malaysia, which was one of the important projects of the BRI. This setback indicates the difficulties associated with China's strategy to establish a global network. However, China is expected to continue executing a variety of policies that will lead to the strengthening of its network power in 2019 as well. Therefore, it is time to start thinking seriously about how China's Network Power will affect our society and how we should respond to this.

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Global Debt

Keep the "Grey Rhino" of Global Debt in the Cage*

By HU XIAOLIAN

For the global economy, the biggest "gray rhino" right now is debt. Following the global financial crisis, due to the extremely loose monetary environment, we have seen a rapid build-up in global debt. According to the early March data of the BIS, the total amount of non-financial sector debt in countries and regions covered in its statistics reached US$178 trillion in Q3 2018, which is notably higher than the late 2008 figure of US$107 trillion. The global debt to GDP ratio also rose from 202% to 231% during the same period.

Country and region-wise, the overall leverage ratio of developed economies increased from 239% at the end of 2008 to 264% in Q3 2018. In particular, the government debt to GDP ratio rose from 64% to 81%. Over two-thirds of the new debts in developed economies came from the government sector. For these economies, the build-up of government debts is the crux of the problem.

For the emerging market economies covered in the BIS statistics, the leverage ratio of their non-financial sector rose from 107% to 179% during the same period of time, up by 72 percentage points, suggesting a rapid expansion in debt. On the whole, the excessive growth of corporate debts is the main problem besetting the emerging markets. The leverage ratio of the corporate sector has risen from 56% to 95%, reaching the level comparable to that of developed economies in absolute terms.

Debt build-up is also picking up speed in some underdeveloped countries. In a global environment of low interest rates, they have borrowed massive amount of foreign debts, leading to a notable increase in the ratio of external debt to GDP. According to World Bank statistics, the total amount of external debt owed by low-income countries reached a record high of US$157 billion in 2017, and the ratio of external debt to GDP rose to 27%.

The ever-growing problem of global debt has weighed on economic growth and caused tremendous risks.

For developed countries, debt sustainability can be maintained in the short term through continued borrowing. Moreover, as the interest rate hike may have already come to a stop, the biggest uncertainty that could trigger debt risk is mitigated.

For emerging markets, population aging is a growing trend, and savings rates are visibly declining in East Asian countries. While the debt level comes down, there is also a drop in growth rate. China takes de-leveraging as an important task of the supply-side structural reform, and has taken active steps to steadily lower the leverage ratio across the society, especially the corporate debt level in the non-financial sector. As things stand now, these measures have delivered some initial results.

*This speech was given by Hu Xiaolian, academic advisor of China Finance 40 Forum and chairman of Export-Import Bank of China, at the international dinner conference on Global Economic Outlook and Financial Risks and Challenges held by CF40 on March 22.

Underdeveloped countries are mostly small economies, with poor resilience and unitary economic structure. Things like commodity price changes and climate change are all likely to have a big impact in a short period. For these countries, there is still a long way to go to achieve debt sustainability.

How can we keep the "gray rhino" of global debt in the cage? The following basic factors are critically important. Factor No.1: can the global economy keep an appropriate speed of growth and avert a collective recession? Factor No.2: can global trade continue to serve as an engine for driving global growth and boosting growth efficiency? Factor No.3: can we keep interest rates basically stable, and prevent drastic changes in the monetary environment? Factor No.4: can the money borrowed produce sound economic returns so that the debts can be serviced and sustained?

To resolve the debt problem, we should try to avoid two extreme scenarios: one is aggressive deleveraging that may cause recession, and the other is debt dilution with hyper-inflation. Currently, to resolve the debt issue, I think we should focus on international coordination and economic development. As far as I am concerned, institutional reform, free flow of factors and efficiency improvement on a global scale is most needed to generate stronger momentum for long-term growth and improve debt sustainability through economic development.

To this end, I think we should strengthen our work in three areas.

First, boost trade growth through effective cooperation and coordination. Right now, there are a lot of discussions about WTO reform. In my view, enhancing the role of trade in driving global growth, improving factor allocation, increasing investment efficiency and accelerating diffusion of innovations shall be the basic objective for WTO reform. The slowdown in global trade has dampened confidence in commercial investment and dragged down global growth. It is therefore necessary to address trade frictions as quickly as possible and guard against trade protectionism.

Second, improve the quality of debt by raising the quality of global output. The absolute amount of debt is only one aspect of the problem, and the quality of debt is another important aspect. Owners of the same amount of debt may have different capabilities for sustaining and servicing their debts. Debts with "better blood-making functions" often tend to have lower risks. In this context, it is imperative to make efforts to ensure greater openness for the orderly flow of labor, capital, technology and other resources, and the optimization of resources allocation. By doing so, we can create an enabling environment for countries to improve their debt quality.

Third, give full play to the role of innovations. It is advisable to combine the original innovation capabilities of developed countries, the capabilities of emerging markets to translate the results of technological innovation into industrial opportunities, and the huge market of developing countries for applying innovation results. By forming synergies among them, the level of consumption in developed countries can be raised, economic growth of emerging markets can be maintained, and debt problem of underdeveloped countries can be addressed. In this way, innovation can play a bigger role in preventing and defusing the risk of mounting global debt.

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Next Financial Crisis May Eclipse 2008*

By DESMOND LACHMAN*

It is difficult to forecast when the next global economic recession will happen. It is much easier to predict its severity.

This is particularly the case in the light of excessively high global debt levels, asset price bubbles and the generalised mispricing of credit market risk. Those considerations, coupled with the lack of adequate policy instruments to respond to the next global slowdown, point to a much more severe crisis than the average post-war recession.

Among the more disturbing vulnerabilities of the global economy is the large amount of debt spawned by years of ultra-unorthodox monetary policy by the world's major central banks. According to the International Monetary Fund, the global debt to GDP level is 250% – around 30 percentage points higher than it was on the eve of the 2008 financial crisis.

Handling a high debt level in the midst of a recession will be a major challenge for policy-makers. It may lead to a wave of defaults that could cause financial market distress, which in turn would risk deepening the recession. That challenge would be compounded substantially if that debt proved to be owed by borrowers of dubious creditworthiness.

There are many reasons to fear that years of unorthodox monetary policy and low interest rates have led to a marked deterioration in lending standards. As former US Federal Reserve Chair Janet Yellen cautioned recently, the size of the risky US leveraged loan market has doubled to more than $1.2tn from around $600bn on the eve of the 2008 recession.

At the same time, there has been a large increase in lending to corporations of questionable creditworthiness in emerging markets. Particularly troubling is the fact that more than $3tn of that debt is dollar-denominated, which will be difficult for those companies to repay if the world economy were to weaken and the dollar to strengthen.

An important reason to be more concerned about high debt levels today than we might have been in 2008 is that the mispricing of global debt in the current economic cycle has become much more pervasive. In 2008, that mispricing was largely limited to US mortgage lending. Today it appears to be across the board and around the world. This could lead to considerable financial market dislocation, if there is a serious repricing of risk to more normal levels and the asset price bubbles in the global equity and housing markets burst.

Examples of credit risk mispricing include the US high-yield debt market and the emerging economy corporate debt market. Borrowing rates in both markets have reached levels that do not nearly compensate the lenders for default risk. Mispricing was also evident in the sovereign debt markets of highly indebted countries like Italy, where until recently the government could borrow long-term at interest rates close to those in the US.

The US is less well-equipped now than it was in 2008 to fight the next recession. With interest rates still low and with considerable political resistance to another round of quantitative easing, the Fed has little room for manoeuvre. Similarly, with the US budget deficit already bloated by large tax cuts at a time of cyclical strength, there is little room for another fiscal stimulus package when the next economic downturn occurs.

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The 2008 crisis caught global policy-makers flat-footed. A coordinated global policy response was required to get the world economy out of that recession. Hopefully this time policy-makers will be better prepared. When the next recession comes around, one must hope that President Donald Trump's administration will take a more constructive stance with respect to the need for global economic policy coordination. However, judging by its 'America first' policy to date, this seems unlikely to happen.

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Belt and Road Initiative

Smooth Sailing or A Bumpy Ride Going Forward

By YASEEN ANWAR*

Ten years earlier we faced the early stages of the Global Financial Crisis (GFC) that changed the shape of the global economic landscape and included the collapse of two venerable Wall Street Firms, Bear Stearns and Lehman Brothers, and that led us to unprecedented negative interest rates in Europe, and what was to be a prelude to a gradual slowing of the dominant Asian economy that was supposed to lift us out of a deep recession and stimulate global growth. What is in store for us going forward?

Today, future Corporate earnings outlook in some analyst's mind is grim, combined with the trending Yield Curve, increased country Debt, Risk Averseness of Financial Institutions to long term credit, looming negative interest rates once again in Europe, continuing contentious Trade War, Geopolitical conflicts, the independence of the Fed in question, and the ever-present unresolved Brexit, provide a compelling backdrop to a possible recession with continuing global uncertainty. So what measures should be taken to protect us from these vulnerabilities and where are we to find the necessary resources to lift us in support of stimulating sustainable global economic growth?

Michael Milken, one of the Notable graduates of the Wharton School at the University of Pennsylvania, created the popular Junk Bond market in the 1980's to enable the smaller, non-rated companies access to capital which they did not nor would have had access to. Milken's creativity in opening new potential economic opportunities triggered not only new Capital Market opportunities for investors, but also added a new stimulus to the overall growth of the economy with new jobs and consumer purchasing power. A whole new industry of New Capital developed that motorized a new generation of professionals and created a new variety of financial products. The Risk/Reward ratio also added a new dimension to Asset Allocation strategies as improved availability of financial data provided added comfort to investors in expanding their Risk appetite in search for higher returns.

Analogous to Milken's strategy, the Belt Road Initiative (BRI) provides that very access to capital for those BRI connected emerging market economies that have NOT had in the past the necessary Investment Grade Ratings to tap the international Bond market for sorely needed funding to finance long term infrastructure projects. Such economies, with vast potential natural resources i.e. Africa, Pakistan, etc., have never had the opportunity to attract offshore investors who require investment grade Ratings dictated by their corporate policies, nor do those investors have the Risk appetite to venture in uncharted emerging markets, or simply opted for safer and Rated opportunities in mature markets of Europe, the U.S., or Japan. Safety and preservation of Capital was foremost in an uncertain and volatile global economy.

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Infrastructure, the core of BRI funding, is and has been the engine of growth for most economies. The Industrial revolution of the 19th century in the U.S. transformed an agrarian based economy to a technological and manufacturing based economy, lifting the U.S. as a leading global economy in the 20th century. The New Deal in the 1930s with its emphasis on Infrastructure reforms in Finance, industry, Agriculture, construction of highways, bridges, Power Dams in the U.S., not only pulled the economy out of Depression of the 1920s, but leap frogged the economy for the remainder of the 20th century and beyond into a trajectory as the largest economy in the world. The domestic network of connectivity in transportation comprising of railroads and trucking, resulted in an economic expansion in SMEs, Agriculture, housing, finance, and so on. In fact, the majority of trade for the U.S. happens to be domestic within its own 50 states.

Such Infrastructure, or the lack thereof, has hampered the very economic development that many BRI related countries sorely need. The shortage of Power in Pakistan has impaired GDP growth rates of up to 3% and the lack of a developed transportation network for refrigerated trucks for distribution of agricultural products, results in a 50% loss of perishable products. It is estimated corrective measures could generate substantial annual FX earnings. Filling this gap and elevating Pakistan's 5th largest milk production rank in the world could generate up to another $500 Million in annual Export earnings.

Given the historical and current backdrop for infrastructure needs, it is difficult to fathom why anyone would be averse to supporting the Financing gap of Trillions the can be filled by BRI as a logical remedy in building the necessary defenses to cushion vulnerabilities. BRI and its collective resources of Multilaterals can also be leveraged to fill the financing 'gaps' and alleviate concerns of Risk Averse private sector lenders and investors.

The past two years have witnessed BRI successes already positively impacting on certain economies with new employment and improved productivity. In 2017, Piraeus handled more than 4 Million containers for onward distribution to Europe, Dusport-Germany is the largest inland port in the world, 10,000 plus companies are now operating across the African continent connecting via an expanding transportation network of rail and roads, more than $60 Billion of new business has been generated between Africa and 54 countries in investments and Tourism, new housing in Indonesia, Power projects in Bangladesh, roads in Pakistan/ Kazakhstan, ASEAN trade has increased last year by over 12% and still increasing with huge potential of the current Asian regional intra trade at 23-25% compared to European/NAFTA intra-regional trade at 57-63%. The current trajectory is in the positive direction.

Logically and intellectually BRI makes sense for the above reasons. Why would anyone want to create obstacles or block it? BRI translates into ample resources and opportunities to stimulate industrial growth and provide the inclusive growth as well as preserve stability on a regional level. Payments settlement risk can also be reduced by using the RMB as an alternative currency. Dark clouds and exogenous shocks are possible on the horizon and regional economies need to install risk mitigating shields. BRI's desirable attributes provide the necessary ingredients to restore faith, confidence, and some stability in the International Monetary System and at the same time generate new employment and reduce poverty in many countries connected to Belt & Road.

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Digital Economy

The Challenge of Digitalization and Social Transformation in Germany and China*

By OLAF SCHOLZ*

I'm delighted to not only meet my esteemed government colleagues during my visit to China as well as business leaders, but to also get the opportunity to engage with you, dear students – China's future generation, its young leaders and most promising future minds.

Many thanks to Prof. Zhang, the Dean of the School of Finance of the prestigious Renmin University, for hosting this debate. I was looking very much forward to it!

Let me start my short remarks with a little story:

In the spring of 2016, an artificial intelligence system called AlphaGo defeated a world champion Go player in a match at a hotel in Seoul. In the US, only a few understood this momentous news. Most Americans were unfamiliar with Go, the ancient Asian game. And the technology that had emerged victorious was even more foreign: a form of AI called machine learning, which uses large data sets to train a computer to recognize patterns and make its own strategic choices.

In China, by contrast, 280 million people watched AlphaGo's win online. There, what really mattered was that a machine owned by a California company, Alphabet, the mother of Google, had conquered a game invented more than 2,500 years ago in Asia. Americans don't even play Go. And yet they had somehow figured out how to vanquish it?

Less than a year later, in May 2017, it was clear to the world, that China would not let the game of AI and machine learning be solely dominated by others: China unveiled its Next Generation AI Development Plan, a document that laid out the country's strategy to become the global leader in AI by 2030.

In doing so, China was one year ahead of Germany. We have presented our Artificial Intelligence Strategy last November. It is also our goal to make Germany and Europe the worldwide leader in the field of AI.

Between now and 2025 the German government intends to provide around three billion euros to implement the strategy. Funds will be channeled primarily into research. We are confident that this funding will be matched by equivalent private investment. We will form and network research clusters.

*This is a speech draft by Mr. Olaf Scholz on the International Seminar on Digital Economy and Social Development-- The Challenge of Digitalization and Social Transformation in Germany and China

*Olaf Scholz, Federal Minister of Finance and Vice-Chancellor of Germany

Together with France, this network will look at the impacts of artificial intelligence on the working world, and in the field of data protection and data availability.

Dear students,

Tackling the challenges of the digital era as well as competing for leadership in shaping it is only the next of many chapters in the long-lasting friendship between China and Germany.

Today, China is our biggest trading partner worldwide. And Germany is China's biggest trading partner in Europe. Our economies are closely intertwined. In fact, it goes further than that – the Chinese and German economies now depend on each other.

It is precisely this increasing level of interconnectedness that makes differences apparent.

I see the digital transformation as a new chapter of our relations within which we can partner up for common goals, learn from each other's differences and commonly shape the new era that will change not only our economies, but also our societies.

We Europeans are working on answers to various questions, many of which are equally relevant for China:

1. What is the architecture of the future digital economy? In a world, in which our key industries – the automotive sector, the energy and manufacturing industries are under great transformation and stress – what are the industrial pillars on which the future digital economy will stand?

I'm curious to hear the view on this matter of AI-expert and fellow co-panelist, Dr. Zhifei Li.

2. How can we achieve greater inclusion and less inequality in the future digital economy?

How can an aging society like the German or Chinese provide social welfare in a technologically and economically transformed environment?

The stability and social peace of our societies will heavily depend on a smart answer to this question.

3. How can we get to the forefront of AI and promote data-based business models while protecting the individual privacy of our citizens? How can we guarantee people's rights to privacy while enabling them to share their data for the public good?

4. And last, but not least: What is the role of the nation state in digital space? How can we preserve and protect our national sovereignty in the digital age?

The answers to these complex questions will decide on the future strength of our economies and inner peace of our societies.

As you know, Germany and the European Union will continue to define and apply the legal framework for citizen related data collection and data use in the future and it will expect everyone who wishes to trade with Europe and its over 500 million citizens to respect this framework.

However, I understand that these questions are often answered very differently in China today.

Dear students,

The world around us is changing.

New opportunities are arising and old certainties are now less sure– which makes this new digital era even more challenging.

This is precisely why I'm looking forward to hearing your views and ideas!

Thank you very much for your attention!

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International Comparison and Trade Effects of Digital Innovation*

By NAKGYOON CHOI, KYUYUB LEE, HYUK-HWANG KIM*

I. Introduction

The fourth industrial revolution is the on-going industrial revolution driven by intelligent information technology. The digital innovations related to artificial intelligence, big data analysis, cloud computing, and the internet of things are driving hyper-connectivity between all products and services through global networks, thereby advancing the data-driven economy. In particular, the data-driven technologies combined with new technologies and established industries and services contribute to the new business models, thereby bringing about the so-called digital disruption.

The recent digital innovation has been accelerated by the market needs to the extent that the mass production system of the established industries needs to be changed into a personalized production system. All the materials and phenomena in the physical world with analogue characteristics have been transformed into digital data to a substantial degree, in terms of speed as well as magnitude. In addition, artificial intelligence systems which can find optimal solutions through data analysis have been utilized widely in various socio-economic areas. The digital innovation taking place in the wake of the fourth industrial revolution is having disruptive effects on products, production processes, and business models of the established industries.

II. Digital Innovation and Trade Pattern

Digital innovation will bring about revolutionary changes in all activities in the social and political sphere, not to mention the areas of technology, industry, trade, and other economic transactions. In a recent research, the OECD (2018) presents the following future scenarios: the "iChoose" scenario, where individuals will play a leading role in economy, politics, and societal activities through deregulation and innovations by the governments and corporations; the "platform government" scenario, where governments are changed into a platform government to manage the mutual relationships among the citizens, corporations, and societal organizations; the "Tech Titans" scenario, where the large companies leading global technology innovation will play pivotal roles in all economic activities, providing better personalized services for the general public than the governments; and the "Artificial Invisible Hands" scenario, in which artificial intelligence replaces the many coordination functions of governments and corporations, guiding the people to make better choices in improving their welfare.

The information on production and consumption collected through the internet of things will be conducive to an optimal production system and smarter consumer choices through big data analysis and artificial intelligence, bringing about fundamental changes in the world economy. In particular, digital innovation will have various impacts on international trade patterns according to technology characteristics and different levels of technology development. Let us take the

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example of a smart factory. In the embryonic stage of the smart factory, the international trade pattern will be determined by the individual levels of technology because the digital innovations are not differentiated from the previous production systems. In the growth stage of a smart factory, the reshoring of the production activities will be facilitated by the comparative advantage in terms of technology and location, changing the trade pattern substantially. In the maturity stages of the smart factory, the factories will be located in the consumer markets by a distributed manufacturing system. The trade pattern will be transformed toward the servicification of manufacturing.

III. International Comparative Analysis of Digital Innovation

In this study, we analyzed the level of digital innovation and digital utilization by country and industry. The level of digital innovation -measured by number of patent grants, number of citations, and H index is analyzed using data on utility patents related to digital innovation technology, among those reported to the U.S. Patent and Trademark Office (USPTO), while the analysis for the level of digital utilization uses both industrial robots data in the World Robotics Reports and ICT access and usage data in the OECD.Stat database.

According to the results of our analysis, significant improvement was made in the world's digital innovation (number of patents), led by the U.S. and Japan, showing a stairstep increase in the years of 1998 and 2010. However, the number of patents in Japan has remained relatively flat since 2000, while the number in China and India has increased rapidly since the mid-2000s.

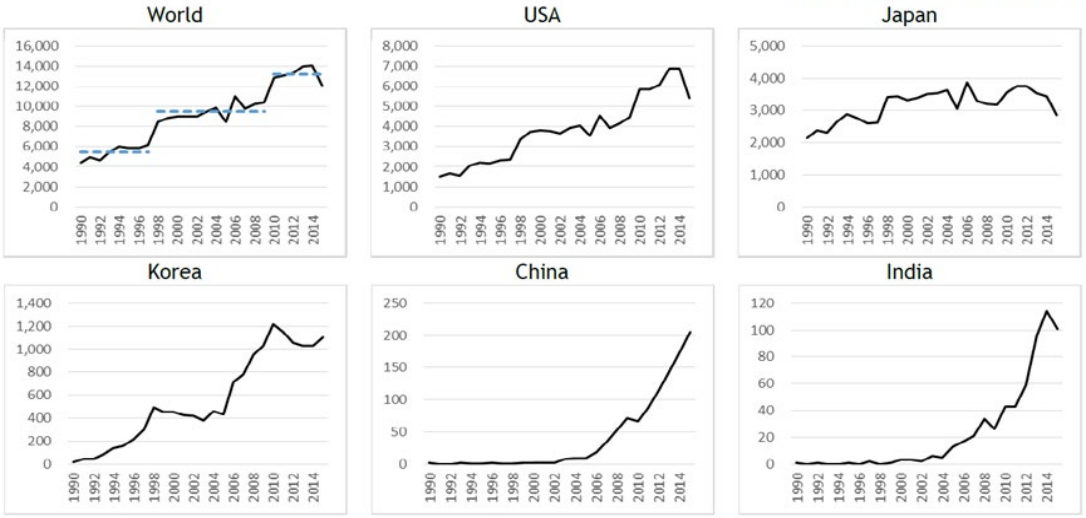
The quantitative and qualitative level of Korea's digital innovation is steadily rising, but still relatively lags behind the U.S. and Japan. In particular, considering the recent decline in Korea's rank on the H index, and the improvement in the level of digital innovation shown in China and India, Korea is likely to experience the same decline as the EU member states.

By industry, the level of digital innovation is focused in the category 26 (computer, electronic and optical products), 28 (machinery and equipment n.e.c.), and 62 (computer programming, consultancy and related activities) industries. Among these industries, category 62 industries have shown dramatic increase recently. When comparing the level of digital innovation in major countries (USA, Japan, Korea, Taiwan, China, India) within the period of 2010-15, it was found that all category 26 and 28 industries were at a high level in all major countries. Korea's level of digital innovation by industry is currently positioned between the U.S., Japan, China and India, according to the analysis by country. In the category 62 industry especially, Korea is at a lower level than India.

Overall, industrial robots indicate an increase in the level of digital utilization. Around 72% of the world's industrial robots are installed and operated in the U.S., Japan, Korea, China and Germany. Korea has installed the third most robots in the world, and operates the fourth largest number of industrial robots actively. In particular, the number of robots in operation per 10,000 workers in Korea is 631, the largest rate recorded in 2016.

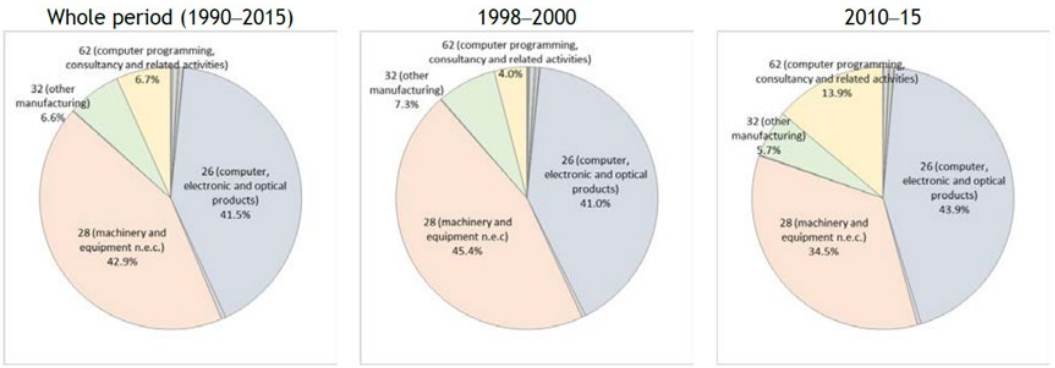
Figure 1. The Trend of Patent Grants by Major Countries

Unit: number of utility patent grants



Source: Author's calculation based on USPTO DVD-ROM.

Figure 2. The Ratio of Patent Grants by Industry



Source: Author's calculation based on USPTO DVD-ROM.

Table 1. Major Countries' Number of Patent Grants Related to Digital Innovation Technology by Industry (2010–15)

Unit: number of utility patent grants

Major Industries		USA	Japan	Korea	Taiwan	China	India
code	name						
20	Chemicals and chemical products	207	135	31	21	6	1
26	Computer, electronic and optical products	14,376	8,314	4,730	1,655	405	340
27	Electrical equipment	177	67	33	43	14	0
28	Machinery and equipment n.e.c.	11,010	10,237	1,245	786	272	39
32	Other manufacturing	1,437	1,703	431	345	51	1
62	Computer programming, consultancy and related activities	9,413	245	63	26	28	75
Industry Total		36,939	20,889	6,591	2,909	792	456

Source: Author's calculation based on USPTO DVD-ROM.

Many of the robots that were installed and in operation during 2011-16 are used in the manufacturing of automotives, electrical and electronics, metal, plastics and chemical products. Korea uses a large number of robots in the electrical and electronics sectors, unlike other major countries that use many robots in the automotive sector.

Lastly, as for the other indicators of digital utilization, the usage of ICT at enterprises is not very high in Korea, with the exception of RFID utilization, despite the very high usage rate of high-speed internet at enterprises (99.3%) and households (99.5%).

IV. The Impact of Digital Innovation on International Trade

This chapter examines the impact of digital innovation on international trade. Digital innovation denotes new products and processes based on data and software codes. Since it is widely known that there is a positive correlation between innovation and productivity, it is natural to conjecture that digital innovation would have an impact on international trade due to changes in fundamental productivity. We select a structural approach rather than a reduced-form econometric approach due mainly to the paucity of relevant data.

A. The model

The world comprises N countries and J sectors, in which a particular country is denoted by n, i $\in$ {1, … , N} and a particular sector by j, k $\in$ {1, … J}. Consumers in each country supply their labor inelastically at wage rates w_n in country n and demand consumption baskets according to Cobb-Douglas preferences with country-sector specific share α_n^j over their consumption of final output bought at prices P_n^j in all sectors. Given prices and income, consumers maximize their utility subject to the budget constraint.

We add fundamental productivity into a multi-country and multi-sector Ricardian model with input-output linkages, trade in intermediate goods, and sectoral heterogeneity in order to quantify the trade effects from digital innovation. Representative firms in each country and sector produce a continuum of varieties of international goods. Following Eaton and Kortum (2002) and Caliendo and Parro (2015), we model efficiencies as random variables so that firms producing intermediate goods differ in their productivity level z_n^j drawn randomly from a Frechet distribution. Given the realization of productivity level at intermediate good sector j in country n, we introduce fundamental productivity T_n^j to the production function for intermediate goods as follows.

$$y_n^j(z_n^j) = z_n^j(T_n^j l_n^j(z_n^j))^{\gamma_n^j} \prod_{k=1}^{J} m_n^{k,j}(z_n^j)^{\gamma_n^{k,j}}$$

Where l_n^j is the labor demand, $m_n^{k,j}$ is the demand for material inputs by firms in sector j from sector k, $\gamma_n^{k,j}$ is material share from sector k in the production of sector j and lastly $1 - \gamma_n^j = \sum \gamma_n^{k,j}$. The structure of production technology shows input-output matrix for each country. From cost minimization, unit cost bundle c_n^j is derived.

Final goods or composite intermediate goods in sector j, Y_n^j, is produced by Ethier (1981). We assume that the final goods cannot be generated by assembling intermediate goods from different sectors other than sector j. The optimal demand function for intermediate goods is derived from final good producer's maximization problem.

International trade is costly. A unit of any intermediate good in sector j shipped from country i to j requires producing $\kappa_{ni}^j \geq 1$units in country i . Final good producers search for the lowest price of intermediate goods across all locations and assemble them to provide their buyers in

their own country. Using some properties of the Frechet distribution, we calculate bilateral trade share π_{ni}^{j} and total expenditures X_n^j for all countries and sectors.

On equilibrium under trade costs and exogenous variables, a wage vector and prices satisfy equilibrium conditions, including a number of optimal behavior of consumers and producers and market clearing conditions in each country.

B. Changes in equilibrium and data

We highlight the link between digital innovation and productivity and between productivity and international trade on a general equilibrium setting to answer counterfactual questions. In order to perform the counterfactual analysis, we first calculate changes in equilibrium following the popular hat calculus.

Cost bundles (N × J equations)

$$\hat{c}_n^j = \hat{w}_n^{\gamma_n^j} \prod_{k=1}^{J} (\hat{P}_n^j)^{\gamma_n^{k,j}}$$

Price index (N × J equations)

$$\hat{P}_n^j = \left[\sum_{i=1}^{N} \pi_n^j \left(\hat{c}_n^j \hat{\kappa}_{ni}^j\right)^{-\theta^j} \left(\hat{T}_n^j\right)^{\theta^j \gamma_n^j}\right]^{-1/\theta^j}$$

Bilateral trade share (N × N × J equations)

$$\hat{\pi}_{ni}^j = \left(\hat{T}_n^j\right)^{\theta^j \gamma_n^j} \left[\frac{\hat{c}_n^j \hat{\kappa}_{ni}^j}{\hat{P}_n^j}\right]^{-\theta^j}$$

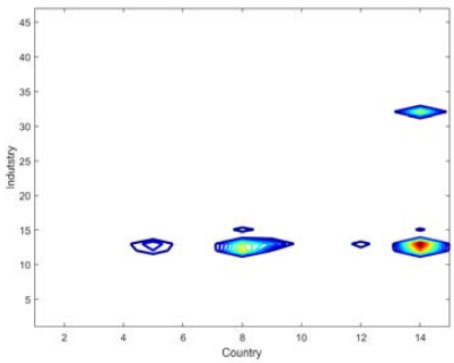
Total expenditures (N × J equations)

$$\hat{X}_n^j X_n^j = \sum_{k=1}^{J} \gamma_n^{j,k} \sum_{i=1}^{N} \hat{X}_{in} X_{in} + \alpha_n^j (\widehat{w_n L_n}) w_n L_n$$

where it is assumed that the world trade is balanced.

Given a system of equations as above, we next measure digital innovation by extracting patents data pertinent to new technology such as Artificial Intelligence, Big Data, Machine Learning, Cloud Computing, and others recorded in the United States Patent and Trade-mark Organization from 2011 to 2015 (Figure 3).

Figure 3. Patents Records Relating to Digital Innovation at Country-industry Level



Note: Author's calculation. Brighter color represents higher number of patents for digital innovation. Such patents are concentrated in the computer, electronic, and machinery sectors in the US, Japan, Korea, and EU.

Next, we proceed to concord the extracted patents data to International Standard Industrial Classification Revision 4. Then, we use the constructed patents data (Figure 3) to generate changes in fundamental productivity at sector-level to examine the trade impact of digital innovation. In addition, we consider changes in fundamental productivity at country-level of estimates from previous studies (e.g., Craft 2004; Craetz and Michaels 2015; O'Mahony and Timmer 2009; McKinsey Global Institute 2017).

In all cases, we use data from the World Input-Output Table released in 2016 to calculate exogenous variables such as input-output coefficients, value-added share, and share of consumption expenditures for the model.

C. Counterfactual Results

We consider ten different scenarios depending on productivity shocks (changes in Tn) from sector-level and country-level. However, we can only show part of the main results in Table 2 due to space limitation.

Counterfactual analysis based on a variant of the Ricardian model shows that digital innovation is beneficial to international trade. In other words, if digital innovation boosts fundamental productivity, it triggers growth in international trade at both sector-level and country-level. If countries/sectors have higher productivity due to digital innovation, those become much more competitive in producing goods or services, affecting trade share, price, expenditure, and many others within the model. As fundamental productivity induced by digital innovation becomes higher and the number of countries that experience enhanced productivity becomes larger, the model predicts that world trade volumes will grow larger accordingly. However, the growth in trade volumes is uneven. Although digital innovation contributes to the growth of world trade volumes, the increases in world trade are concentrated in certain countries and/or sectors that lead digital innovations.

V. Conclusions

This study provides the following implications for Korean private companies and its government. First, Korean private companies need to expand their R&D investments in software and programming related to Artificial Intelligence (AI), internet of things, and big data areas in which the quantitative as well as qualitative level of Korean patents are relatively low compared to the U.S. and Japan. They need to strengthen their competitiveness in digital innovation technologies. For its part, the government must step up wide-ranging deregulation measures to facilitate digital innovations related to data flow and technical interoperability.

Second, efficient policy governance needs to be set up to systematically support digital innovation in private sectors. This is because the digital policies in the age of the fourth industrial revolution are expected to have wide-ranging effects on the economy as well as society. According to an OECD study (2017) on national digital strategy governance, OECD member countries have allocated respective responsibilities to various ministries. A systematic governance system needs to be established to lead development, and to monitor and coordinate implementations.

Third, the Korean government needs to cooperate with WTO member countries to revise the international trade rules related to digital trade. In particular, trade rules such as the Technical Barriers to Trade (TBT), Intellectual Property Rights (IPR), and Telecommunication Agreements need to be urgently revised through WTO negotiations.

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IMI International Monetary Review

Minutes from Macro-finance Salon

Regional Financial Arrangements (RFA) and the International Monetary Fund*

By C. RANDALL HENNING

Pitfalls and Benefits of a Multiplicity of Institutions

(1) Pitfalls

— Gaps and excessive overlaps in coverage

— Moral hazard, including private-sector and official-sector moral hazard

— Multiple avenues for private "capture" of financial rescues

— Creditor "shopping" by borrowers

— Delayed resort to the IMF under the "nightmare scenario"

(2) Benefits

— Competition in areas of positive spillover (analysis and forecasting)

— Redundancy when access to one of the institutions is blocked

Conceptual Arguments

(1) Comparative Advantages of Globalism and Regionalism

— Drawing upon a universal risk pool

— Comprehending broad possible range of country experience and problems

(2) Moral Hazards

—It is important to note the disparity of susceptibility to different moral hazards between the European and non-European RFAs.

(3) The Apex Creditor

— Any situations that involves multiple lenders poses the question of creditor seniority.

(4) Institutional Independence

— Reform of the executive boards would be desirable, but takes the view that it should retain political responsibility for program approvals.

(5) Conflict Resolution

—Informalism is essential for resolving inter-institutional conflicts.

* The minutes are based on the speech by C.Randall Henning, Professor of International Economic Relations at American University, from the Workshop on Emerging Countries in Global Financial Governance held on February 26, 2019.

The Regional Financial Arrangements

Latin America (FLAR): The Latin American Reserve Fund takes pride in greater activity for the facility, no formal link to the IMF and uncontroversial governance. Meanwhile, it also faces several challenges and difficulties, for example, the surveillance, the consensus-oriented governance and the small size itself.

East Asia (ASEAN+3 Institutions):

— Japan and China do not yet have confidence that ASEAN+3 institutions can exact adjustment when necessary

— Indonesia pose a challenge for the region

— Invest in other elements of the safety net simultaneously, not wanting to place all their "eggs" in one regional "basket"

— Create different, possibly rival, sets of BSAs

— Complex is dense institutionally, but knitted together by the link

Europe (ESM):

— Provide stability support under strict conditionality

— Cooperate closely with the IMF

— Can raise funds on the capital markets and has a debt management office to handle bond issuance

— Has a broad set of lending instruments and more flexibility than the IMF

Recent Evolution of the IMF

— Undertake numerous reforms to its lending instruments and guidelines on conditionality

— Review its lending framework, relationship with regional financial arrangements and financial facilities

Conclusions and Recommendations

(1) Latin American Reserve Fund (FLAR):

—Scaling up requires ensuring potential large new members against losses.

(2) East Asia (ASEAN+3):

— Grant AMRO authorities to serve as full secretariat of CMIM

— Pool reserves into a single account as capital or quota contributions

— Publish the CMIM Agreement

— IMF link appears secure for the moment

(3) Europe (ESM):

— Advancing reforms to the ESM;

— Ratification would not eliminate member-state veto over financial assistance

— Demand for IMF involvement by linchpin creditors continues

For further details

All developments regarding IMI can be followed at http://imi.org.cn/ or http://imi.org.cn/en/.
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IMI International Monetary Review

Fragmentation and Centralization in Global Economic Governance--Why is Financial Regulatory Standard-setting Different?*

By ANDREW WALTER

Evidence of Basel's Relative Resilience

— Little conflict among major countries in recent years over financial regulatory policy

— Remains relatively productive since 2016 in spite of the growing volatility

— Still exhibits a low degree of international institutional competition even after the dramatic regulatory failures

Explanations of Fragmentation and Centralization in Global Economic Governance

— Strong market incentives for follower states to adopt the financial regulatory standards of dominant states

— Strong incentives for leading states to foster a unitary global institution for propagating their standards as multilateral standards

— Strong network benefits for all actors converging on a single set of financial regulatory standards

Benefits of Basel Participation for EMCs

— Status benefits due to formal equality & exclusivity of Basel

— Domestic political leverage for reformers

— Learning from more developed, higher capacity peers

— Political benefits to leaders: some insurance against destabilizing crises

— Limited political costs: formal equality, weak secretariats, national discretion permitted, low domestic political salience

— Potential for 'internal graduation': EMCs may gradually build market importance and regulatory capacity thus influence over global standard-setting

Emerging Country Government Preferences and Behaviour

(1) China

— Emphasizing the status and learning benefits as well as the opportunity it presents to enhance its influence in global financial governance.

— Focusing on promoting economic development and regulatory reforms

* The minutes are based on the speech by Andrew Walter, Professor of International Relations at University of Melbourne, from the Workshop on Emerging Countries in Global Financial Governance held on February 26, 2019.

— Be consistent that China can obtain multiple benefits from participation in Basel

(2) India

— Higher capital ratios as envisaged in Basel III would hurt growth in EMEs

—Favour greater reliance on national solutions rather than the establishment of alternative institutions

— Such local adaption strategies are less easily available to EMCs

How Can Resilience be Sustained and Enhanced

— Deepen domestic financial markets

— Integrate risk assessment between the IMF, FSB and BIS

— Integrate contrarian views, including those from the non-financial sector

For further details

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IMI International Monetary Review

Research Report

The Guangdong-HK-Macau Greater Bay Area-mapping Out the Region's Listed Companies*

By STEVE WANG*

Summary

Given the significance of public listed companies to a local municipality in terms of economy and capital market, we look into the relative strength and competitiveness of each of the cities in the Guangdong-HK-Macau Greater Bay Area (GBA) through mapping out the profiles and characteristics of all the domestic and overseas listed firms from the region.

A total of 557 companies from the GBA are listed on China's domestic exchanges, while 1,843 GBA firms are listed on the international exchanges (including HK Exchange), including a total of 1,630 HK-registered firms.

Among the domestic listed firms, Shenzhen holds a dominant place with a 55% share, followed by Guangzhou (19%), Foshan (7%), Dongguan (5%), Zhuhai (5%), Zhongshan (4%), Jiangmen (2%), Huizhou (2%) and Zhaoqing (1%). By market cap, Shenzhen enjoys an even stronger position at 67% of the total, illustrating a larger average size of the Shenzhen listed firms.

Among the overseas listed firms (including dual-listed ones), Hong Kong/Macau dominates the table at an 89% share in the total count but only 65% in the total market cap. When excluding the HK/Macau listed firms, Shenzhen again dominates the table with a 50% share in the total count, followed by Guangzhou (24%) and Foshan (6%), or 79% in the total market cap for Shenzhen, followed by Guangzhou (12%) and Foshan (4%).

When looking into the industry profile, we find that larger cities like Hong Kong, Shenzhen, Guangzhou, Macau and Zhuhai all have high concentrations of listed firms in the consumer products & services industry, the technology-centric TMT industry and the financial services, while smaller cities such as Dongguan, Foshan, Huizhou, Zhaoqing and Jiangmen have higher percentages from industrial firms.

Between HK/Macau and the mainland GBA city group, HK/Macau counts consumer companies as the largest concentration of listed firms, followed by industrial corporations. In contrast, the mainland GBA city group counts industrial corporations as the highest concentration, followed by consumer companies. Both groups have sizable concentrations of

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listed firms in the TMT and real estate industries, while financial firms (excluding real estate) do make up 10% for HK/Macau, but only 4% for the mainland GBA cities.

Through the perspective of public listed companies, we may be able to shed some light on the outlook of each of the 11 GBA cities in their significance and role to be played for this economic powerbase. HK is expected to continue to be a world-class business and financial centre; Macau to remain a niche and unique player focusing on world-class gaming and entertainment services; Shenzhen to become a world high-tech centre and a regional financial centre complementing HK; Guangzhou to further develop into a key regional business and metro hub; Zhuhai/Zhongshan to develop into a regional business hub complementing and servicing Macau; and the rest of GBA cities to become high-end manufacturing bases.

1. Public Listed Companies as an Economic Development Indicator

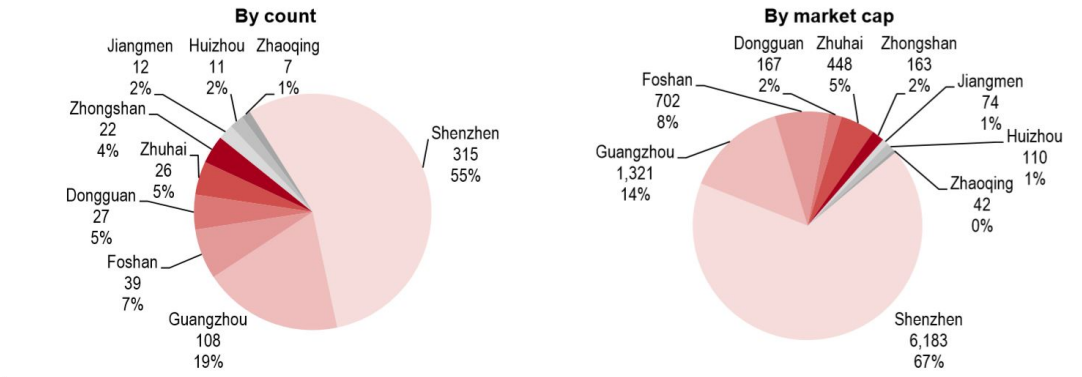
Given the fact that a public listed company generally commands a relatively more visible brand name, better finance flexibility and higher enterprise value, pursuing public listing of their home-based enterprises has always been an economic development policy for Chinese local governments and municipalities. The enhanced fund-raising capacity and public commitment from a listed company should generally serve well for the local governments in terms of employment, tax revenue, city profile, and other economic synergies.

In further details, a listed company has the power to utilise its stocks as a financing vehicle for quick fund raising and asset acquisitions that, in the end, could benefit local business investment and financial position. The wealth effect from a company listing can also be an important boost to local economy, as the monetisation of share holdings through public listing often creates instant wealth effect from the owners of the listed company, including share-holding senior managers and other employees with stock incentives. In many cases, public floatation has become the quickest way for many of the stakeholders of the company to materialise wealth and rise in the wealth rank.

2. Mapping the Public Listed Companies in the Greater Bay Area (GBA)

The Guangdong-HK-Macau Greater Bay Area boasts a high concentration of listed companies (based on the corporate registration location). They are either listed on the domestic exchanges (Shanghai or Shenzhen Exchanges) or overseas international exchanges (such as HK Exchange, NY exchanges, Singapore Exchange). In some cases, a company may be dual- or multiple listed on different exchanges. A total of 557 firms from GBA are listed on the domestic exchanges, but none are from HK or Macau since domestic exchanges are not yet opened to overseas corporations (see Figure 1). On the other hand, a total of 1,843 GBA firms are listed on the international exchanges, including a total of 1,630 from HK registered firms (see Figures 2&3).

Figure 1. Domestic Listed Companies from the GBA: by Total Number (left) and by Total Market Cap (in RMB bn, right)

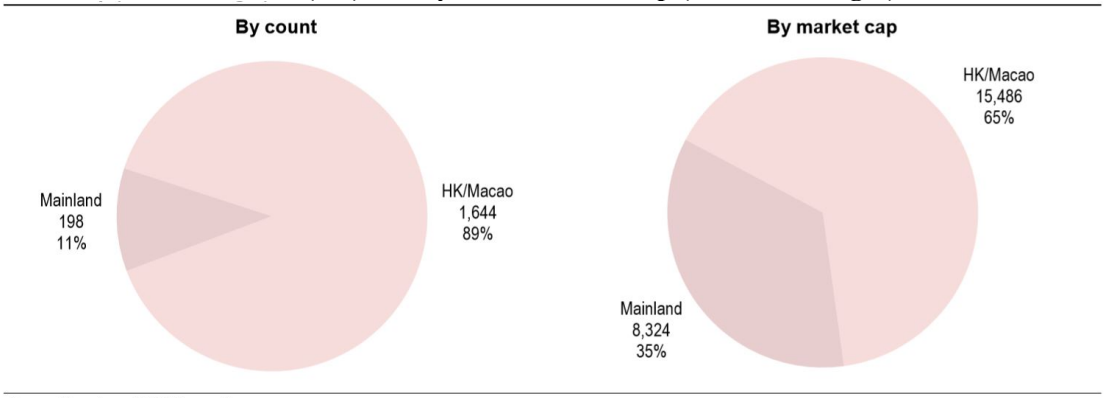


Source: Bloomberg, BOCI Research

For the domestic listed firms from the GBA, Shenzhen holds a dominant position with a 55% share in total, followed by Guangzhou (19%), Foshan (7%), Dongguan (5%), Zhuhai (5%), Zhongshan (4%), Jiangmen (2%), Huizhou (2%) and Zhaoqing (1%). By market cap, Shenzhen enjoys a position even more prominent, making up 67% of the total, followed by Guangzhou (14%), Foshan (8%), Zhuhai (5%), Zhongshan (2%) and others smaller than 2%. Obviously, the average size of Shenzhen listed firms (RMB19.6bn) by market cap is larger than the rest of the GBA (RMB12bn).

For the overseas listed firms from the GBA (including dual listed ones), Hong Kong/Macau registered companies dominate the table (see Figure 2). A majority of these HK/Macau registered firms are HK locally-generated enterprises (about 1,263), as compared to about 411 firms with parents based in the mainland (mainland background). Although the locally registered HK/Macau firms account for 88% of the total listed stocks in number, they only make up 63% of the pool by market cap. Again, this demonstrates the average market cap of the mainland firms listed on the overseas exchanges (HK$42bn) is larger than that of the HK/Macau firms (HK$9bn).

Figure 2. Overseas Listed Companies from the GBA (Mainland vs. HK/Macau Firms): by Total Number (left) and by Total Market Cap (in HK$ bn, right)



Source: Bloomberg, BOCI Research

To further illustrate the detailed characteristics of the mainland firms listed on the overseas exchanges, we exclude the HK/Macau listed firms from the data set to redraw the geographic distribution profiles (see Figure 3). Again, Shenzhen dominates the table. By total number, Shenzhen makes up 50% of the group, followed by Guangzhou (24%), Foshan (6%), Dongguan (5%), Huizhou (5%), etc. By market cap, Shenzhen makes up 79%, Guangzhou 12%, Foshan 4%, Huizhou 2%, etc. In other words, Shenzhen not only dominates in the total number of overseas listed firms but also boasts a much larger average size in market cap. We will show this point again later in the discussion of Fortune Global 500 Firms from the GBA, as Shenzhen has more Fortune 500 firms than any of the other GBA cities.

3. Industry Profile of GBA Listed Firms

We combine the two data sets (domestic and overseas listed firms) of the GBA to look into the industry profiles of these GBA listed companies. Through these profiles we could see the significance of some industry sectors for each of the GBA cities (see Figure 4).

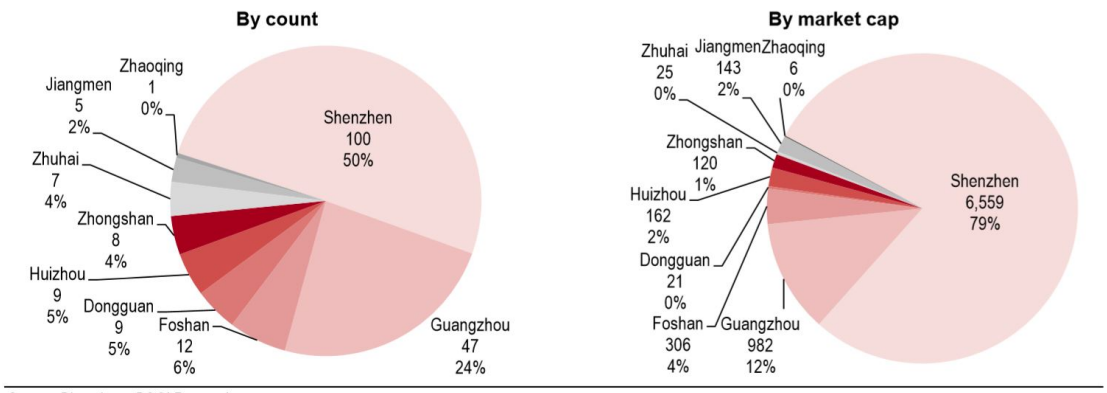
For the larger cities of GBA, such as Hong Kong, Shenzhen, Guangzhou, Macau, Zhuhai, the consumer products & services industry, the technology-centric TMT industry and the financial services industry make up the big portion of their respective pools of listed firms, while for those smaller cities, such as Dongguan, Foshan, Huizhou, Zhaoqing and Jiangmen, industrial firms represent a large portion.

In the technology-centric TMT area, both Shenzhen and Zhuhai boast the highest percentage, demonstrating the significance of technology for their overall economies. Guangzhou, Zhongshan, HK and Zhaoqing also feature sizable percentages.

On the other hand, real estate firms make up a sizable portion of the listed firms for many of the GBA cities and are often more significant than the typical financial sector. This marks the fact that the real estate industry in the GBA is important to the local economies. For example, HK, Guangzhou, Zhuhai, Foshan, Shenzhen and Huizhou all see real estate firms making up a good percentage for each of them.

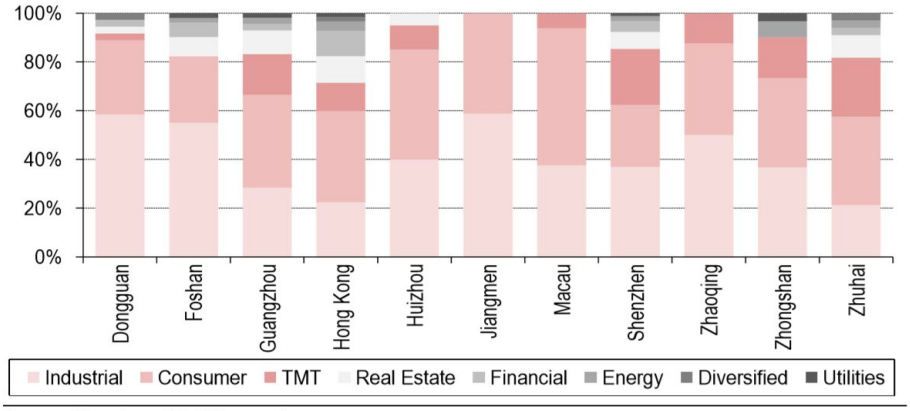
In the aspect of financial firms, Hong Kong boasts the highest percentage. This is naturally expected as HK is truly a global financial centre. Surprisingly, however, Foshan, though by a large distance, also boasts a sizable percentage in this segment, followed by Shenzhen, Guangzhou, Zhuhai and Dongguan.

Figure 3. Overseas Listed Companies from the Mainland Cities of GBA: by Total Number (left) and by Total Market Cap (in HK$ bn, right)



Source: Bloomberg, BOCI Research

Figure 4. Industry Distribution of Listed Firms from the GBA



Source: Bloomberg, BOCI Research

4. What are the Listed Firms Telling Us?

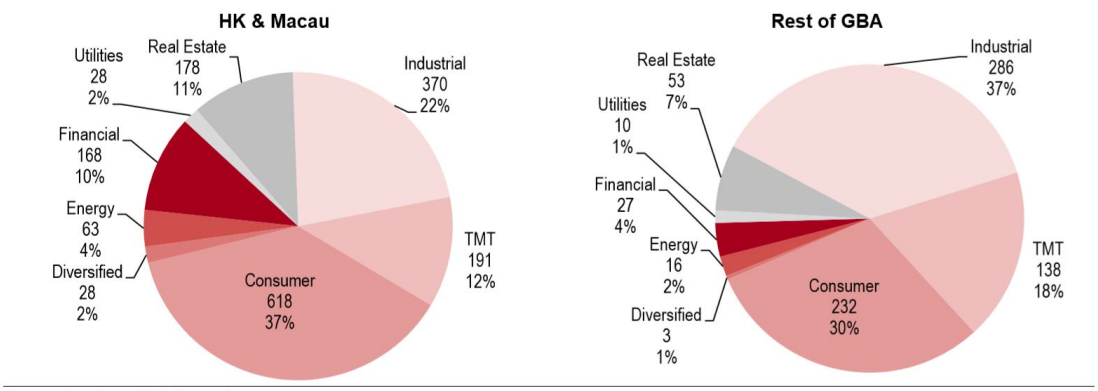
We further look into the relative competitive strengths in different industries between the two distinctive groups of the GBA: the special administrative regions of HK & Macau and the mainland cities of the GBA (the rest of GBA), based on their listed companies (see Figure 5).

HK/Macau features consumer companies as the largest group of listed firms, followed by industrial companies. In comparison, Rest of GBA has industrial companies as the largest group of listed firms, followed by consumer companies.

Away from these two largest groups, TMT is the third largest group for both regions, followed by real estate.

However, in HK/Macau, the typical financial firms (excluding real estate) do make up 10% of their listed firms, but for the Rest of GBA they only account for 4%. If we include real estate firms into the broad financial sector, the broad financial sector represents 21% for HK/Macau, but only 11% for the Rest of GBA. Obviously, the financial sector is a much more important corporate base for HK/Macau than Rest of GBA, based on the listed companies.

Figure 5. Industry Profiles of Listed Companies in GBA: HK/Macau (left) vs. Rest of GBA (right)



Source: Bloomberg, BOCI Research

5. The Top Listed GBA Firms

We also examine the characteristics of top listed firms from the GBA (by market cap) for more colours on the key business profiles of the region and its cities.

Figure 6 shows the top 20 A-share listed firms from the region. Again, Shenzhen firms dominate the table with a total number of 13, followed by Guangzhou's 4 and Foshan's 2. By industry, consumer products & services firms make up the most (7), followed by financials (6) and real estate (3).

Figure 6. Top 20 Listed A-share Firms from the GBA (as of 11 March 2019)

Stock Code	Company	City	Industry	Market cap *(RMB bn)*
601318 CH	Ping An Insurance Group Co of	Shenzhen	Financial	1,277
600036 CH	China Merchants Bank Co Ltd	Shenzhen	Financial	773
601138 CH	Foxconn Industrial Internet Co	Shenzhen	TMT	319
000333 CH	Midea Group Co Ltd	Foshan	Consumer	304
000002 CH	China Vanke Co Ltd	Shenzhen	Real estate	301
000651 CH	Gree Electric Appliances Inc o	Zhuhai	Consumer	270
000001 CH	Ping An Bank Co Ltd	Shenzhen	Financial	212
603288 CH	Foshan Haitian Flavouring & Fo	Foshan	Consumer	201
001979 CH	China Merchants Shekou Industr	Shenzhen	Real estate	168
600048 CH	Poly Developments and Holdings	Guangzhou	Real estate	155
002352 CH	SF Holding Co Ltd	Shenzhen	Industrial	160
300760 CH	Shenzhen Mindray Bio-Medical E	Shenzhen	Consumer	156
002594 CH	BYD Co Ltd	Shenzhen	Consumer	132
000776 CH	GF Securities Co Ltd	Guangzhou	Financial	119
000063 CH	ZTE Corp	Shenzhen	TMT	123
002736 CH	Guosen Securities Co Ltd	Shenzhen	Financial	121
600999 CH	China Merchants Securities Co	Shenzhen	Financial	111
601238 CH	Guangzhou Automobile Group Co	Guangzhou	Consumer	111
600029 CH	China Southern Airlines Co Ltd	Guangzhou	Consumer	87
002475 CH	Luxshare Precision Industry Co	Shenzhen	Industrial	90

Source: Bloomberg, BOCI Research

Figure 7 shows the top 20 listed firms from HK & Macau. Except two firms from Macau (in gaming/entertainment industry), the rest are all from HK. By industry sector, financials have the most (5), followed by consumer, diversified and real estate industries (all at 3), respectively

Figure 7. Top 20 HK Listed Firms from HK & Macau (as of 11 March 2019)

Stock Code	Company	City	Industry	Market cap (HK$ bn)
941 HK	China Mobile Ltd	Hong Kong	TMT	17,322
1299 HK	AIA Group Ltd	Hong Kong	Financial	9,438
11 HK	Hang Seng Bank Ltd	Hong Kong	Financial	3,621
2388 HK	BOC Hong Kong Holdings Ltd	Hong Kong	Financial	3,441
267 HK	CITIC Ltd	Hong Kong	Financial	3,462
388 HK	Hong Kong Exchanges & Clearing	Hong Kong	Financial	3,469
1 HK	CK Hutchison Holdings Ltd	Hong Kong	Diversified	3,100
688 HK	China Overseas Land & Investment	Hong Kong	Real estate	3,112
1928 HK	Sands China Ltd	Macau	Consumer	3,067
762 HK	China Unicom Hong Kong Ltd	Hong Kong	TMT	2,971
66 HK	MTR Corp Ltd	Hong Kong	Industrial	2,886
3 HK	Hong Kong & China Gas Co Ltd	Hong Kong	Utilities	2,810
1113 HK	CK Asset Holdings Ltd	Hong Kong	Real estate	2,384
27 HK	Galaxy Entertainment Group Ltd	Macau	Consumer	2,260
1997 HK	Wharf Real Estate Investment C	Hong Kong	Real estate	1,773
1038 HK	CK Infrastructure Holdings Ltd	Hong Kong	Industrial	1,735
87 HK	Swire Pacific Ltd	Hong Kong	Diversified	1,265
19 HK	Swire Pacific Ltd	Hong Kong	Diversified	1,265
6 HK	Power Assets Holdings Ltd	Hong Kong	Utilities	1,172
288 HK	WH Group Ltd	Hong Kong	Consumer	1,136

Source: Bloomberg, BOCI Research

Figure 8 shows the top 20 listed mainland firms from the GBA in the international markets. Again, Shenzhen firms lead the table with 11, followed by Guangzhou's 5, and 1 for each of the other 4 GBA cities.

Figure 8. Top 20 HK Listed Firms from the GBA excluding HK & Macau (as of 11 March 2019)

Stock Code	Company	City	Industry	Market cap (HK$ bn)
700 HK	Tencent Holdings Ltd	Shenzhen	TMT	34,369
2318 HK	Ping An Insurance Group Co of	Shenzhen	Financial	14,937
3968 HK	China Merchants Bank Co Ltd	Shenzhen	Financial	9,049
2202 HK	China Vanke Co Ltd	Shenzhen	Real estate	3,524
3333 HK	China Evergrande Group	Guangzhou	Real estate	3,268
2007 HK	Country Garden Holdings Co Ltd	Foshan	Real estate	2,394
1211 HK	BYD Co Ltd	Huizhou	Consumer	1,540
763 HK	ZTE Corp	Zhongshan	TMT	1,439
1776 HK	GF Securities Co Ltd	Guangzhou	Financial	1,394
6099 HK	China Merchants Securities Co	Shenzhen	Financial	1,304
2238 HK	Guangzhou Automobile Group Co	Jiangmen	Consumer	1,303
1816 HK	CGN Power Co Ltd	Shenzhen	Utilities	954
1551 HK	Guangzhou Rural Commercial Bank	Guangzhou	Financial	481
2039 HK	China International Marine Containers	Shenzhen	Industrial	360
268 HK	Kingdee International Software	Shenzhen	TMT	315
1606 HK	China Development Bank	Shenzhen	Financial	228
317 HK	CSSC Offshore and Marine	Guangzhou	Industrial	206
867 HK	China Medical System Holdings	Shenzhen	Consumer	199
136 HK	HengTen Networks Group Ltd	Guangzhou	TMT	194
1638 HK	Kaisa Group Holdings Ltd	Shenzhen	Real estate	193

Source: Bloomberg, BOCI Research

6. The Fortune Global 500 Firms from GBA

We expand our study to the Fortune Global 500 firms for more colours. Chinese enterprises have become a major group of constituents in the annual Fortune Global 500 rank. And their weight in this global enterprise ranking survey continues to grow in recent years. Increasingly, many of them come from the GBA (see Figure 9).

For the ranked firms from the GBA, Shenzhen features more companies in the list than other cities of the region. Besides, its ranked companies were also generally placed higher in the ranking table. Specifically, Shenzhen boasts a total of six firms, followed by five from HK, three from Guangzhou and two from Foshan. In fact, China Evergrande Group has moved its HQ from Guangzhou to Shenzhen recently (in August 2018), and China Resources has also recently built its mainland HQ in Shenzhen, both of which are expected to further boost Shenzhen's total Fortune Global 500 count in the next ranking survey.

Again, all of these have demonstrated the continuing rising significance and status of Shenzhen among the GBA cities.

Figure 9. 2018 Fortune Global 500 Firms from the GBA

Rank	Stock code	Company Name	Location	Industry
29	601318 CH/2318 HK	Ping An Insurance	Shenzhen	Financial
72	NA	Huawei Investment & Holding	Shenzhen	TMT
86	NA	China Resources	Hong Kong	Diversified
110	NA	China Southern Power Grid	Guangzhou	Utilities
202	601238 CH/2238 HK	Guangzhou Automobile Industry Group	Guangzhou	Manufacturing
213	600036 CH	China Merchants Bank	Shenzhen	Financial
230	3333 HK	China Evergrande Group	Guangzhou	Real estate
280	NA	China Merchants Group	Shenzhen	Diversified
283	JS SP	Jardine Matheson	Hong Kong	Diversified
295	1299 HK	AIA Group	Hong Kong	Financial
323	000333 CH	Midea Group	Foshan	Manufacturing
331	700 HK	Tencent Holdings	Shenzhen	TMT
332	000002 CH/2202 HK	China Vanke	Shenzhen	Real estate
339	NOBL SP	Noble Group	Hong Kong	Basic materials
353	2007 HK	Country Garden Holdings	Foshan	Real estate
374	1 HK	CK Hutchison Holdings	Hong Kong	Diversified

Source: Fortune, BOCI Research

7. The Case for Each of the GBA cities

Although the public listed companies do not necessarily represent the whole picture of the business and economic status and state of a local municipality, the importance of this subgroup of business and enterprises does offer us some insights into the areas of strength and competitiveness of a city (see Figure 10).

Being an international financial centre and a key capital raising hub for both HK and mainland enterprises, HK is expected to continue to be a world-class business centre attracting companies seeking to list in HK and to set up home base in the city. By this token, HK is expected to continue its leading position in the GBA in having a high congregation of listed firms under its roof. These list firms will continue to span over a wide spectrum of the industry scope, but with a relatively sizable percentage in the financial sector.

Macau is expected to remain a niche and unique player focusing on gaming and entertainment services that offer world-class consumer experience for tourists from China and around the world.

Next in line is Shenzhen, which also has a sizable concentration of listed companies only after

HK, thanks to its advantage as the first Chinese special economic zone, the home for China's second largest stock exchange, the Shenzhen Stock Exchange, and a highly opened market. Shenzhen's meteoric economic rise in modern Chinese history has greatly benefited from, not only the preference policies as a special economic zone, but also from a combination of other important reasons, such as its close proximity to HK, early experience from this neighbour city, the inter-city flows through economic, capital, investment and citizen exchanges between Shenzhen and HK.

Shenzhen has already demonstrated its power base in both financial and TMT industries, as the city features more Fortune Global 500 firms in these two industries than any of the other GBA cities does, including HK. We expect Shenzhen, among the GBA cities, will continue to lead in the technology-eccentric TMT industry, as well as other high-tech industries (AI, semi, healthcare, etc.), to become a world high-tech centre in the future, while also building up a regional financial centre complementing HK.

Guangzhou is expected to further develop into a key regional business and metro hub for the GBA and the southern China with its strengths in manufacturing, consumer, high-techs and real estate.

Zhuhai, plus its satellite neighbour Zhongshan, is expected to develop into a regional business hub complementing and servicing the city of Macau,

For the rest of GBA cities, most of them are expected to become high-end manufacturing bases for both China and the world, with increasing focuses on the high-value end of the supply chain and the downstream end closer to consumers.

Figure 10. Future Perspective for the GBA Cities

City	Industry Strength & Future Significance
Hong Kong	Global consumer & financial services centre
Shenzhen	Global high-tech centre & regional financial centre
Guangzhou	Key regional business hub
Macau	Gaming, entertainment & tourism oasis
Foshan	High-end manufacturing & real estate
Zhuhai	Regional business hub complementing Macau
Dongguan	High-end manufacturing
Huizhou	High-end manufacturing & vocational home/resorts
Zhongshan	Satellite neighbor of Zhuhai
Jiangmen	High-end manufacturing
Zhaoqing	High-end manufacturing

Source: BOCI Research

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Multivariate Filter Estimation and ARDL Model Analysis of China's Potential Output*

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In this paper, we apply a new multivariate filter approach developed by Borio et al. (2014) to estimate China's potential output. Furthermore, we build an ARDL model to analyze the influence on potential growth caused by important factors that contribute to estimation and China's development. Our results show that the current economic slowdown is not a cyclical phenomenon and China's potential growth has declined since 2010. We also show that fix asset investment and trade, which have a long run relationship with potential output, exert negative long-run effect on potential growth justifying the implementation of China's recent supply-side reforms.

Keywords: Potential output; Economic growth; Multivariate filter; ARDL

JEL Classification: C32, C51, E23

1. Introduction

Three decades of China's economy rapid growth is a miracle of world economic development and also becomes a hot academic topic among researchers. However, China's growth has slowed down for almost four years, manifesting the ineffectiveness of government's stimulus policies. Yet it's unclear whether the persistent decrease in actual growth implies a decline of potential growth. Due to the downturn of economy, China is initiating reforms focusing on the supply side of the economy. These reforms include cutting housing inventories, tackling debt overhang, eliminating superfluous industrial capacity and other measures, while few have mentioned the impact of two demand-side factors, i.e. investment and trade, on China's potential growth in past and yet leaving questions for the validity of supply-side reform. To answer these questions, we apply a new multivariate filter approach to estimate China's potential output. Further, we adopt an auto regressive distributed lag(ARDL) model to analyze the influence of investment and trade on China's potential growth.

Potential output, defined as the output that could be achieved without giving pressure on

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inflation or output level realizing full utilization of economic inputs (Okun, 1962; Mishkin, 2007), is a critical notion in macroeconomics. Both short-run policymaking and long-term welfare are associated with the potential output and deviations from it. However, such evaluation of output gap and potential growth is challenging since they are unobservable. Thus economists developed various methods to estimate the potential output. The conventional and prevalent technique is univariate filters (Beverigde and Nelson，1981；Baxter and King，1999；Hodrick and Prescott，1997) which take time series as the combination of different periodic components and analyze them purely from a statistical perspective. Owing to its simple procedure and moderate data requirements, it has been used for decades and is still popular in emerging market economies. On the other hand, to overcome the drawbacks of lacking economic information and strong assumption about output gap, multivariate filter approaches equipped with structural economic relationships (Beneš, Jaromír, et al, 2010; Blagrave, Patrick, et al, 2015) and financial imbalance factor (Borio, Disyatat, and Juselius, 2013) are developed. However most multivariate filter methods could not be adapted to developing countries for two reasons. First, economic relationships, for example the Phillips curve (Nugent, Jeffrey B., and Constantine Glezakos, 1982), may not be satisfied in those countries which makes it insignificant to contain them in the process of estimation. Second, many emerging markets do not provide accurate macroeconomic data about employment rate, inflation deflator and other important information.

In this paper, we aim to avoid issues mentioned above by adopting Borio et al. (2014)'s parsimonious approach and embedding information of fixed asset investment and export in observation equation to estimate potential output. Our results show that China's potential growth has slowed down since 2010 and its actual growth rate fluctuates below the potential rate. The output gap remains positive after government's four-trillion investment plan which had little effect in improving potential growth. Besides, by fitting an ARDL model we find that although fixed asset investment and export as driving the actual output growing for a long time, they are not beneficial for increasing the potential output in the long run which reflects structural issues of China's economy and makes it reasonable to implement the supply-side reform focusing on both long run and high quality growth.

2. Methodology and data

The method we applied is based on benchmark HP filter approach. We assume an AR(1) process for output gap and directly add economic information into the observation equation,

$$y_t = y_t^* + \beta(y_{t-1} - y_{t-1}^*) + \theta' a_t + \varepsilon_{1,t} \quad (1)$$

$y_t$and $y_t^*$are actual and potential output respectively. To avoid the situation that output gap becomes a random walk and its cumulative variance goes to infinity,$|\beta|$needs to be less than one.$\varepsilon_1$is assumed to be normally distributed with mean zero and varianceσ_1^2.$a_t$is a vector of economic variables that contribute to estimating potential output.

The state equation can be written as

$$\Delta y_{t+1}^* = \Delta y_t^* + \varepsilon_{0,t} \quad (1)$$

where$\varepsilon_0$is similar as$\varepsilon_1$but with varianceσ_0^2. Equation (2) implies that potential growth is a random walk. With state equation, the corresponding loss function minimization problem for observation equation is

$$\underset{y_t^*}{Min} \sum_{t=1}^{T} \left[\left((\varepsilon_{1,t})^2 + \lambda_1 (\Delta y_{t+1}{}^* - \Delta y_t^*)^2 \right) \right] \quad (2)$$

The scaling factor, $\lambda_1 = \frac{\sigma_1^2}{\sigma_0^2}$ determines the weight between two terms in (3) among which $\varepsilon_1$depends on both dynamic term and economic variables. To overcome small sample

problem, we need to iterate values of λ_1 to make the potential output estimated by multivariate method$y^*_{MVF,t}$satisfies the condition[1]

$$\frac{var(y_t - y^*_{HP,t})}{var(\Delta y^*_{HP,t} - \Delta y^*_{HP,t-1})} = \frac{var(y_t - y^*_{MVF,t})}{var(\Delta y^*_{MVF,t} - \Delta y^*_{MVF,t-1})} \quad (3)$$

where$y^*_{HP,t}$is HP filter's estimate.

Allowing for the essential properties of information variables[2], the potentially economic variables include fix asset investment and trade which are widely believed as important forces for China's economic growth (Qiao Yu, 1998). Their annual growth rate are 21.1% and 18% respectively since 1978's initiation of Reform and Opening policy[3] which not merely power China's GDP growth but also improve total factor productivity. In addition, the recent financial crisis and asset boom-bust cycle in many countries show that financial sector can exert influence on real sector (Claessens et al., 2012). Especially in China, fixed asset investment and export are closely related to bank loans due to the banking oriented financial system and compulsory exchange settlement mechanism. Most part of state owned enterprises funding resource is loans (F. Allen et al., 2005) and tremendous quantity of debt related to banking sector becomes a potential factor for financial imbalance in China nowadays. Thus, we choose fixed asset investment, trade and loan as economic variables and embed them into observation equation. We also add export and real estate investment into analyzing process after the estimation.

Table1. Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
GDP	134662.8	140185.4	5234.8	636138.7
Trade	3908.988	3595.006	286.69	11425.9
Fixed Asset Investment	32306.86	41227.1	315.36	159620.6
Export	2102.155	1946.158	149.69	6457.64
Real Estate Investment	6393.512	7811.997	29.04	27304.31
Loan	24533.61	26008.02	496.42	97800

The data are quarterly and estimation period is from 1993q1 to 2015q2.Samples are collected from People's Bank of China and CEInet Statistics Database. Seasonality problem is avoided by using X-12 method. And we use Kalman filter to form the likelihood of the system with gamma priors and maximize the posterior density function with respect to parameters[4] and regressors with lags of up to four periods are allowed to go into models.

3. Results and Analysis

By adding different economic information, we find that both fixed asset investment and trade contribute to estimate potential output and they are statistically significant when embedded together. Thus, we use model 4 to get the estimates.

Table 2. Estimation Results of Observation Equation

1 The reason for using condition (4) is that we add dynamic terms in observation equation and may cause the scaling factor setting too little weight on reducing potential output variability compared to standard HP filter. Detailed explanations can be found in Borio et al. (2014).

2 The properties that make economic variables significant in observation equation include two aspects. One is that variables should be correlated with output at specific frequencies setting by scaling factor and the other one is that variables should have stable means. Thus, we follow Borio et al. (2014)'s method using Cesàro mean to de-mean all economic variables so that they can meet the requirement of the approach.

3 The growth rates are computed by using the data from "China Statistical Yearbook".

4 Assumptions for prior mean and standard deviation of auto-regressive parameter and scaling factors are following Borio et al.(2014) and Chang C, Chen K, Waggoner D F, et al.(2015)'s work. As prior distribution, we assume the gamma distribution with standard deviation of 0.3 for all parameters and the prior mean for auto-regressive parameter is 0.65 of which the interval is between 0 and 0.95. Coefficients for economic information variables have prior means equal to 0.4.

	β	θ_1 Loan	θ_2 Fixed Asset Investment	θ_3 Trade	λ_2 Scaling Factor
Model 1	0.9500***	0.0392			6.5100
	（13.5412）	（1.1189）			
Model 2	0.9497***		0.1131**		6.1500
	（9.5754）		（1.9747）		
Model 3	0.9499***			1.8756***	3.2900
	(7.5712)			(6.1723)	
Model 4	0.9480***		0.1013***	1.8016***	6.0500
	（13.5417）		（2.5018）	（14.2544）	

Note: ***, ** and * denote statistical significance at the 1%, 5% and 10% levels, respectively. Numbers in parentheses are t statistics. The notation denotes same meaning in table 3.

Table 3. Results from ARDL Model Estimation

Model 1 ARDL (1,2,2)			
Short Term Effect Coefficients			
Δinvestment$_{t-1}$	0.0099***	Δtrade$_{t-1}$	0.0546*
	（2.7304）		（1.7832）
Δinvestment$_{t-2}$	0.0067*	Δtrade$_{t-2}$	0.0375
	（1.8816）		（1.0999）
Long Term Effect Coefficients			
investment	-0.0048***	trade	-0.0864***
	（-3.1207）		（-3.9506）
Bounds Test			
5.1620			
5% Significance Level		1% Significance Level	
I0 Bound	I1Bound	I0 Bound	I1Bound
3.79	4.85	4.41	5.52
Model 2ARDL (1,1,1)			
Short Term Effect Coefficients			
Δinvestment$_{t-1}$	0.0252*	Δtrade$_{t-1}$	0.0818
	（1.9218）		（1.4628）
Long Term Effect Coefficients			
investment	-0.0309***	trade	-0.0923**
	（-3.7011）		（-2.4097）
Bounds Test			
0.7656			
10% Significance Level		5% Significance Level	
I0 Bound	I1Bound	I0 Bound	I1Bound
3.17	4.14	3.79	4.85

Note: Variables in ARDL model follow the order as GDP, investment and trade. Instead of using fix asset investment and trade as regressors in model 1, we use real estate investment and export in model 2.

Figure 1 shows China's potential output keeps declining since 2010 with real growth rate fluctuating below it. Although government's stimulus plan has slight influence on raising real

growth, it was not effective on improving potential growth thus leaving real growth decreasing subsequently. With the knowledge of the trend for potential output, we could tell the slowdown of China's economic growth is not a cyclical phenomenon but a result of potential growth fall.

Figure 1 Potential and Real Growth Rate

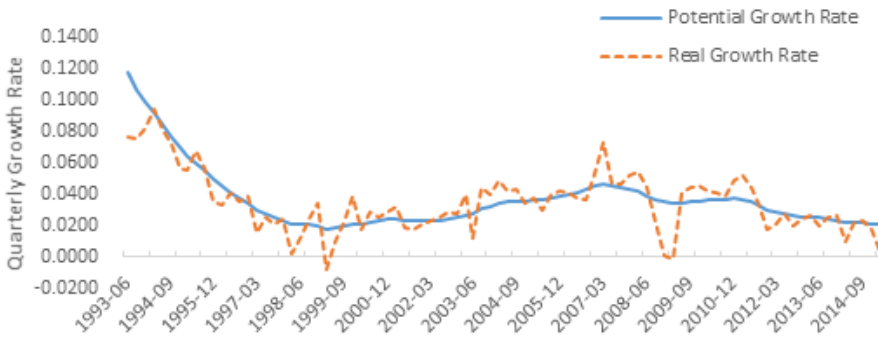
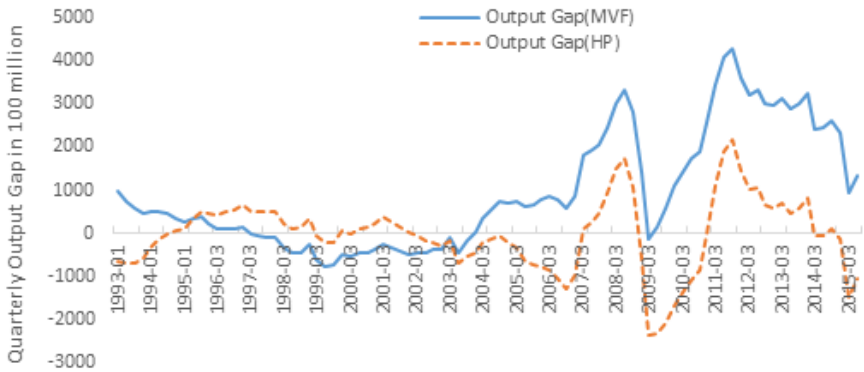


Figure 2 compares multivariate filter approach with standard HP filter results. Large differences appear after 2008's financial crisis. Significant negative output gap emerges in HP filter approach, while it doesn't show up in multivariate filter approach. Taking government four-trillion investment plan into consideration, positive output gap is more in line with China's real performance since China successfully stimulates the demand side in a short time with tremendous government investment followed by asset bubble, over-capacity issue and local government debt risk nowadays.

Figure2 Comparison of Output Gaps



To further analyze potential growth, besides total fixed asset investment and trade, real estate investment and export are used in ARDL model to examine how the most important components in these two areas affect growth. Meanwhile, we can check the robustness of the regression. Following Pesaranet al.(1999)'s method, the error correction form of ARDL model can be written as,

$$\Delta g_t = c_0 + \sum_{j=1}^{n} a_j \Delta investment_{t-j} + \sum_{j=1}^{n} b_j \Delta g_{t-j} + \sum_{j=1}^{n} d_j \Delta trade_{t-j} + n_1 investment_{t-1} + n_2 g_{t-1} + n_3 trade_{t-1} + \varepsilon_t \quad (4)$$

a_j and $b_j$measure short-run effects on dependent variable and coefficients n_1,n_2,n_3 represent

long term influences. Potential output is set as the dependent variable while investment, trade and lagged value of these variables are independent variables. By using bounds test (Pesaran et al.,2001), the existence of level relationships between these variables are tested. The reason for using bounds test is that it can be well adapted on small sample without the certainty that underlying regressors are trend- or first-difference stationary. The null hypothesis of bounds test are $n_1 = n_2 = n_3 = 0$. AIC criterion is adopted to obtain lagged rank for independent variables in ARDL model.

The results show that all factors have negative long run effect on potential growth. However, they have positive short run effect, especially when it comes to investment factor. Hence, these factors are beneficial in improving short-term economic performance, while they cause path-dependence issue of China's growth and imbalance between internal and external economy which finally harm the long run performance. Besides, fixed asset investment, trade and output have long run relationship. Meanwhile, no significant evidence is found for export and real estate investment according to bounds test.

4. Conclusion

We apply a new multivariate filter approach to estimate China's potential output which embeds economic information and avoids estimation problems that other methods may face when used in developing countries. In addition, ARDL models are built to analyze influences on potential output caused by factors that are crucial in China's economy. The results show that China's potential growth has declined since 2010. Besides, fixed asset investment and trade have negative long-run effect on potential growth which becomes more serious when focusing on real estate investment and export part. The former two have long-term relationship with potential output and all results show the rationale for the implementation of China's recent supply-side reforms which focus on improving economy structure and potential growth, thus achieving rapid and sound development.

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The Role of Derivatives in Hedge Fund Activism*

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Using a hand-collected sample of hedge fund activist engagements from 1994 to 2014, this study analysed the role of derivatives in the hedge fund activism. Evidence shows abnormal returns of targets of hedge fund activists who did not use derivatives exceeded the abnormal returns of targets of hedge fund activists who employed derivatives around the activist engagement disclosure period. We also find that idiosyncratic volatility of targets of hedge fund activists who did not use derivatives was more reduced than those of targets of hedge fund activists who used derivatives. Finally, the probability of takeovers increases for hedge fund activists who did not use derivatives.

Keywords: Hedge Funds; Investor Activism; Mergers & Acquisitions; Event Studies; Derivatives

JEL Classification: G14, G34

1. Introduction

Activist hedge funds have been on the rise and their organisational structure position them to be efficient activists. Lack of regulation in the hedge fund industry also plays a major role in providing hedge funds with enough flexibility to undertake activist demands. For instance, hedge funds are not subject to the ERISA or "prudent man" regulations and are not required to maintain high levels of diversification to receive preferential tax status. Hedge funds typically "lock-up" investor capital for a long period of time to carry out their strategies and therefore cannot be redeemed freely. Mutual funds, on the contrary, are required to maintain high levels of liquidity and must meet daily withdrawal requests, if any. This is exactly where hedge funds have an edge over activist mutual funds on the aspect of undertaking activist engagements, especially when activist campaigns require the activists to hold large, illiquid blocks of assets for prolonged periods of time. This paper studies the financial derivatives which is a commonly used instrument by hedge fund managers and often believed to be highly effective while undertaking activist engagements.

Example: Bill Ackman vs. Herbalife: An example of derivatives used by activist hedge funds

One of the most popular hedge fund activist engagements was William Ackman's Pershing Square Capital Management targeting Herbalife. William Ackman's Pershing Square Capital Management bet $1 billion against Herbalife after accusing it of running a pyramid scheme. In 2013, Ackman swapped more than 40% of his shares for put options, as per Pershing Square's investor letter. The letter stated as follows:

"In order to mitigate the risk of further mark-to-market losses on Herbalife, in recent weeks we have restructured the position by reducing our short equity position by more than 40% and

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replacing it with long-term derivatives, principally over-the-counter put options. The restructuring of the position preserves our opportunity for profit – if the Company fails within a reasonable time frame we will make a similar amount of profit as if we had maintained the entire initial short position – while mitigating the risk of further substantial mark-to-market losses – because our exposure on the put options is limited to the total premium paid. In restructuring the position, we have also reduced the amount of capital consumed by the investment from 16% to 12% of our funds."

According to the letter, Mr. Ackman recognised losses and covered $400 million worth of Herbalife stock by buying OTC put options. This led him to limit his losses from the stock going up further. Ackman and Pershing Square would have profited if the stock declined below the strike prices and would have only made a minor loss per share if the stock stayed at the same level or went up (La Roche, 2013). William Ackman's use of put options in his battle against Herbalife is a classic example of how hedge fund activists utilised derivatives.

There are a number of reasons for the popularity of derivatives among hedge fund activists. First of all, the lack of regulation plays a key role. For instance, there were many cases in which hedge fund activists used "empty voting"[1] strategies (Anabtawi and Stout, 2010). Derivatives are very often used as constituents of activist strategies, because they are almost unregulated, leveraged, unstandardized and opaque. The lack of regulation was recorded by Helleiner and Pagliari (2010) , who found that in the cases of hedge funds, regulators focused on the "indirect regulation", that is, they emphasized on overseeing the involvement of bank lending while encouraged hedge funds and their bank counterparties to self-regulate and disclose information to the markets.[2] Secondly, the lack of legal barriers that restrict hedge funds from over leveraging and excessive short selling, as evidenced by (Shadab 2009), also implicitly encourages activist hedge funds towards derivatives. Moreover, hedge funds are typically exempt from the Company Act which imposes heavy regulations upon financial institutions against risky betting. Specifically, under the Company Act, entities that are using short sales or derivatives must hedge their positions in a segregated account. Since this is not applicable to hedge funds, their positions of derivatives can be very aggressive, and, as a result, can be more effective while pursuing activist strategies. Shadab (2009) also found that the superior performance of hedge funds was attributable to the legal regime under which hedge funds operated, thereby allowing them to pursue the aforementioned innovative investment strategies. The research by Chen (2011) provides further evidence that hedge funds using derivatives exhibit lower fund risks (e.g., market risk, and event risk) and are less likely to liquidate in a deteriorated market condition. Chen (2011) also finds that derivatives are more used by hedge funds that require higher minimum investment, charge higher fees, have shorter capital lockup periods[3], and employ effective auditing services. Overall, existing literature has indeed justified why hedge funds introduce derivatives as part of their trading strategies.

However, according to Partnoy (2015), activist hedge funds were found to have rarely used derivatives. They instead chose to buy "undervalued" stocks outright of the targeted firms. Furthermore, according to a study by Deloitte (2014), the additional costs arising from credit valuation adjustment (CVA)[4] charges were found to have been the highest for equity derivatives. This could be one of the reasons why most activist hedge funds prefer to directly buy the target stock instead of purchasing derivatives. After all, given that the use of derivatives places hedge funds in a unique position, there is a possibility that hedge fund activists benefit from using

1 "Empty voting" strategy involves the activist separating the right to vote shares from the beneficial ownership of these shares.
2 Also see EICHENGREEN, B. 2003. Governing global financial markets: international responses to the hedge-fund problem. Governance in a Global Economy: Political Authority in Transition, 168-198.and ROBOTTI, P. 2006. Mapping the regulatory debate on hedge funds: a political analysis. FMG Discussion Paper, London, Financial Markets Group at the London School of Economics.
3 See also (Greenwood and Schor, 2009).
4 CVA can be described as the market value of counterparty credit risk.

derivatives. This paper is keen to explore whether the use of derivatives enables hedge fund activists to create additional value.

In this study, we construct a set of hand-collected samples of engagements by hedge fund activists, and we use this dataset to measure market reactions when activists use derivatives to hoard targeted stocks and disclose their stakes in the targeted companies. Our research also tries to study the possibility of derivatives as an instrument to drive down the price volatility of the targeted stock. And, most importantly, the role of derivatives is examined with respect to the most profitable[5] and popular activist strategy: mergers.

Empirical results of our research provide valuable contributions towards understanding the role of derivatives in hedge fund activist engagements. Firstly, we find that the market reacts positively to targets of hedge fund activists around the period of disclosure irrespective of whether hedge fund activists used derivatives or not. However, the abnormal returns of targets of hedge fund activists who did not use derivatives exceeded the abnormal returns of targets of hedge fund activists who used derivatives and the difference was statistically significant. This result suggests that the market believed that hedge fund activists who purchased the target shares directly had a higher probability of successful activism than those who adopted a "wait-and-watch" approach by using derivatives. Secondly, both hedge fund activists who used derivatives and did not use derivatives aided in the reduction of idiosyncratic volatility of their targets post the announcement date. However, the idiosyncratic volatility was found to have reduced more for targets of hedge fund activists who did not use derivatives. Finally, hedge fund activists who did not employ derivatives increased the probability of takeovers of their targets, thereby justifying the positive market reaction towards these targets. Greenwood and Schor (2009) attributed positive abnormal returns experienced by the target around the activist engagement period to the ability of the activist to push for the sale of the target. Furthermore, we found that the hedge fund activists who did not use derivatives targeted smaller companies compared to the targets of hedge fund activists who used derivatives. This made it easier for the hedge fund activists to pursue the sale of the target without having to seek an increase in effective ownership stakes through the usage of derivatives (Hu and Black, 2007).

The contribution of this paper is threefold: First, this is the first paper that analyses the role of derivatives in hedge fund activism in a comprehensive manner. Earlier studies have considered the possibilities of derivatives influencing hedge fund activism, but have not studied the role of derivatives within a context of volatility. Second, this paper studies the market reaction to the use of derivatives by hedge fund activists. Third, our paper provides a testing ground for studying the value creation through the usage of derivatives. Greenwood and Schor (2009) found that the abnormal positive reactions experienced when an activist disclosed its stake was attributed to the ability of the activist to force the company to be acquired. Becht et al., (2017) further supported the finding by concluding that takeovers are the most popular activist engagement. Our finding suggests that hedge fund activists who did not use derivatives increased the probability of takeover of their target companies, thereby indicating that derivatives are ineffective financial instruments while undertaking activist engagements.

The rest of the paper is structured as follows: Section II reviews relevant literature. Section III states the hypotheses. Section IV describes our dataset. Section V outlines the methodology used for empirical analysis. Section VI provides empirical results and discussion. Section VII concludes the paper.

5 See GREENWOOD, R. & SCHOR, M. 2009. Investor activism and takeovers. Journal of Financial Economics, 92, 362-375. And BECHT, M., FRANKS, J. R., GRANT, J. & WAGNER, H. F. 2015. The returns to hedge fund activism: An international study.

2. Review of Literature

Since the SEC adopted the Regulation MA-related "free communication" Rule 14a-12 in 1999 (Briggs, 2006), there was a boom in hedge fund activism in the United States. As a result, a number of studies have examined the impact of activism on hedge fund firm performances.

Brav et al. (2008) pioneered this area to analyse the impact of hedge fund activism using a large sample over the time period between 2001 and 2006. Their paper found that hedge fund activists proposed strategic, operational, and financial remedies with success or partial success in two-thirds of the cases. Clifford (2008) found that certain features of hedge funds like longer lock-ups and withdrawal notification periods played a major role in assisting their activist efforts. The targets of hedge fund activists were found to have large excess returns in equity investments as well as improved operating performance because of activist outcomes. The paper also found that hedge fund activists generated significantly greater returns compared with their passive peers, thereby concluding that their returns could have mitigated their monitoring costs. Academic interests in this field are not confined in US market. Becht et al. (2010) studied 362 European activist interventions using a sample that included both public and private interventions. The public activist interventions were associated with positive abnormal returns around the time of activist stake disclosures. Private activism generated less returns compared to public activism and this was attributed to the finding that public activism was associated with a higher probability of takeovers. Mooradian and Boyson (2009) studied the influence of intense[6] hedge fund activism on target firms. They found that targets of intense hedge fund activists showed strong improvements in operating performance for up to three years following the activism, whereas the remaining targets did not. It was also found that all hedge fund activists, both intense and non-intense, gained from the improved target stock performance during the activism period. Boyson and Mooradian (2011) found that activist hedge funds improved both short-term stock performance and long-term operating performance of the target firms and concluded that activist hedge funds benefitted target firms' shareholders and the hedge funds themselves. Many studies also showed that hedge fund activists were also known to have created positive long-term impact on their target firms. He et al. (2016) studied the impact of hedge fund activism on corporate innovation and found that innovative firms were as likely to be targeted by hedge fund activists as non-innovative firms. They also found that activist hedge funds generated positive abnormal returns to shareholders during a 5-year period post intervention, thereby concluding that activist hedge funds were not myopic investors and that they generated long-term benefits to shareholders by enhancing output of their targets. However, Bebchuk et al. (2017) tested the empirical validity of the claim that interventions by hedge fund activists had a detrimental effect on long-term interests of companies and their shareholders and found that the data did not support this claim.

To sum up, existing literature generally agrees on the meaningful efforts by hedge fund activists, but very few studies examined the mechanism through which activist hedge funds created value. For instance, Greenwood and Schor (2009) attributed the positive abnormal returns of target firms around the time an activist disclosed its stake to the ability of the activist to force the company to get acquired. This argument is supported by Becht et al.(2017) who find that takeovers are the most profitable activist strategy. Boyson et al. (2017) found that activism mergers are more likely when the activist hedge fund has a record of aggressive intervention, substantial prior merger experience, or has switched from passive to activist ownership. They further found that value creation through activism mergers to have arisen from monitoring target

[6] Activists were classified as "intense" if the activist hedge fund acquired all or a portion of the target firm's stake in a setting other than open market and when one of the following conditions remained valid: either the activist hedge fund's filing with the SEC stated a specific activism agenda or the activist hedge fund obtained more than one type of the target firm's securities.

management and are not explained by bidder overpayment.

This paper studies the role of derivatives in the hedge fund activism. We examine the question whether the ability to use derivatives provides activist hedge funds with any additional advantage while undertaking activist efforts. Hu and Black (2007) found that hedge funds routinely used leverage and options to increase their effective ownership in target firms. They found that decoupling votes and shares using equity derivatives and other capital market developments was efficient. They also found that hedge funds have held more votes than economic ownership (a situation known as "empty voting") while at other times they held undisclosed economic ownership without votes, but often with the *de facto* ability to acquire votes if needed (a situation known as "hidden ownership"). Therefore, the study by (Hu and Black, 2007) suggests that it is possible that derivatives play an important role in achieving activist efforts. Our study not only aims to examine the role of derivatives to understand how the market responds when hedge fund activists adopt "empty voting" or "hidden ownership", but also analyse whether the derivatives enable hedge fund activists to increase the probability of sales of the target firms.

3. Hypotheses

The purpose of this paper is to answer two research questions: (1) Do hedge fund activists create more value for their targets by using derivatives? (2) Does the use of derivatives increase the probability of takeovers involving hedge fund activists? Accordingly, our proposed testable hypotheses are:

H1: Hedge Fund Activists Create Short-Term and Long-Term Value to Target Firms Using Derivatives.

Testing H1 helps us to analyse why activist hedge funds rarely use derivatives (Partnoy 2015). We examine this by testing the market reaction when hedge fund activists using derivatives announce their stakes in the target firms. Testing H1 would also help to analyse whether the market has high expectations on hedge fund activists exercising their derivatives to achieve a successful activist engagement. If activist hedge funds create short-term value and/or long-term value to their targets by using derivatives to undertake activist engagements, then our finding should encourage more hedge fund activists to use derivatives. And if not, then it would justify why only a few activist hedge funds resorted to derivatives.

H2: The Use of Derivatives has a Positive Influence on Hedge Fund Activist's Target Share Price Volatility.

Literature found that using derivatives resulted in a decrease in the volatility of the underlying stocks. Skinner (1989) found that the variance of the stock returns decreased by an average of 4.8% as a result of options on those stocks. Conrad (1989) found that variance on excess stock returns reduced from 2.29% to 1.79% as a result of derivatives. Bansal et al. (1989) concluded that the volatility reduced by 6.4% after options are listed. Therefore, tests of H2 reveal whether the hedge fund activists are able to reduce idiosyncratic volatility by using derivatives. If the use of derivatives is the reason for the reduction of idiosyncratic volatility, then the importance of derivatives in hedge fund activism is highlighted.

H3: Hedge Fund Activists Increase the Probability of Takeovers of Target Firms Using Derivatives.

Greenwood and Schor (2009) showed that the positive abnormal returns realized by activist targets are due to the ability of the activist to force the company to be acquired. And these results were reinforced by Becht et al. (2017). Exercising derivatives would enable the activist to gain more shares, and thereby owning more voting power. As a result, there is a greater probability for takeovers involving activists. Testing H3 could help to understand whether the use of

derivatives increases the success of takeovers.

4. Data

The sample of hedge fund activist engagements is constructed from the SC 13D filings. Every institutional manager, including an activist hedge fund, is to file a Schedule 13D filing with the Securities and Exchange Commission (S.E.C.) if they acquire more than 5% of a publicly listed firm. Documents are required to be filed within 10 days post the purchase of the company's securities. The SC 13D filings outline the size of the purchase and investors' intentions. Since 2000, it has been a common practice for an activist to attach a letter to the target firm's management and board within their SC 13D filings (Greenwood and Schor, 2009). Each individual SC 13D filing contains 8 items. Items that are meaningful to this study include: "Item 4: Purpose of Transaction" announcing the intention of the activist; "Item 1: Security and Issuer" clarifying the type of security purchased, including derivative contracts if any adopted; "Item 3: Source and Amount of Funds or other consideration" summarizing the source and the amount of funds for each activist effort; "Item 5: Interest in the Securities of the Issuer" illustrating the voting rights of the activist, and other security related information; "Item 6: Contracts, Arrangements, Understandings, or Relationships with Respect to Securities of the Issuer" disclosing any underlying derivative contracts, or other arrangements made by the activist pertaining to the target firm.

Our database of activist is built as follows: First, the list of activists is recorded from the Thomson Reuters Shareholder Activism Intelligence database. And the SEC EDGAR database is then accessed and the raw Schedule 13D filings of each activist are documented. All the eight items are recorded initially, and then classified based on "Item 4: Purpose of Transaction". Types of activist are identified and recorded according to their website information together with websites such as WhaleWisdom. As a result, our sample consists of 5,926 activist events by 872 activists in a period between 1994 and 2014. Activists are classified as: hedge funds, financial institutions, private equity companies, investment managers, investment companies, individual investors, industrial owners, pension funds, and shareholder committees. Because this study focuses on hedge fund activists, so a filtration is then followed. And our final activist sample pertaining to hedge fund activist records a total number of 3,806 SC 13D filings filed by 290 activist hedge funds. After screening Items 1, 3, 5, and 6 of each SC 13D filing of hedge fund activists, there are 275 activism events where hedge fund activists introduce derivatives[7]. The distribution of hedge fund activist engagements with derivatives is outlined in Appendix A. In Appendix A, there was a major drop in the use of derivatives in the years of 2008, 2009 and 2010. This suggests the use of derivatives was heavily influenced by the 2008 financial crisis. It also shows derivatives were once again popular post the financial crisis in 2013-2014. After merging and cross-matching with stock prices (CRSP) and accounting information (COMPUSTAT), our consolidated sample consists of 175 activism events. After all, the number of 175 is not many, and an important reason for this limited number of observations is because most hedge fund activists aim to be more pro-active in their activist engagements instead of adopting a "wait-and-watch" approach by purchasing derivatives. In order to analyse the short- and long-term market reactions, a matching procedure is then adopted. The matching sample is constructed based on the year, size and market-to-book ratio of the targets.[8] The matched sample contains 241 observations.

[7]The derivatives here include options, futures, and forwards.
[8] Detailed procedures of how to match samples are available upon request.

5. Methodology

5.1 CAR

To analyse the gain experienced around the time hedge fund activists using derivatives disclose their stakes in the target firms, the announcement period excess returns were measured by computing cumulative abnormal returns (CARs). According to Moeller et al.(2004), this is done by using standard event study methods, and abnormal returns are computed over an 11-day event window [-5, +5]. These announcement period excess returns are computed using the market model as shown in equation (1):

$$AR_{it} = R_{it} - (\alpha + \beta R_{mt}),\ \text{t=1,2,...,T.} \quad (1)$$

where, AR_{it} stands for the abnormal return of a target company i on time t; R_{it} is the return of the target company i on t, and R_{mt} is the market return on time t (measured by the CRSP value-weighted index return). The excess returns of the target companies around the time when hedge fund activists disclose their stake is the sum of the abnormal returns over the 11 days (-5 to +5) surrounding the announcement day of the activist engagement as shown in equation (2):

$$CAR_i = \sum_{t=-1}^{t=+1} AR_{it} \quad (2)$$

5.2 BHAR

We then calculate the buy-and-hold abnormal returns (BHARs) to examine the long-run announcement period gains to both targets of hedge fund activists who use derivatives and the targets of hedge fund activists who do not use derivatives. To compute BHARs, we follow the methodology by Liang (2008):

$$BHAR_{iT} = \prod_{t=1}^{T}(1 + R_{it}) - \prod_{t=1}^{T}(1 + R_{mt}) \quad (3)$$

where $R_{it}$and R_{mt} stand for the monthly stock return and the market return, respectively. We further define the mean BHAR over a time period T as:

$$BHAR_T = \frac{1}{n}\sum_{i=1}^{n} BHAR_{iT} \quad (4)$$

5.3 Factor Models

To examine the influence of derivatives on the cumulative abnormal returns, the 11-day CARs are regressed against a set of control variables:

$$\mathrm{CAR_i} = \alpha + \beta_1 \mathrm{Derivative} + \beta_2 \ln(\mathrm{MV}) + \beta_3\left(\frac{\mathrm{M}}{\mathrm{B}}\right) + \beta_4 \mathrm{Leverage} + \beta_5\left(\frac{\mathrm{CF}}{\mathrm{E}}\right) + \beta_6(\mathrm{Cash}) + \beta_7\left(\frac{\mathrm{P}}{\mathrm{E}}\right) + \mathrm{f_t} + \varepsilon \quad (5)$$

The CAR_i in equation (5) is the 11-day CARs computed using the market model. The key variable of interest is the dummy variable "Derivative", which takes the value of 1 for targets of hedge fund activists who used derivatives and 0 for targets of hedge fund activists who did not use derivatives. All the other control variables are explained in Appendix B. Equation (5) also accounts for the year fixed effects.

In addition, in order to study whether the use of derivatives increases the probability of takeovers involving hedge fund activists, a Probit model is constructed as follows:

$$\text{Acquired} = \alpha + \beta_1 \text{Derivative} + \beta_2 \ln(\text{MV}) + \beta_3 \left(\frac{\text{M}}{\text{B}}\right) + \beta_4 \text{Leverage} + \beta_5 \left(\frac{\text{CF}}{\text{E}}\right) + \beta_6 (\text{Cash}) + \beta_7 \left(\frac{\text{P}}{\text{E}}\right) + \varepsilon \quad (6)$$

The dependent variable in equation (6), the "Acquired", is a dummy variable that takes the value of 1 for targets that are acquired and 0 for targets that remain independent following the involvement of hedge fund activists.

5.4 The Idiosyncratic Volatility

The idiosyncratic price volatility of the target stocks by hedge fund activists is then examined. The purpose of doing this is to reveal the possible impact of the derivatives on the market reaction as well as on the volatility of stock prices around the time when the hedge fund activist disclosed their stakes in the target firms. This study follows the three-step approach by Bali and Cakici (2008) to compute the idiosyncratic volatility:

Step 1: The return of each stock is assumed to be driven by a common factor and firm-specific shock ε_i. By assuming a single-factor return generating process, idiosyncratic volatility is then measured relative to a traditional CAPM:

$$R_{i,t} - r_{f,t} = \beta_{i,t}(R_{m,t} - r_{f,t}) + \varepsilon_{i,t} \quad (7)$$

In equation (7), $R_{i,t}$ is the return on a stock i; $R_{m,t}$is the market return; $r_{f,t}$is the risk-free rate; $\varepsilon_{i,t}$ is the idiosyncratic return.

Step 2: The market model is then estimated:

$$R_{i,t} = \alpha_{i,t} + \beta_{i,t}(R_{m,t}) + \varepsilon_{i,t} \quad (8)$$

Step 3: The idiosyncratic volatility of stock i is measured as the standard deviation of the residuals:

$$IVOL_{i,t} = \sqrt{var(\varepsilon_{i,t})} \quad (9)$$

6. Results and Discussion

Table 1 outlines the summary statistics of targets of hedge fund activists who use derivatives as well as the matching sample. Results in Table 1 suggest that hedge fund activists use derivatives while targeting large companies, as evidenced by comparing market values. This is consistent to the fact that hedge fund activists prefer "hidden ownership". Large companies are typically held by many shareholders. As a result, they tend to be difficult targets for the activists to pursue activism. Hence, hedge fund activists could opt for holding undisclosed economic ownership without votes, but often with the *de facto* ability to acquire votes if needed through the use of derivatives. This situation is known as "hidden ownership" (see Hu and Black, 2007).

Table 1. Summary Statistics of Targets of Hedge Fund Activists Using Derivatives

	Firm characteristics							
	Combined sample		Derivative sample		Matching sample		Difference (Derivative–Matching)	
	Mean	*N*	Mean	*N*	Mean	*N*	Mean	*P*-Value
MV ($mil)	2187.6	416	2954.98	175	1630.33	241	1324.65***	0.0000
Ln(MV)	13.43	410	13.59	174	13.31	236	0.28	0.1150
M/B	2.186	416	2.197	175	2.177	241	0.020	0.9310
Leverage	0.3624	411	0.3785	173	0.3508	238	0.0277	0.3260
Cash Flows/Equity	0.00003	407	0.00004	173	0.00002	234	0.00002	0.3940
Cash	225.95	413	293.96	174	176.49	239	117.47***	0.0054
Cash/Assets	0.1092	413	0.1021	174	0.1144	239	−0.0123	0.2916
P/E	18.07	401	22.16	170	15.07	231	7.09	0.1211

Notes: This table presents summary statistics for the full sample of hedge fund activist engagements, portioned by the engagements where hedge fund activists used derivatives and matching engagements. All variables are defined in appendix 2. Continuous variables are winsorized at the 2 and 98% levels. *P*-Values are shown in parentheses. *T*-test is used to test the difference in means. Statistical significance at the 1, 5 and 10% levels are denoted as ***, ** and *, respectively.

We then examine the market reaction towards disclosure announcements by hedge fund activists who use derivatives and compare the corresponding gains with the matching sample. The results of the difference between the 11-day CARs[9] of the two samples are displayed in Panel A of Table 2. As evidenced by Table 2[10], although the market reacts positively when hedge fund activists, who use derivatives, disclose their stakes in the targets, the gains are larger in the case where the hedge fund activists did not employ derivatives. Furthermore, the difference between the 11-day cumulative abnormal returns of the two samples was found to be negative and statistically significant at the 1% level. Hedge fund activists who employ derivatives are granted the right but not obligation to purchase shares of the target at a future date. The market, therefore, seems to treat these hedge fund activists as being hesitant towards undertaking activist engagements, or assume that these hedge fund activists do not have the necessary ownership to successfully pursue any activist engagement. On the other hand, the hedge fund activists, who do not employ derivatives but purchase the shares directly, are capable of immediately negotiating with the management. Therefore, the market values their capability more than the hedge fund activists who adopt a "wait-and-watch" strategy by using derivatives.

Results from the univariate analysis are further confirmed in the multivariate setting. The 11-day CARs are regressed against a set of control variables, and the results are listed in Panel B of Table 2. The key variable of interest is the dummy variable "Derivatives", which equals to 1 for hedge fund activist engagements if derivatives are involved. And as shown by Panel B in Table 2, the coefficient of the dummy variable is negative and statistically significant at 1% significance level across all the four specifications, thereby justifying the finding that targets of hedge fund activists who did not use derivatives outperformed the targets of hedge fund activists who used derivatives in the short-run.

[9] We considered the 3-day and the 5-day event windows for both univariate and the multivariate analysis. The univariate analysis showed that the difference in CARs were insignificant for the 3-day and the 5-day windows. This was further justified by the multivariate analysis, that is, the Derivative dummy variable was negative but insignificant across all four specifications for both the 3-day and the 5-day event windows. Leverage and Cash/Assets were the only variables affecting the 3-day event CARs. Both were negatively related to the 3-day CARs. This finding suggested that firms that had high leverage and lower levels of cash experienced negative short-term market reaction. Leverage was once the again the variable affecting the 5-day CARs and it was negatively related to the 5-day CARs. This finding suggested that once again, higher the firm leverage, the poorer the market-reaction. For brevity, the results are not reported in Table 2. As a robustness check, we also computed the 3-day, 5-day, and 11-day abnormal returns using the market-adjusted model and found the results to be similar. For brevity, these results are also not reported in tables.

[10] In the analysis of CARs, four observations are missing: three observations missing for derivative sample and one observation missing for non-derivative sample. This is because the stock price returns or the market returns are missing, which are needed to compute CARs.

Table 2. Gains to Targets of Hedge Fund Activists Using Derivatives

Panel A: Univariate analysis								
	Full sample		Derivative sample		Matching sample		Difference (Derivative–Matching)	
	Mean	*N*	Mean	*N*	Mean	*N*	Mean	*P*-Value
CAR [−5, 5] (%)	3.92***	412	1.86**	172	5.40***	240	−3.54***	0.0029
	(0.0000)		(0.0331)		(0.0000)			
Panel B: Multivariate analysis								
			(1)		(2)		(3)	(4)
Dependent variable			CAR [−5, +5]					
Derivative			−0.0340***		−0.0368***		−0.0342***	−0.0395***
			(0.006)		(0.003)		(0.005)	(0.002)
Ln (MV)					−0.0020			0.0037
					(0.721)			(0.540)
M/B					−0.0065**			−0.0007**
					(0.019)			(0.011)
Leverage					0.0164			0.0077
					(0.442)			(0.733)
CF/E							−88.64*	−93.06*
							(0.067)	(−0.056)
Cash							0.00002	0.00001
							(0.200)	(0.506)
P/E							−0.00001	0.00001
							(0.933)	(0.941)
Constant			−0.0998		−0.1641***		−0.1028	−0.1988***
			(0.235)		(0.001)		(0.162)	(0.000)
N			411		400		382	373
R^2			0.0741		0.0999		0.1086	0.1353

Notes: This table presents short-term gains of targets of hedge fund activists who use derivatives. Panel A shows univariate analysis. CAR [−5, 5] is the 11-day market model cumulative abnormal returns around the announcement. CARs are winsorized at the 1 and 99% levels. *P*-Values are shown in parentheses. *T*-test is used to test the significance of the mean. Statistical significance at the 1, 5 and 10% levels are denoted as ***, ** and *, respectively. Panel B shows multivariate analysis. Targets' announcement abnormal returns (CAR [−5, 5]) are regressed (OLS) against a set of explanatory variables (Activist dummy and target firm characteristics). All variables are defined in appendix 1. In all models, industry fixed effects are controlled for. For brevity, their coefficients are not reported in the table. The number of observations used in different specifications may vary because of the missing value of one or more variable. All continuous variables are winsorized at the 2 and 98% levels. *P*-Values shown in parentheses are adjusted for heteroskedasticity. Statistical significance at the 1, 5 and 10% levels are denoted as ***, ** and *, respectively.

Furthermore, our study also looks into long-term gains of targets in hedge fund activist engagements. Table 3 illustrates the comparative results of the 6-month, 12-month, and 24-month BHARs. As observed from Table 3[11], there is no statistical difference between the two samples across all the three time windows. And this indicates that the use of derivatives has no impact on the long-term market reaction. Given that the individual BHARs are not significant, we can conclude that implementation of derivatives by hedge fund activists does not create any long-term value to their target firms.

[11] In the analysis of BHARs, more observations are missing. This could be because the target could have either been acquired or simply delisted within 6 months, 12 months, or 24 months.

Table 3. Long-Term Gains to Targets of Hedge Fund Activists Using Derivatives

	Full sample		Derivative sample		Matching sample		Difference (Derivative–Matching)	
	Mean	*N*	Mean	*N*	Mean	*N*	Mean	*P*-Value
BHAR6 (%)	1.45 (0.3911)	324	−0.82 (0.7292)	150	3.41 (0.1546)	174	−4.23	0.2119
BHAR12 (%)	−0.77 (0.7672)	303	−2.49 (0.4783)	138	0.66 (0.8629)	165	−3.15	0.5495
BHAR24 (%)	2.95 (0.4817)	219	1.44 (0.8263)	96	4.14 (0.4509)	123	−2.70	0.7500

Notes: This table presents long-term gains of targets of hedge fund activists who use derivatives. BHAR6 is the six-month market-adjusted model buy-and-hold abnormal returns around the announcement. BHAR12 is the 12-month market-adjusted model buy-and-hold abnormal returns around the announcement. BHAR24 is the 24-month market-adjusted model buy-and-hold abnormal returns around the announcement. Variables are winsorized at the 2 and 98% levels. *P*-Values are shown in parentheses. *T*-test is used to test the significance of the mean. Statistical significance at the 1, 5 and 10% levels are denoted as ***, ** and *, respectively.

The idiosyncratic volatility of the stock prices is then evaluated before and after the hedge fund activist, who used derivatives, disclosed its stake. The results are displayed in Table 4[12]. Both the hedge fund activists that used derivatives and those that did not all reduced the idiosyncratic volatility of their target firms' stocks. However, the reduction in idiosyncratic volatility is greater for target firms where the hedge fund activist did not use derivatives. This finding of a reduction in idiosyncratic volatility is consistent with literature[13] and suggests that activist hedge funds utilised derivatives to drive down the volatility associated with the underlying stocks of the target firms. However, the finding that hedge fund activists who did not employ derivatives reduced the idiosyncratic volatility by a greater amount suggests that the use of derivatives had no unique impact on the idiosyncratic volatility.

Table 4. Idiosyncratic Volatility of Targets of Hedge Fund Activists Using Derivatives

	Full sample		Post-announcement		Pre-announcement		Difference (Post–Pre)	
	Mean	*N*	Mean	*N*	Mean	*N*	Mean	*P*-Value
Panel A. Idiosyncratic volatility of targets of hedge fund activists using derivatives								
Volatility (%)	2.78	348	2.52	173	3.04	175	−0.52**	0.0359
Panel B. Idiosyncratic volatility of targets of hedge fund activists not using derivatives								
Volatility (%)	2.93	482	2.46	241	3.41	241	−0.95***	0.0001

Notes: To examine whether targets of hedge fund activists have improved when hedge fund activists used derivatives, the idiosyncratic volatility of targets is computed before and after the hedge fund activist discloses its stake. The methodology of Bali and Cakici (2008) is followed for computing idiosyncratic volatility. Panel A shows idiosyncratic volatility of targets of hedge fund activists using derivatives post announcement. Panel B shows idiosyncratic volatility of targets of hedge fund activists not using derivatives post announcement.

For the question of whether hedge fund activists used derivatives are to increase the probability of sale of their targets. Greenwood and Schor (2009) had found that the positive abnormal returns experienced around the time the activist disclosed its stake in the target were attributed to the ability of activists to push for the sale of the target. These findings were further supported by Becht et al. (2017), who found that takeovers were the more profitable and popular activist strategy. The findings of (Hu and Black (2007) suggest that hedge funds routinely used leverage and options to increase their effective ownership stakes in target firms. Increased ownership implies increased voting power, the use of derivatives, therefore, could increase the probability of a successful activist campaign. Since takeovers are the most popular strategy with

[12] There are two observations missing in the pre-announcement period for the derivative sample. This is because there were stock price returns and market returns missing for these two observations.

[13] See (Skinner, 1989), (Conrad, 1989), and (Bansal et al., 1989).

hedge fund activists, there is a possibility that hedge fund activists will use derivatives to increase their voting power in order to increase the probability of takeovers of the target. In our paper, in order to analyse whether hedge fund activists increased the probability of takeovers by using derivatives, our hedge fund activism database was merged with the Thomson One Banker Mergers and Acquisitions database to obtain the number of deals with hedge fund activist involvement where the hedge fund activist used derivatives. By adopting the methodology of Greenwood and Schor (2009), only those deals that occurred within 18 months after the hedge fund activist using derivatives disclosed its stake were considered for the analysis. Table 5 lists the distribution of these deals. Panel A outlines the distribution of deals by time, Panel B outlines the distribution of deals by industry, and Panel C outlines a few deal characteristics.

Table 5. Distribution of Deals with Hedge Fund Activist Involvement

Panel A: Distribution of deals by year

Year	No. of deals	Per cent (%)	Year	No. of deals	Per cent (%)
1995	1	0.56	2006	11	6.18
1996	2	1.12	2007	22	12.36
1997	8	4.49	2008	12	6.74
1998	6	3.37	2009	7	3.93
1999	8	4.49	2010	10	5.62
2000	3	1.69	2011	13	7.30
2001	2	1.12	2012	12	6.74
2002	4	2.25	2013	17	9.55
2003	2	1.12	2014	23	12.92
2004	3	1.69	2015	7	3.93
2005	5	2.81			
			Total	178	100.00

Panel B: Distribution of deals by industry

Industry	No. of deals	Per cent (%)	Year	No. of deals	Per cent (%)
Consumer products & services	12	6.74	Materials	11	6.18
Energy & power	14	7.87	Media and entertainment	9	5.06
Financials	13	7.30	Real estate	8	4.49
Healthcare	20	11.24	Retail	21	11.80
High technology	32	17.98	Consumer staples	8	4.49
Industrials	17	9.55	Telecommunications	13	7.30
			Total	178	100.00

Panel C: Deal characteristics of hedge fund activism mergers using derivatives

	Mean	*N*
Deal value ($ mil.)	1944.61	178
Completed (%)	64.61	178

Notes: This table presents deals with hedge fund activist involvement during 1994–2015, which includes both targets where the activist hedge fund used derivatives and targets where hedge fund activists did not use derivatives as part of acquiring targets' stock. Panel A outlines the distribution of deals by year. Panel B outlines the distribution of deals by Target Industry.

The results of the Probit model are shown in Table 6. As evidenced from Table 6, the key dummy variable "Derivative" is negative and significant, thereby implying that hedge fund activists who did not use derivatives increased the probability of takeover of the target firms. This is consistent to Partnoy (2015) that activist hedge funds were found to have rarely used derivatives. It could also be because of the difference in target size. It was found that hedge fund activists who did not use derivatives targeted firms of smaller size. The ease of pushing for a sale of target of smaller size could have also contributed to this result. The inverse relationship between target size and probability of takeovers, as evidenced from Table 6, supports this theory. Given that the target size was small and given that such targets were more prone to takeovers, there was no reason for hedge fund activists to use derivatives to pursue takeovers. Finally, this

result also justifies why targets of hedge fund activists who did not use derivatives outperformed targets who used derivatives around the time the hedge fund activist announced its stake. Greenwood and Schor (2009) attributed the abnormal returns around the time of activist disclosure to the ability of hedge fund activist to push for the sale of the target. Since hedge fund activists who did not use derivatives increased the probability of takeovers, the market reaction was more positive for the targets of these hedge fund activists.

Table 6. Probability of Takeovers of Targets of Hedge Fund Activists Using Derivatives

Dependent variable	(1) *Acquired*	(2)	(3)	(4)
Derivative	−0.1537	−0.1770	−0.3407**	**−0.2952***
	(0.220)	(0.266)	(0.047)	**(0.096)**
Ln(MV)		−0.0589		−0.1384**
		(0.212)		(0.025)
M/B		−0.00002		0.00002
		(0.504)		(0.510)
Leverage		−0.5462*		−0.3671
		(0.053)		(0.252)
CF/E			1.330***	1.491***
			(0.000)	(0.000)
Cash			0.00003	0.0003
			(0.853)	(0.253)
P/E			0.0002	0.0004
			(0.887)	(0.728)
Constant	0.2469***	1.3769**	0.2439**	2.0489***
	(0.003)	(0.025)	(0.034)	(0.008)
N	416	277	262	254
Pseudo R^2	0.0027	0.0229	0.1066	0.1335

Notes: *Acquired* binary variable is regressed against a set of explanatory variables using a probit model. The *Acquired* binary variable takes the value of 1 for targets of hedge fund activists using derivatives, which get acquired and 0 for targets of hedge fund activists using derivatives, which do not get acquired. All variables are defined in appendix 1. All continuous variables are winsorized at the 2 and 98% levels. *P*-Values shown in parentheses are adjusted for heteroskedasticity. Statistical significance at the 1, 5 and 10% levels are denoted as ***, ** and *, respectively.

7. Conclusion

This paper examined the role of derivatives in hedge fund activism. We analysed the cumulative abnormal returns around the time when hedge fund activists using derivatives disclosed their stakes in the target firm and compared them with the cumulative abnormal returns of targets of hedge fund activists who did not employ derivatives. Evidence showed the 11-day CARs of targets of hedge fund activists who did not use derivatives exceeded the 11-day CARs of targets of hedge fund activists who used derivatives. Results thereby indicate that the market reacted positively when hedge fund activists did not employ derivatives. This suggested that the market had higher confidence in hedge fund activists who did not use derivatives. We also analysed the buy-and-hold abnormal returns and found that irrespective of whether they used derivatives or not, hedge fund activists did not create any long-term value to their targets. Furthermore, we examined whether hedge fund activists, by using derivatives, reduced the idiosyncratic volatility of the target share price and found that both hedge fund activists who used derivatives and those who did not use derivatives reduced idiosyncratic volatility of the target firms. Previous studies had found that stock price volatility was reduced due to the use of derivatives. Our finding that hedge fund activists who did use derivatives reduced the idiosyncratic volatility by a larger amount than hedge fund activists who used derivatives, however, suggested that hedge fund activists did not use derivatives with the intention of reducing targets' stock price volatility. Finally, this study examined whether hedge fund activists increased the probability of takeover by using derivatives and found that hedge fund activists who did not use derivatives increased the probability of takeovers by 29.52%. This finding

helped to justify why hedge fund activists rarely used derivatives Partnoy, (2015).

Overall, our paper concluded that the use of derivatives did not create any additional value for targets of hedge fund activists. On the contrary, it further justified why hedge fund activists rarely used derivatives. Therefore, hedge fund activists are better off by directly purchasing shares of the targets that they believe are undervalued.

The contribution of this paper is threefold. First, this is the first paper that examines the role of derivatives in hedge fund activism in a comprehensive manner. Second, this paper studies the market reaction to the use of derivatives by hedge fund activists. Our finding suggests that the market rewards the hedge fund activists who did not use derivatives. Most importantly, our paper provides a testing ground for studying the value creation through the usage of derivatives. This study also finds that hedge fund activists who did not use derivatives increase the probability of takeover of their target companies, thereby indicating that derivatives are not effective financial instruments while undertaking hedge fund activist engagements. There was neither short-term value creation nor long-term value creation by hedge fund activists using derivatives.

Our paper mainly focused on options, futures, and forwards as the derivative instruments used by activist hedge funds. Future research could explore the use of other derivative instruments, such as credit default swaps, by activist hedge funds and its impact on situations related to firm bankruptcy. Subrahmanyam (2014) examined the effect of credit default swaps on credit risk and found that the credit risk of reference firms increased significantly upon the inception of CDS trading. This was also evident in the bankruptcy talks between Caesars Entertainment Corp. and activist hedge fund Elliott Management Corp (Keller, 2014). Future research could examine whether hedge fund activists use such instruments and their impact when they target financially distressed firms.

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Appendix

A. Distribution of Hedge Fund Activist Engagements Involving Derivatives by Year

Panel A: Distribution of Deals by Year					
Year	**No. of Deals**	**Percent (%)**	**Year**	**No. of Deals**	**Percent (%)**
1994	1	0.36	2005	19	6.91
1995	1	0.36	2006	20	7.27
1996	4	1.45	2007	29	10.55
1997	20	7.27	2008	14	5.09
1998	7	2.55	2009	6	2.18
1999	7	2.55	2010	12	4.36
2000	7	2.55	2011	24	8.73
2001	6	2.18	2012	13	4.73
2002	12	4.36	2013	27	9.82
2003	11	4.00	2014	29	10.55
2004	11	4.00			
			Total	**275**	**100.00**

B. Definition of Variables

Variable	Definition
Panel A: Gains to Targets	
CAR [-5, 5]	Cumulative abnormal returns around the announcement over 11-days [-5, 5] surrounding the d of activist engagement announcement, computed using market model.
Volatility	Idiosyncratic volatility of targets of both hedge fund activists who use derivatives and who do not use derivatives before and after the activist engagement announcement.
Panel B: Key Explanatory Variable	
Derivative	Dummy variable equals one for targets of hedge fund activists who employ derivatives
Acquired	Dummy variable equals one for targets of hedge fund activists, who employ derivatives, that g acquired
Panel C: Firm Characteristics	
MV	Market value of the firm 4 weeks before the announcement (CRSP item PRC×SHROUT)
Ln(MV)	Natural logarithm of MV.
M/B	Market value of equity 4 weeks before the announcement (CRSP item PRC×SHROUT) divide by book value of equity at the fiscal year end before the announcement (Compustat item CEQ
Leverage	Total debt over total capital at the fiscal year end before the announcement (Compustat item (DLTT+DLC)/(DLTT+DLC+SEQ))
CF/E	Cash flows at the fiscal year end before the announcement (Compustat item IB+DP-DVP-DV(divided by market value of equity 4 weeks before the announcement (CRSP item PRC×SHROUT)
Cash	Cash of the target firms (Compustat Item CH)
Cash/Assets	Cash of the target firms (Compustat Item CH) divided by total assets (Compustat item AT)
P/E	Stock Price (CRSP Item PRC) divided by earnings per share (Compustat Item NI/Compustat Item CSHO)

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Are There Gains From Using Information Over the Surface of Implied Volatilities*

By GUO BIAO, HAN QIAN AND LIN HAI*

We investigate the out-of-sample predictability of implied volatility using the information over the implied volatility surface. We show that implied volatility surface is useful for the out-of-sample forecast of implied volatility up to 1 week ahead. Trading strategies based on the predictability of implied volatility could generate significant risk adjusted gains after controlling for transaction costs. Significant results also depend on the way of modeling implied volatility surface. We then calibrate a two factor stochastic volatility option pricing model to implied volatility data. Results show that implied volatility is better explained by both long and short-term variance factors.

Keywords: Economic significance; Implied volatility; Out-of-sample forecast; Two-factor stochastic volatility model

1. Introduction

Whether asset returns are predictable has been a longstanding research question in literature.[1] On option market, Harvey and Whaley (1992), Gonclaves and Guidolin (2006), Konstantinidi, Skiadopoulos, and Tzagkaraki (2008), Chalamandaris and Tsekrekos (2010, 2011) and Neumann and Skiadopoulos (2013) find that option implied volatilities are statistically predictable. However, the economic profits become insignificant once the transaction costs are accounted for. Literature documents a disparity between statistical and economical significance of option market predictability.[2]

In this paper, we solve the disparity by using implied volatility surface information. The trading of the option market is dominated by short-maturity options. Nevertheless, Bakshi, Cao, and Chen (1997) find that long-dated options have information not readily available from short-dated options. Recently, Christoffersen, Jacobs, Ornthanalai, and Wang (2008) and Christoffersen, Heston, and Jacobs (2009) proposed component volatility models, and decomposed stochastic volatility into long- and short-term components. They find that component volatility models perform better than one-factor stochastic volatility model. These findings suggest there exists useful information in the whole implied volatility surface. Bakshi et al. (1997), Christoffersen et al. (2008, 2009) analyze the statistical significance. We extend their analysis to investigate the economic significance of implied volatility surface, and document significant economic gains by using the information of implied volatility surface.

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[1]See, for example, Fama and Schwert (1977), Fama and French (1988), Campbell and Shiller (1988), Kothari and Shanken (1997), Rapach et al. (2010, 2013), Pettenuzzo, Timmermann, and Valkanov (2014), Rapach, Ringgenberg, and Zhou (2016) on predicting stock returns; Keim and Stambaugh (1986), Fama and French (1989), Greenwood and Hanson (2013), Lin et al. (2014), Lin, Wu, and Zhou (2017) on predicting corporate bond returns; and Fama and Bliss (1987), Campbell and Shiller (1991), Cochrane and Piazzesi(2005), Goh, Jiang, Tu, and Zhou, (2012), Sarno, Schneider and Wagner (2016), Gargano, Pettenuzzo, and Timmermann(2017), Lin, Liu, Wu, and Zhou (2017) on predicting Treasury bond returns.

[2]Similar disparity of statistical and economic significance on Treasury return predictability is documented in Thornton and Valente (2012).

We test whether incorporating the information of implied volatility surface can improve the prediction of implied volatility. If both long- and short-maturity implied volatilities contain useful information, using the whole implied volatility surface information will be able to improve the volatility forecast that is only based on one particular maturity information. We examine 14 models and compare their out-of-sample performance with that of the benchmark AR(1) model. These competing models are two adapted Nelson and Siegel models used by Diebold and Li (2006) for Treasury securities and by Chalamandaris and Tsekrekos (2011) for currency options, six time series models similar to Diebold and Li (2006), five combination models as in Rapach, Strauss, and Zhou (2010) and a Mallows model averaging (MMA) combination as in Hansen (2007, 2008). We use the implied volatility surface information of the at-the-money (ATM) options and the options with 0.40 and 0.60. We choose call option in our main analysis, and use put option as a robustness check. We find that, historical surface information plays a significant role in the prediction of implied volatilities. When daily data are used to forecast the 30-day implied volatility 1 day ahead and 5 days ahead, the best out-of-sample R^2 value is as high as 7.39% and 7.64%, respectively.[3] Results are significant across almost all maturities. Our results reveal the importance of using the whole implied volatility surface information. However, these models lose their predictive power beyond a week, suggesting that only the historical information within 1 week of the forecast date is important for the short-term forecast of index option market.

To examine whether the predictability has economic value, we construct a trading strategy based on a forecast by each model, and compare the portfolio performance with that of the benchmark AR(1) model. Using the gain on Leland's alpha (Leland, 1999) as the performance measure, we find that those models that utilize information from the entire surface generate significant economic profits up to 5 days ahead even after transaction costs are considered. For example, when daily data are used, the trading strategy based on the 1-day-ahead forecast by the VAR(1) model of volatility change (VARC) generates a gain on Leland's alpha of 11.13% relative to the benchmark, and is significant at the 1% level. The trading strategy based on the 5-day-ahead forecast by the VAR(1) model of volatility change (VARC) generates a gain on Leland's alpha of 2.13% relative to the benchmark, and is significant at the 10% level. Results are robust to the impact of transaction cost. This finding distinguishes our study from most other literature that finds no predictability of the option market after considering transaction costs.

Our findings are robust over time and over different options. A sub-sample analysis using data during the recent 2007–2009 financial crisis period finds that the predictability still exists during the crisis. Implied volatilities can still be predicted 5 days ahead. Moreover, their economic significance of 1-day-ahead forecast becomes stronger during the crisis. Analysis using put option data and data with a broader range confirms our main results.

In order to explain why implied volatility surface information helps improve the forecast, we estimate a two-factor stochastic volatility option pricing model to extract a long-term and a short-term variance factor. Regressions of option implied volatilities on these two factors reveal that both variance factors are important to explain the time variations of implied volatility. Long-maturity implied volatilities are more associated with the long-term variance factor, while short-maturity implied volatilities are more related to the short-term variance factor. Both long- and short-maturity implied volatilities contain useful information of the implied volatility term structure. We are able to provide a better prediction by using them jointly.

Our study contributes to the literature in several ways. Our findings shed light on volatility

3 These results are higher than or comparable to studies on the predictability of other financial markets. See, for example, Gargano et al. (2017) on Treasury return predictability, Lin et al. (2014) and Lin, Wu, et al. (2017) on corporate bond return predictability, and Rapach et al. (2010), Pettenuzzo et al. (2014) and Rapach et al. (2016) on stock return predictability.

modeling. We evaluate an extensive set of 14 models. Our finding that the whole implied volatility surface provides useful information in forecasting implied volatility suggests that a one-factor model is not sufficient for volatility modeling. In this regard, we provide empirical evidence consistent with the emerging component volatility models.

We document both statistical and economic significance of option market predictability using the information of implied volatility surface. This finding is different from literature that documents significant statistical predictability but fails to uncover the economic significance. This finding provides new insights to the economic profit by the predictability of implied volatility.[4]

Egloff, Leippold, and Wu (2010) and Johnson (2017) show that besides level, slope also helps predict the implied variance. We differ from them by considering more flexible models to use the information contained in the surface of implied volatilities. As a robustness check, we also compare the 14 models with the two-factor model that uses level and slope as the predictors. Results continue to show that a more flexible model specification using VAR framework provides a superior forecasting power up to 1 week.

The rest of the paper is structured as follows. Section 2 introduces our empirical methodologies, including the 14 prediction models tested, the out-of-sample performance evaluation criteria, and the two-factor stochastic volatility option pricing model. Section 3 discusses the data and presents the empirical results of out-of-sample forecast. Section 4 provides several robustness checks, including a sub-sample analysis using data covering the recent crisis period, the out-of-sample performance of put options, the comparison with other benchmark, predictability using option data with a different range and gain on alpha from a different asset pricing model. Section 5 reports the results of stochastic volatility model calibration. Section 6 concludes the paper.

2. Empirical Methodology

In this section, we first explain the prediction models to be tested, and the statistical and economic significance measures for evaluating prediction performance. We then introduce the two-factor stochastic volatility option pricing model used to calibrate the term structure of implied volatilities.

2.1 Out-of-sample forecast

We use out-of-sample forecast to test the importance of using the information of implied volatility surface. Suppose we have implied volatility data from time 1 to time T, and the out-of-sample forecast starts from time m. At any time t between m and T, we use the information up to time t to estimate the coefficients, and then use the estimated coefficients and information at time t to forecast the implied volatility h days ahead. At time t + h, we compare the forecast implied volatility and the realized implied volatility to calculate the out-of-sample forecast errors. This procedure is repeated from time m to T − h.

2.1.1 Prediction models

The Nelson and Siegel (NS, 1987) model and its extension (Diebold & Li, 2006) are widely accepted by industry for forecasting the yield curve due to their simplicity and efficiency. The interest rate and implied volatility term structures are quite similar in many aspects (see Christoffersen et al., 2009; Derman, Kani, & Zou, 1996). Just as each Treasury security has a corresponding yield to maturity, each traded index option has a corresponding implied volatility. Both the yield curve and implied volatility term structure exhibit a high degree of time and cross-sectional variation. Since the NS model is an empirical model, it can be borrowed directly

4Galai (1977), Chiras and Manaster (1978), Poon and Pope (2000) and Hogan, Jarrow, Teo, and Warachka, (2004) also find significant excess returns of option trading strategies even when transaction costs are considered.

to model the term structure of implied volatilities. We fit the implied volatility curve with moneyness v, σ, using the NS model,

$$\sigma_t^v(\tau) = \beta_{1t}^v + \beta_{2t}^v \frac{1 - \exp^{(-\lambda_t \tau)}}{\lambda_t \tau} + \beta_{3t}^v \left(\frac{1 - \exp^{(-\lambda_t \tau)}}{\lambda_t \tau} - \exp^{(-\lambda_t \tau)} \right) \quad (1)$$

where τ is time to maturity and parameters β_{1t}^v, $\beta_{2t}^v$and $\beta_{3t}^v$are estimated by ordinary least squares (OLS) with λ_t fixed a pre-specified value of 0.0147.[5] The loading on β_{2t}^v is 1，a constant that does not decay to 0 in the limit; hence β_{1t}^vmay be viewed as a long-term factor. The loading on β_{2t}^v is$1 - \frac{exp^{-\lambda_t t}}{\lambda_t t}$, a function that starts at 1 but decays monotonically and quickly to 0; and hence may be viewed as a short-term factor. The loading on β_{3t}^v is$1 - \frac{exp^{-\lambda_t t}}{\lambda_t t} - exp^{-\lambda_t t}$, which starts at 0 and increases, and then decays to 0, hence it may be viewed as a medium-term factor.[6]

Besides the NS model, we consider six time series models following Diebold and Li (2006), five combination models as in Rapach et al. (2010) and the MMA combination as in Hansen (2007, 2008). Table 1 lists all 14 models evaluated in this paper. By using dummy variables for the options of different moneyness, we are able to combine the volatility surface information that has advantage over the use of the volatility curve information alone. We use the implied volatility surface information of the ATM options and the options with 0.40 and 0.60.[7] We define three dummy variables ID1 ¼ if it is an ATM option and 0 otherwise, ID2 ¼ if the option's 0.40 and 0 otherwise, ID3 ¼ if the option's 0.60 and 0 otherwise. We use superscript v to denote the moneyness. For implied volatility curve, we use the information of short-, medium- and long-maturity implied volatilities. In particular, we use 30-, 91-, 152-, 365-, and 730-day implied volatilities in the analysis. We then forecast the implied volatility surface h days ahead with the following models:

5 Parameter λt governs the exponential decay rate; small values of λt produce slow decay and can better fit the curve for long maturities, while large values of λt produce fast decay and can better fit the curve for short maturities. Parameter λt also governs where the loading on βv3t achieves its maximum. As a result, we choose a λt value that maximizes the loading on the medium-term (122-day) factor, which gives 0.0147.

6 Please refer to Guo, Han, and Zhou (2014) for a more detailed discussion.

7 This choice follows Bollen and Whaley (2004), Han (2007) and Yan (2011). For example, Bollen and Whaley (2004) and Han (2007) define ATM calls with Δ between 0.50 and 5/8 (approximately 0.60), and ATM puts with Δ between −0.50 and −3/8 (approximately −0.40). Yan (2011) defines OTM puts with Δ between −0.45 and −0.20. In the robustness check, we test the predictability using data with Δ between 0.30 and 0.70.

Table 1. Prediction models

Model framework	Model No.	Model ID	Model description
Nelson-Siegel	(1)	NSAR	Nelson-Siegel factors as univariate AR(1) processes
Nelson-Siegel	(2)	NSVAR	Nelson-Siegel factors as multivariate VAR(1) processes
VAR	(3)	VARL	VAR(1) on volatility levels
VAR	(4)	VARC	VAR(1) on volatility changes
ECM	(5)	ECM1	ECM(1) with one common trend
ECM	(6)	ECM2	ECM(1) with two common trends
PCA	(7)	PCA	AR(1) regression on three principal components
Empirical component	(8)	EC	VAR(1) on empirical level, slope and curvature
Combination forecast	(9)	MC	Mean combination forecast
	(10)	MD	Median combination forecast
	(11)	TM	Trimmed mean combination forecast
	(12)	DMSPE1	DMSPE combination forecast with $\theta = 1$
	(13)	DMSPE2	DMSPE combination forecast with $\theta = 0.9$
	(14)	MMA	MMA combination forecast
Benchmark		AR(1) on volatility levels	

This table lists the 14 prediction models tested in this paper. The last row explains the benchmark model.

(1) Nelson-Siegel factors as univariate AR(1) processes (NSAR):

$$\hat{\sigma}^{v}_{t+h}(\tau) = \hat{\beta}^{v}_{1,\,t+h} + \hat{\beta}^{v}_{2,\,t+h}\frac{1-\exp^{(-\lambda_t\tau)}}{\lambda_t\tau} + \hat{\beta}^{v}_{3,\,t+h}\left(\frac{1-\exp^{(-\lambda_t\tau)}}{\lambda_t\tau} - \exp^{(-\lambda_t\tau)}\right), \tag{2}$$

Where $\hat{\beta}^{v}_{i,t+h} = a_{1,i}ID_1 + a_{2,i}ID_2 + a_{3,i}ID_3 + \left(b_{1,i}ID_1 + b_{2,i}ID_2 + b_{3,i}ID_3\right)\hat{\beta}^{v}_{i,t}, i = 1,2,3.$ $a_{1i}a_{2i}a_{3i}, b_{1i}b_{2i}b_{3i}$are all scalars

(2) Nelson-Siegel factors as multivariate VAR（1）processes（NSVAR）:

$$\hat{\sigma}^{v}_{t+h}(\tau) = \hat{\beta}^{v}_{1,t+h} + \hat{\beta}^{v}_{2,t+h}\frac{1-\exp^{(-\lambda_t\tau)}}{\lambda_t\tau} + \hat{\beta}^{v}_{3,t+h}\left(\frac{1-\exp^{(-\lambda_t\tau)}}{\lambda_t\tau} - \exp^{(-\lambda_t\tau)}\right), \tag{3}$$

Where $\widehat{\beta}^{v}_{t+h} = a_1ID_1 + a_2ID_2 + a_3ID_3 + (b_1ID_1 + b_2ID_2 + b_3ID_3)\hat{\beta}^{v}_{t};\ \hat{\beta}^{v}_{t} = \left[\hat{\beta}^{v}_{1t}\hat{\beta}^{v}_{2t}\hat{\beta}^{v}_{3t}\right]T.$ $a_1, a_2, a_3$are 3x1 vectors, and b_1, b_2, b_3 are 3x3 matrices.

(3) VAR(1) on volatility levels (VARL):

$\hat{\sigma}^{v}{}_{t+h}a_1ID_1 + a_2ID_2 + a_3ID_3 + (b_1ID_1 + b_2ID_2 + b_3ID_3)\sigma^{v}_{t}$, where

$$\sigma^{v}{}_{t} = \begin{bmatrix} \sigma^{v}_{t}(30) \\ \sigma^{v}_{t}(91) \\ \sigma^{v}_{t}(152) \\ \sigma^{v}_{t}(365) \\ \sigma^{v}_{t}(730) \end{bmatrix}. \ a_1, a_2, a_3 \text{ are } 5\times 1 \text{ vectors, and } b_1, b_2, b_3 \text{ are } 5\times 5 \text{ matrices.}$$

(4) VAR(1) on volatility changes (VARC): $\hat{z}^v{}_{t+h} = a_1 ID_1 + a_2 ID_2 + a_3 ID_3 + (b_1 ID_1 + b_2 ID_2 + b_3 ID_3) z^v{}_t$,

where $z^v{}_t = \begin{bmatrix} \sigma_t^v(30) - \sigma_{t-h}^v(30) \\ \sigma_t^v(91) - \sigma_{t-h}^v(91) \\ \sigma_t^v(152) - \sigma_{t-h}^v(152) \\ \sigma_t^v(365) - \sigma_{t-h}^v(365) \\ \sigma_t^v(730) - \sigma_{t-h}^v(730) \end{bmatrix}$. a_1, a_2, a_3 are 5×1 vectors, and b_1, b_2, b_3 are 5×5 matrices.

(5) ECM(1) with one common trend (ECM1): $\hat{z}^v{}_{t+h} = a_1 ID_1 + a_2 ID_2 + a_3 ID_3 + (b_1 ID_1 + b_2 ID_2 + b_3 ID_3) z^v{}_t$, where

$z^v{}_t = \begin{bmatrix} \sigma_t^v(30) - \sigma_{t-h}^v(30) \\ \sigma_t^v(91) - \sigma_t^v(30) \\ \sigma_t^v(152) - \sigma_t^v(30) \\ \sigma_t^v(365) - \sigma_t^v(30) \\ \sigma_t^v(730) - \sigma_t^v(30) \end{bmatrix}$. $a_1, a_2, a_3 a_1, a_2, a_3$ are 5×1 vectors, and b_1, b_2, b_3 are 5×5 matrices.

(6) ECM(1) with two common trends (ECM2): $\hat{z}^v{}_{t+h} = a_1 ID_1 + a_2 ID_2 + a_3 ID_3 + (b_1 ID_1 + b_2 ID_2 + b_3 ID_3) z^v{}_t$,

where $z^v{}_t = \begin{bmatrix} \sigma_t^v(30) - \sigma_{t-h}^v(30) \\ \sigma_t^v(91) - \sigma_{t-h}^v(91) \\ \sigma_t^v(152) - \sigma_t^v(30) \\ \sigma_t^v(365) - \sigma_t^v(30) \\ \sigma_t^v(730) - \sigma_t^v(30) \end{bmatrix}$. a_1, a_2, a_3 are 5×1 vectors, and b_1, b_2, b_3 are 5×5 matrices.

(7) AR(1) regression on three principal components (PCA). We first conduct a principal component analysis on the volatility time series data. Denote the largest three eigenvalues by λ_1^v, λ_2^v, and λ_3^v, with associated eigenvectors q_1^v, q_2^v, and q_3^v, and the first three principal components $x^v{}_t = [x_{1t}^v \quad x_{2t}^v \quad {}^v x_{3t}]^{\mathrm{T}}$. We first forecast $x^v{}_{t+1}$ with an AR(1) model, $\hat{x}_{i,t+h}^v = a_{1,i} ID_1 + a_{2i} ID_2 + a_{3i} ID_3 + (b_i ID_1 + b_i ID_2 + b_i ID_3) x_{i,t}^v, i = 1, 2, 3,$ and then generate forecasts for volatilities as $\hat{\sigma}_{t+h}^v(\tau) = q_1^v(\tau)\hat{x}_{1,t+h}^v + q_2^v(\tau)\hat{x}_{2,t+h}^v + q_3^v(\tau)\hat{x}_{3,t+h}^v$. $a_{1,i},\ a_{2,i},\ a_{3,i}, b_{1,i},\ b_{2,i},\ b_{3,i}$ are all scalars.

(8) VAR(1) on empirical level, slope and curvature (EC): $\sigma_{t+h}^v = a_1 ID_1 + a_2 ID_2 + a_3 ID_3 + (b_1 ID_1 + b_2 ID_2 + b_3 ID_3) F^v{}_t$,

where $F^v{}_t = \begin{bmatrix} \sigma_t^v(365) \\ \sigma_t^v(365) - \sigma_t^v(30) \\ 2 \times \sigma_t^v(122) - \left(\sigma_t^v(365) + \sigma_t^v(30)\right) \end{bmatrix}$. We compute the empirical level, slope and curvature of the volatility term structure. The empirical level is defined as the 365-day implied volatility. The slope is the 365-day implied volatility minus the 30-day implied volatility. Finally, the curvature is two times the 122-day implied volatility minus the sum of the 365- and 30-day implied volatilities. a_1, a_2, a_3 are 3×1 vectors, and b_1, b_2, b_3 are 3×3 matrices.

Research has shown that combination forecasts typically outperform individual forecasts both statistically and economically. For example, Rapach et al. (2010) find that combinations deliver consistent forecast gains for equity premium predictions. Lin, Wang, and Wu (2014) document similar findings using corporate bond return data. So besides the forecasts in model (1) to (8), we further combine them as $\hat{\sigma}_{ct+h}^v(\tau) = \sum_{k=1}^8 w_{k,t}^v(h,\tau)\hat{\sigma}_{k,t+h}^v(\tau)$, where $\hat{\sigma}_{k,t+h}^v(\tau)$ is the individual forecast using model k and $w_{k,t}^v(h,\tau)$ is the weight to be placed for the model-k forecast. Depending on the choice of weight $w_{k,t}^v(h,\tau)$, we provide five combination forecasts:

(9) The mean combination forecast (MC): $w_{k,t}^v(h,\tau) = 1/8$.

(10) The median combination forecast (MD): the median of $\hat{\sigma}_{k,t+h}^v(\tau), k = 1, 2, \ldots, 8$.

(11) The trimmed mean combination forecast (TM): $w_{k,t}^v(h,\tau) = 0$ for the smallest and largest forecasts and $w_{k,t}^v(h,\tau) = 1/6$ for the remaining forecasts.

(12) DMSPE (discount mean square prediction error) combination forecast one (DMSPE1): $w_{k,t}^v(h,\tau) = \frac{\left(\phi_{k,t}^v(h,\tau)\right)^{-1}}{\sum_{i=1}^8 \left(\phi_{i,t}^v(h,\tau)\right)^{-1}}$,

where $\phi_{k,t}^v(h,\tau) = \sum_{j=m}^{t-h} \theta^{t-h-j} \left(\sigma_{j+h}^v(\tau) - \hat{\sigma}_{k,j+h}^v(\tau)\right)^2$. This weighting scheme gives more weight to the individual forecast

with smaller out-of-sample prediction error. θ is a discounting factor deciding the size of the weights given to recent forecasts and m is the starting time of the out-of-sample forecast. We take $\theta = 1$ for no discounting to the remote forecast.

(13) DMSPE combination forecast two (DMSPE2): Same as model (12) except that $\theta = 0.9$ to give greater weight to recent forecasts.

Hansen (2007, 2008) proposes a forecast combination based on the MMA method. This method selects the forecast weight by minimizing a Mallow criterion that is a penalized sum of the square residuals. Hansen shows that MMA forecasts have better performance than other feasible forecasts.

(14) MMA combination (MMA). Let $w^v{}_t(h,\mathbf{t}) = \left[w^v_{1,t}(h,\tau)\ldots w^v_{8,t}(h,\tau)\right]T$ be the weight vector of the individual forecast, $\sigma^v{}_{j+h}(\tau) = \left[\hat{\sigma}^v_{1,j+h}(\tau)\ldots\hat{\sigma}^v_{8,j+h}(\tau)\right]^{\mathrm{T}}$ be the vector of the individual h-day ahead forecast of T-day implied volatility with moneyness v at time j, and $G = [g(1)\ldots g(8)]^{\mathrm{T}}$ be the vector of the predictor number used in the individual forecast. The MMA combination forecast set $w^v{}_t(h,\tau)$ to minimize $C^v_t(h,\tau)$ with the conditions that all $w^v_{k,t}(h,\tau)$ are non-negative and that $\sum_{k=1}^{8} w^v_{k,t}(h,\tau) = 1$. $C^v_t(h,\tau)$ is calculated by $C^v_t(h,\tau) = \sum_{j=m}^{t-h}\left(\sigma^v_{j+h}(\tau) - \sigma^v{}_{j+h}(\tau)^{\mathrm{T}} w^v_t(h,\tau)\right)^2 + 2w^v_t(h,\tau)^{\mathrm{T}} G s^2_v$, where s^2_v is an estimate of the variance of residuals from the largest fitted model.

2.1.2 Out-of-sample forecast evaluation

In order to check the performance of the prediction models relative to the benchmark model, we calculate the out-of-sample R^2 statistics of each model for each maturity across different moneyness, given by

$$R^2_{OS}(\tau) = 1 - \frac{\sum_v \sum_{j=m}^{T-h}\left(\sigma^v_{j+h}(\tau) - \hat{\sigma}^v_{j+h}(\tau)\right)^2}{\sum_v \sum_{j=m}^{T-h}\left(\sigma^v_{j+h}(\tau) - \bar{\sigma}^v_{j+h}(\tau)\right)^2}. \tag{4}$$

$\hat{\sigma}^v(\tau)$ and $\bar{\sigma}^v(\tau)$ are the forecast of implied volatility with moneyness v by model (1) to model (14) and the forecast by the benchmark AR(1) model, respectively. A positive $R^2_{OS}(\tau)$ value indicates that the prediction model outperforms the benchmark model. For model (12) and model (13) that require hold-out period (p) to calculate the optimal weight, the forecasting errors used to calculate the $R^2_{\mathrm{OS}}(\tau)$ values start from $m+p$ until $T-h$. We calculate the MSPE-adjusted statistic to test the significance of $R^2_{\mathrm{OS}}(\tau)$. Define

$$f_{t+h}(\tau) = \sum_v\left[\left(\sigma^v_{t+h}(\tau) - \bar{\sigma}^v_{t+h}(\tau)\right)\right]^2 - \sum_v\left[\left(\sigma^v_{t+h}(\tau) - \hat{\sigma}^v_{t+h}(\tau)\right)^2 - \left(\hat{\sigma}^v_{t+h}(\tau) - \bar{\sigma}^v_{t+h}(\tau)\right)^2\right], \tag{5}$$

and the MSPE-adjusted statistic is obtained by regressing $f_{t+h}(\tau)$ on a constant. The p-value corresponding to the constant from a one-sided test determines the significance of $R^2_{\mathrm{OS}}(\tau)$. We use Hodrick (1992) to calculate the standard errors that are robust to data overlap. To test the overall performance of the prediction models relative to the benchmark model, we also calculate the overall out-of-sample R^2 statistics of each model using

$$R^2_{\mathrm{OS}} = 1 - \frac{\sum_\tau \sum_v \sum_{j=m}^{T-h}\left(\sigma^v_{j+h}(\tau) - \hat{\sigma}^v_{j+h}(\tau)\right)^2}{\sum_\tau \sum_v \sum_{j=m}^{T-h}\left(\sigma^v_{j+h}(\tau) - \bar{\sigma}^v_{j+h}(\tau)\right)^2} \tag{6}$$

and test its significance with

$$f_{t+h} = \sum_\tau \sum_v\left[\left(\sigma^v_{t+h}(\tau) - \bar{\sigma}^v_{t+h}(\tau)\right)\right]^2 - \sum_\tau \sum_v\left[\left(\sigma^v_{t+h}(\tau) - \hat{\sigma}^v_{t+h}(\tau)\right)^2 - \hat{\sigma}^v_{t+h}(\tau) - \bar{\sigma}^v_{t+h}(\tau)^2\right]. \tag{7}$$

2.1.2 Economic significance

We follow Cao and Han (2013) to evaluate the trading performance of the out-of-sample forecast and test whether the models generate abnormal profits. In order to avoid the potential problems by using the interpolated data in the economic significance analysis, we use S&P 500

index option transaction data to construct the portfolio. The trading strategies are simply based on the forecast volatility. Specifically, at date t we long (short) an option if the forecast volatility for that maturity at date t þ h is larger (smaller) than the current volatility. We delta-hedge our option position by buying (selling) shares of S&P 500 index if we short (long) the options. The hedge ratio is calculated using the Black-Scholes option pricing formula. Its daily gain is calculated as

$$\pi_{i,t+1} = \left(\left(C_{i,t+1} - C_{i,t} \right) - \left((S_{t+1} - S_t)\Delta_{it} \right) - a \frac{r_{f,t}}{365} \left(C_{i,t} - \Delta_{it} S_t \right) \right) \tag{8}$$

C is the call option price, S is the S&P 500 index price, $r_{f,t}$ is the risk-free rate at date t, a is the number of calendar days between two trading dates. The same equation for the delta-hedged put options is applied, except we replace the call option price and delta with those of put option. We finally scale the dollar return $\pi_{i,t+1}$ by the absolute value of $C_{i,t} - \Delta_{it} S_t$ to convert to percentage return.

In order to compute returns of constant maturity, we construct option portfolios targeting maturities of 30, 91, 152, 365, and 730 days, with portfolio weights estimated in a way similar to Constantinides, Jackwerth, and Savov (2013). We form five portfolios made up of calls, each with targeted time to maturity of 30, 91, 152, 365, or 730 days. The weight of each option in a portfolio is calculated using an univariate Gaussian weighting kernel in days to maturity, with bandwidths of 10 days to maturity for the weighting kernel. We delete the options in a portfolio with weight smaller than 1% to remove outliers and normalize portfolio weights to sum to one. Thus, on any day our trading includes 15 portfolios with maturities of 30, 91, 152, 365, and 730 days, and moneyness of ATM, Δ0.40 and Δ0.60. We rebalance the portfolio daily and repeat the trade in the out-of-sample period. We then compound daily returns to h-day-ahead portfolio returns. We use the same approach to put options.

The gain on Leland's alpha is used to gauge the economic performance of these trading strategies. Leland's alpha takes into account the deviation of portfolio returns from normal distribution and is $\alpha_p = E[r_p] - \beta_p \left(E[r_m - r_f] \right) - r_f$, where r_m denotes the market return approximated by the S&P 500 index return, $\beta_p = \frac{\mathrm{cov}\left(r_p, -(1+r_m)^{-\gamma}\right)}{\mathrm{cov}\left(r_m, -(1+r_m)^{-\gamma}\right)}$ measures the systematic risk and $\gamma = \frac{\ln(E[1+r_m]) - \ln\left(1+r_f\right)}{\mathrm{var}(\ln(1+r_m))}$ measures the relative risk aversion. For comparison, these measures are then subtracted by the corresponding Leland's alpha of the benchmark AR(1) model.[8] A larger-than-zero gain on Leland's alpha thus indicates that the trading strategy generates an excess risk-adjusted return over the benchmark model. We annualize the gain on Leland's alpha and test its significance with Newey and West (1987) t-statistics adjusted for serial correlation.

Transaction cost is an important factor we need to control when we compare the performance of two trading strategies. A positive gain on Leland's alpha of one trading strategy might be due to its more aggressive trading. Thus its economic significance disappears once the transaction cost is accounted for. In order to examine whether our results are robust to the impact of transaction cost, we follow Cao, Han, Tong, and Zhan (2017) and introduce the transaction cost into the trading. We first use the mid price (MidP) that is the mid-point of bid and ask price. It does not assume any transaction cost. We then consider the effective option spread to be 10%, 25%, and 100% of the quoted spread.[9]

2.2 A two-factor stochastic volatility option pricing model

In order to measure the impact of different volatility components on the implied volatility term structure, we estimate a two-factor stochastic volatility option pricing model, as in Christoffersen et al. (2009), where the variance of the risk-neutral ex-dividend stock return is determined by two factors,

8 By saying gains from using information over surface of implied volatilities, we are more interested in comparing the models that use surface information with the benchmark model that does not use it. Thus all the statistical and economic significance measure we report in the paper are the comparison results to reflect our research focus.

9 Studies of effective spread on equity options include Mayhew (2002), De Fontnouvelle, Fisher, and Harris (2003) and Muravyev and Pearson (2016). Mayhew (2002) and De Fontnouvelle et al. (2003) find that the ratio of effective spread to the quoted spread is less than 50% for equity options. Muravyev and Pearson (2016) show that for the average trade, effective spreads that take account of trade timing are one-third smaller than the traditionally used effective spreads.

$$dS_t = rS_t dt + \sqrt{V_{1t}} S_t dz_{1t} + \sqrt{V_{2t}} S_t dz_{2t},$$

$$dV_{1t} = (a_1 - b_1 V_{1t})dt + \sigma_1 \sqrt{V_{1t}} dz_{3t},$$

$$dV_{2t} = (a_2 - b_2 V_{2t})dt + \sigma_2 \sqrt{V_{2t}} dz_{4t}, \quad (9)$$

where z1t and z2t are uncorrelated, the correlation between z1t and z3t is ρ1 and the correlation between z2t and z4t is ρ2. We define the factor that is more persistent (b closer to zero) as the long-term variance factor, while the other is the short-term variance factor. As shown in Christoffersen et al. (2009), European options can be valued by a closed-form formula under this framework.

3. Data and Empirical Results

Our sample includes the implied volatilities of S&P 500 index options from 1996 to 2015. We use the volatility surfaces taken from the Ivy DB OptionMetrics database, with 10 different maturities (30, 60, 91, 122, 152, 182, 273, 365, 547, and 730 days) on each observation date. Since not all maturities are traded on each date, OptionMetrics interpolates the surface to obtain the missing data. Table 2 reports the mean, maximum, minimum, standard deviation, and autocorrelation of implied volatilities of ATM call options with different maturities.[10] The volatility curve is upward sloping, and long-maturity implied volatilities have smaller standard deviations than short-maturity implied volatilities. For example, the 730-day implied volatility has a mean of 20.17% and a standard deviation of 4.43%, while the 30-day implied volatility has a mean of 18.83% and a standard deviation of 7.51%. The different persistence across maturities suggests a necessity to model the long- and short-maturity implied volatilities separately.

Figure 1 plots the time series of the implied volatilities of ATM call options. It is clear that volatilities are time varying, with spikes occurring between 1998 and 1999, between 2002 and 2003 and between 2008 and 2009. They reflect the impact of the Asian crisis, the accounting scandal and the credit crisis, respectively. In the following empirical studies, we focus on the implied volatilities of five different maturities (30, 91, 152, 365, and 730 days) to reduce the dimensions in panel data model.

Table 3 reports the trading summary of options with different maturities. We report both the trading volume and the open interest. The option data with a negative bid-ask spread, a negative trading volume and open interest or a negative implied volatility are excluded. The trading volume and open interest of ATM (call and put) options, call options with 0.60 and call options with 0.40 are calculated from the options with moneyness between 45% and 55%, between 55% and 65% and between 35% and 45%, respectively.

10 The results of other moneyness are close to those of ATM options.

Table 2. Summary statistics

Maturity (days)	Mean (%)	Std. dev. (%)	Min. (%)	Max. (%)	ρ(10)	ρ(30)	ρ(60)	ρ(180)
30	18.83	7.51	8.14	74.83	0.89	0.75	0.61	0.34
60	19.07	6.87	9.08	67.22	0.92	0.80	0.66	0.38
91	19.21	6.45	9.70	60.45	0.93	0.82	0.69	0.41
122	19.33	6.09	10.23	57.44	0.94	0.84	0.71	0.43
152	19.44	5.78	10.45	53.84	0.94	0.85	0.73	0.45
182	19.54	5.56	10.60	50.38	0.95	0.86	0.75	0.46
273	19.70	5.17	10.96	46.48	0.95	0.88	0.78	0.49
365	19.81	4.96	11.25	44.48	0.96	0.89	0.79	0.50
547	20.02	4.60	11.61	40.19	0.96	0.90	0.81	0.52
730	20.17	4.43	11.74	38.66	0.96	0.90	0.81	0.53

This table reports the summary statistics (mean, standard deviation, minimum, maximum, autocorrelation with lags of 10, 30, 60, and 180 days) of the implied volatilities of ATM call options. The sample period is from 1996 to 2015.

Figure 1. Implied volatility of selected maturities

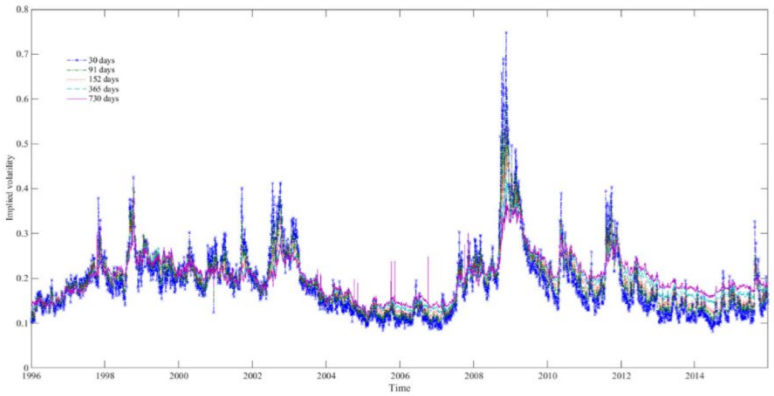

FIGURE 1 Implied volatility of selected maturities. This graph plots the time series of implied volatilities of selected maturities, specifically 30, 91, 152, 365, and 730 days. Sample period is from 1996 to 2015 [Color figure can be viewed at wileyonlinelibrary.com]

Trading in the option market is dominated by short-maturity options. For example, for the ATM call options, the options with maturities less than three months contribute about 79.39% to the total trading volume and about 54.90% to the total open interest. On the other hand, the options with maturities longer than 1 year only account for 2.96% of the total trading volume and 9.57% of the total open interest. The trade of long-maturity options is much less than that of short-maturity options. It is of great interest to investigate whether these limited trading contains useful information about future implied volatilities.

As a comparison, we also report the trading summary of call options with 0.70 using the options with moneyness between 65% and 75%, and 0.30 using the options with moneyness between 25% and 35%. Trading of call options with 0.70 is less active than those of 0.60, and dominated by short-maturity options. Nevertheless, trading of call options with 0.30 is more active than those of 0.40. This suggests that these options are liquid and frequently traded by investors.[11] In the robustness test, we add the options with 0.70 and 0.30 in the analysis to test whether the forecast result is robust to inclusion of more options.

We start the out-of-sample forecast in 2002. Parameters are estimated using a recursive

11 Thanks for the anonymous referee to point this out.

window. Implied volatilities are forecast 1, 5, and 20 days ahead. The holdout out-of-sample period for model (12) and model (13) is set as 60 days.

We fit the implied volatility curve using the NS model by OLS on each observation date. Unreported results show that β1t, as a long-term factor, displays a more persistent pattern than the other two factors. On the contrary, β2t and β3t are volatile since they represent the short and medium terms. They are especially pronounced when the market is turbulent. β1t moves smoothly and captures the trend of the volatility very well, verifying that it reflects a long-term volatility. β2t and VIX mimic each other, and taken together with the close movement between β2t and the empirical slope lines, indicate that β2t reflects the short-term volatility component and can be interpreted as a slope factor. The time variations of these factors provide some preliminary evidence that confirms the necessity of decomposing volatilities into long- and short-term components.[12]

Table 3. Trading summary of S&P 500 index options

Maturity (days)	Volume	Percentage	Open interest	Percentage	Volume	Percentage	Open interest	Percentage
	ATM call				ATM put			
<30	40,826,704	29.12	193,057,678	20.17	42,851,640	30.27	180,550,841	21.07
30–91	70,480,199	50.27	332,449,354	34.73	72,196,523	51.00	326,092,925	38.06
91–152	14,868,885	10.61	123,813,077	12.93	15,524,699	10.97	122,601,772	14.31
152–365	9,870,019	7.04	216,370,952	22.60	8,436,133	5.96	169,304,814	19.76
365–730	3,257,799	2.32	77,318,610	8.08	2,169,028	1.53	52,129,581	6.08
>730	900,996	0.64	14,251,508	1.49	379,320	0.27	6,088,079	0.71
All	140,204,602	100.00	957,261,179	100.00	141,557,343	100.00	856,768,012	100.00
	Call with $\Delta = 0.60$				Call with $\Delta = 0.40$			
<30	23,023,845	38.11	195,034,840	24.31	34,707,239	44.34	189,011,008	22.96
30–91	25,997,656	43.03	308,898,741	38.50	29,377,294	37.53	288,242,921	35.02
91–152	4,682,105	7.75	99,185,971	12.36	5,848,476	7.47	113,299,573	13.76
152–365	4,439,338	7.35	147,334,272	18.36	6,264,739	8.00	178,055,275	21.63
365–730	1,800,099	2.98	45,091,625	5.62	1,778,007	2.27	48,277,885	5.86
>730	472,063	0.78	6,799,529	0.85	301,047	0.38	6,288,435	0.76
All	60,415,106	100.00	802,344,978	100.00	78,276,802	100.00	823,175,097	100.00
	Call with $\Delta = 0.70$				Call with $\Delta = 0.30$			
<30	13,014,136	55.83	201,197,166	33.64	37,280,577	46.16	203,664,354	24.08
30–91	7,809,005	33.50	244,844,064	40.94	28,084,411	34.78	285,230,619	33.72
91–152	980,076	4.20	65,617,431	10.97	5,995,761	7.42	119,034,913	14.07
152–365	1,081,000	4.64	70,052,792	11.71	7,302,547	9.04	188,065,864	22.23
365–730	354,853	1.52	14,594,019	2.44	1,799,856	2.23	43,772,154	5.17
>730	69,372	0.30	1,765,233	0.30	294,143	0.36	6,158,059	0.73
All	23,308,442	100.00	598,070,705	100.00	80,757,295	100.00	845,925,963	100.00

This table reports the trading volume and open interest of S&P 500 index options from 1996 to 2015. Option data with either a negative bid-ask spread, a negative trading volume and open interest or a negative implied volatility are excluded. The trading volume and open interest of ATM (call and put) options, call options with Δ equal to 0.60, 0.40, 0.70, and 0.30 are calculated from the options with moneyness between 45% and 55%, between 55% and 65%, between 35% and 45%, between 65% and 75% and between 25% and 35%, respectively.

3.1 Statistical significance

Table 4 reports the out-of-sample R^2OS statistics for all 14 models. The top, middle and bottom panels report the forecast results of 1, 5, and 20 days ahead, respectively. The results in

12 In Appendix 1, we plot the time series of β1t, β2t , and β3t of the NS model.

the top panel show that most of our models beat the benchmark for a 1-day forecast. For example, 13 out of the 14 models generate a positive R^2OS statistic at the 5% significance level or above for the 30-day implied volatility, and all combination forecasts have a greater than zero R^2OS statistic and are significant at the 1% level. Similarly, there are 10 models that outperform the benchmark model at the 5% level or above for the 730-day implied volatility.

Among all the models, model VARC, which runs a VAR(1) model on the volatility change, and MMA combination, have the greatest R^2OS value. Model ECM1 and model ECM2, which are ECM models with one and two common trends, respectively, also perform well. This suggests that the historical surface information is helpful when forecasting a particular maturity implied volatility. It is interesting to observe that most of the R^2OS statistics for the models using NS factors (model NSAR and model NSVAR) are negative, suggesting that they are not as good as the benchmark model in the out-of-sample period. This demonstrates the difference between in-sample fitting and out-of-sample forecast.

It is also interesting to observe that although forecast performance is improved overall by the use of the whole implied volatility surface information, not all models generate desirable results. Results using the principal components of the implied volatility curve (PCA and EC) are not significant. This finding is consistent with Kelly and Pruitt (2013, 2015) who claim that principal components may contain common error components that are irrelevant to forecasting, hence producing poor forecasting performance. Models PCA and EC use level information, while models VARC, ECM1, and ECM2 use the information of volatility changes that removes the volatility trend. Therefore, the performance difference across these models implies that both the information set and the way of modeling the information set are important when out-of-sample forecasts are performed on the option market.

Turning now to the performance of the 5-day-ahead forecast, the R2OS are smaller than those of 1-day-ahead forecast. There are nine models that have positive statistics that are significant at the 5% level for all maturities. The performance worsens for long-maturity implied volatilities. There is only one model (ECM1) that is significant at the 5% level for the 730-day implied volatility, while there are 10 such models for the 1-day-ahead forecast. However, models VARC, ECM1, and ECM2 continue to perform quite well for the 5-day-ahead forecast. The combination forecasts seem to deliver stable and significant results. Thus, in general, the implied volatility is still predictable 5 days ahead when we use daily data.

The bottom panel of Table 6 reports the results of the R^2OS statistics of the 20-day-ahead forecast. It is clear that the forecasting abilities disappear and that none of the models is able to generate a positive R^2OS statistic consistently across all maturities at the 5% significance level. Models VARC, ECM1, and ECM2 that perform well in the 1-day-ahead and 5-day-ahead forecasts fail to beat the benchmark model in the twenty-day-ahead forecast.

In order to visually observe the performance of the models over time, we also calculate their monthly aggregate out-of-sample forecast errors and compare them with those of the benchmark model. Figure 2 plots the difference of the monthly aggregate out-of-sample forecast errors between model VARC, one of the best-performing models reported in Table 6, and the benchmark model. A negative value means that model VARC performs better in that month. We standardize the series to make the pattern clear. Figure 2 shows that, for the 1-day-ahead forecast of all maturities implied volatilities and the 5-day-ahead forecast of short-maturity implied volatilities, most of the differences are negative, suggesting that model VARC consistently outperforms the benchmark model during the sample period.

Table 4. R^2OS of implied volatility forecast

	Model													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Maturity days	NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
	One day ahead (%)													
30	−2.26	1.10[a]	2.51[a]	6.10[a]	5.25[a]	5.48[a]	1.44[a]	0.49[a]	6.07[a]	5.17[a]	5.71[a]	6.20[a]	6.14[a]	7.39[a]
91	−12.59	−3.71	2.36[a]	5.87[a]	4.18[a]	5.05[a]	−7.15	−7.05	3.52[a]	3.22[a]	3.34[a]	4.10[a]	3.74[a]	6.68[a]
152	−9.14	−1.07	2.16[a]	6.65[a]	4.05[a]	5.24[a]	−8.38	−7.82	4.04[a]	3.59[a]	3.81[a]	4.46[a]	4.10[a]	7.28
365	−25.35	−4.49	2.24[a]	11.07[a]	3.65[a]	5.21[a]	−9.26	−4.69	5.44[a]	4.28[a]	4.67[a]	6.06[a]	5.61[a]	10.92[a]
730	−5.96	−8.36	1.86[a]	15.20[a]	2.44[a]	4.26[a]	−9.76	−30.14	4.36[a]	3.68[a]	3.79[a]	5.37[a]	7.18[a]	14.88[a]
All	−7.54	−1.39	2.36[a]	7.23[a]	4.52[a]	5.24[a]	−3.42	−4.98	5.08[a]	4.36[a]	4.73[a]	5.45[a]	5.40[a]	8.09[a]
	Five days ahead (%)													
30	−0.57	1.85[a]	0.84[a]	6.33[a]	4.72[a]	4.83[a]	2.86[a]	0.83[b]	5.57[a]	4.13[a]	4.92[a]	5.68[a]	6.54[a]	7.64[a]
91	−9.94	−3.56	−1.55	4.53[a]	2.1[a]	2.18[a]	−2.89	−3.44	1.90[a]	0.73[b]	1.52[a]	2.10[a]	3.24[a]	4.87[a]
152	−7.57	−0.38	−1.58	4.27[a]	1.77[a]	1.76[a]	−1.54	−2.34	2.56[a]	1.54[b]	2.17[a]	2.66[a]	3.67[a]	4.66[a]
365	−17.83	−1.87	−1.44	4.83	1.22[a]	0.91[c]	−3.07	−2.76	2.60	1.28	2.10[c]	2.74	4.01[b]	4.82[c]
730	−5.10	−6.10	−0.87	6.36	1.00[b]	0.46[c]	−6.56	−16.86	2.02	1.32[c]	1.70[c]	2.28	4.43[c]	6.89
All	−5.24	−0.41	−0.31	5.52[a]	3.25[a]	3.26[a]	−0.03	−1.83	3.89[a]	2.63[a]	3.37[a]	4.03[a]	5.08[a]	6.34[a]
	Twenty days ahead (%)													
30	−3.05	−2.18	−5.37	−5.73	−6.14	−6.76	1.63	−2.43	−1.14	−1.99	−2.14	−0.92	2.06	2.60[a]
91	−10.36	−4.93	−7.08	−4.53	−7.66	−8.71	−0.53	−3.65	−3.03	−4.19	−4.11	−2.81	0.52	1.04[a]
152	−10.81	−3.38	−7.55	−5.47	−7.73	−9.08	0.38	−3.58	−2.95	−3.84	−3.88	−2.77	0.36	1.04[c]
365	−15.93	−2.56	−6.81	−5.75	−7.22	−9.23	1.22	−3.33	−2.03	−3.21	−2.88	−1.91	1.78	1.29
730	−6.42	−2.45	−4.32	−5.76	−5.64	−7.96	−0.30	−6.37	−0.14	−2.07	−1.05	−0.10	4.48	1.91
All	−7.26	−3.06	−6.18	−5.41	−6.81	−7.86	0.78[b]	−3.20	−1.89	−2.91	−2.88	−1.69	1.55[b]	1.84[a]

This table reports the R^2_{OS} statistics of the implied volatility forecasts of the 14 prediction models. AR(1) model is used as the benchmark to calculate the R^2_{OS} statistics. A positive R^2_{OS} statistic indicates that the prediction model outperforms the benchmark model. The statistical significance for the R^2_{OS} statistic is based on the *p*-value of the MSPE-adjusted statistic. The Hodrick (1992) standard error is used for the *p*-value calculation to account for the impact of overlapping residuals. [a, b, c]denote significance at the 1%, 5%, and 10% level, respectively. The sample period is from 1996 to 2015, while the out-of-sample forecast starts from 2002 and ends in 2015.

3.2 Economic significance

The statistical significance results in Table 4 suggest that these models can forecast implied volatilities rather well up to 5 days ahead. To explore the economic significance of this predictability, we further develop the option trading strategies as described in section 2. Following Goncalves and Guidolin (2006), we apply several filters to avoid microstructure-related bias. First, we exclude thinly traded options with less than 100 contracts per day. Second, we keep only the options with a positive bid-ask spread, a positive open interest and a positive implied volatility. Third, we exclude noisy contracts with fewer than 6 trading days to maturity and prices lower than $3/8. Since the Leland's alphas are subtracted from those of the benchmark, any model with economically significant predictability returns a positive gain on Leland's alpha.

Table 5 reports the results. The performance of models VARC, ECM1, and ECM2 continues to be among the best. The combination forecasts also provide better economic performance than the benchmark model. The economic significance of the 1-day-ahead forecast is much stronger than that of the 5-day-ahead forecast. MidP uses mid price and does not assume any transaction cost. For model VARC, which performs the best, the gain on Leland's alpha for the 1-day-ahead forecast using MidP is 11.13% and significant at the 1% level. It declines to 2.13% for the 5-day-ahead forecast. In sharp contrast, none of the 14 models considered is economically significant for the 20-day-ahead forecast. This is consistent with our earlier finding that the historical implied volatility surface information is important for predicting the implied volatility only up to 1 week ahead.

The economic significance results are robust to the impact of transaction costs. Results change little when different levels of transaction costs are introduced. For example, the gain on Leland's alpha of 1-day-ahead forecast using VARC only decreases from 11.13% to 10.79% when we change the effective option spread from 0% (using MidP) to 100% of the quoted spread. One possible reason is that both the tested models and the benchmark model involve transaction costs. As a result, the impact of transaction costs on their performance difference is balanced out.

Figure 2. Difference of the out-of-sample forecast errors between the VAR(1) model on volatility change (VARC) and the benchmark model.

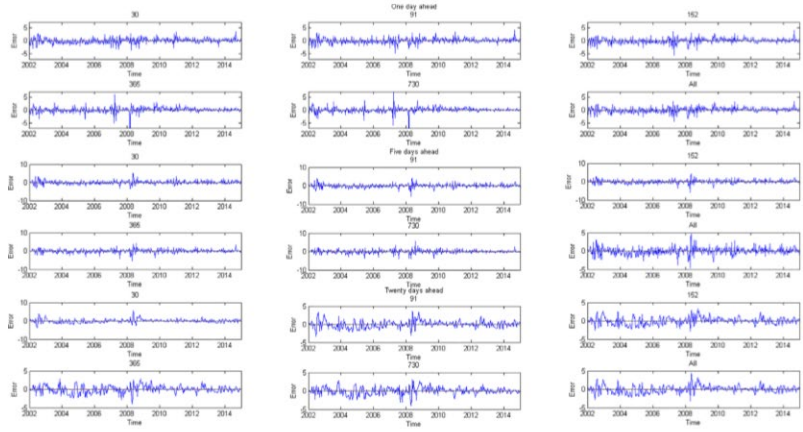

FIGURE 2 Difference of the out-of-sample forecast errors between the VAR(1) model on volatility change (VARC) and the benchmark model. This graph plots the standardized difference of monthly aggregate out-of-sample forecast errors between the best-performing model, VAR(1) on volatility change, and the benchmark model. A negative value means a smaller out-of-sample forecast error for the VARC model [Color figure can be viewed at wileyonlinelibrary.com]

Table 5. Economic significance of implied volatility forecast: Gain on Leland's alpha

	Model													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
	One day ahead													
Mid price	−0.23	1.25	6.37[a]	11.13a	9.86[a]	10.57[a]	−0.01	0.64	7.80[a]	7.49[a]	7.85[a]	8.20[a]	8.16[a]	12.87[a]
10% effective spread	−0.23	1.25	6.37[a]	11.12[a]	9.86[a]	10.57[a]	−0.01	0.64	7.80[a]	7.49[a]	7.85[a]	8.20[a]	8.16[a]	12.87[a]
25% effective spread	−0.23	1.25	6.38[a]	11.11[a]	9.86[a]	10.57[a]	−0.02	0.63	7.80[a]	7.49[a]	7.85[a]	8.20[a]	8.16[a]	12.87[a]
100% effective spread	−0.32	1.29	6.46[a]	10.79[a]	9.89	10.62[a]	−0.21	0.51	7.81[a]	7.54[a]	7.88[a]	8.21[a]	8.19[a]	12.82[a]
	Five days ahead													
Mid price	−1.18	−1.00	−0.11	2.13[c]	1.30	1.45	−0.05	−1.13	0.58	0.01	0.32	0.63	1.42[c]	2.32[c]
10% effective spread	−1.18	−1.00	−0.11	2.13[c]	1.30	1.46	−0.05	−1.13	0.58	0.01	0.32	0.63	1.42[c]	2.32[c]
25% effective spread	−1.19	−0.99	−0.10	2.12[c]	1.30	1.46	−0.06	−1.13	0.59	0.02	0.32	0.63	1.42[c]	2.31[c]
100% effective spread	−1.32	−0.89	0.06	1.85	1.38	1.55	−0.15	−1.16	0.67	0.14	0.42	0.71	1.51	2.23[c]
	Twenty days ahead													
Mid price	−1.42	−1.33	−1.09	−1.39	−1.11	−1.47	−0.10	−1.34	−1.15	−1.23	−1.22	−1.14	−0.63	0.49
10% effective spread	−1.42	−1.33	−1.09	−1.40	−1.11	−1.47	−0.10	−1.34	−1.15	−1.23	−1.22	−1.15	−0.63	0.49
25% effective spread	−1.43	−1.32	−1.08	−1.41	−1.10	−1.46	−0.10	−1.34	−1.15	−1.22	−1.21	−1.14	−0.63	0.49
100% effective spread	−1.61	−1.19	−0.96	−1.74	−0.97	−1.29	−0.11	−1.24	−1.05	−1.11	−1.10	−1.06	−0.54	0.57

This table reports the gain on Leland's alpha of each model. On date t, we long (short) an option if the forecast volatility for that maturity at date $t + h$ is larger (smaller) than the current volatility. We consider options with maturities of 30, 91, 152, 365, and 730 days. Following Constantinides et al. (2013), we construct option portfolios targeting these maturities. We re-balance the portfolio daily and repeat the trade in the out-of-sample period. We delta-hedge our option portfolio. We first use the mid price (MidP) that does not assume any transaction costs to calculate the gain on Leland's alpha. We then assume the effective option spread to be 10%, 25%, and 100% of quoted spread. [a, b, c]denote significance at the 1%, 5%, and 10% level, respectively. The sample period is from 1996 to 2015, while the out-of-sample forecast starts from 2002 and ends in 2015.

Figure 3 plots the standardized aggregate monthly returns of the portfolios that are based on the forecast one day ahead. For those models that have significantly positive gain on Leland's alpha (models VARL, VARC, ECM1, ECM2, MC, TM, DMSPE1, DMSPE2, and MMA), returns are relatively stable during the normal time, but become volatile during the crisis period. Most have a large downward spike during the crisis, suggesting that these trading strategies could be subject to downside risk. The only exception is model VARC. It has a sudden return increase during the crisis, hence providing a better hedge against downside risk compared with other models. Figure 4 plots the standardized aggregate monthly returns of the portfolios that are based on the forecast five days ahead, and the findings are similar.

Figure 3.Time series of monthly portfolio return: 1-day-ahead forecast.

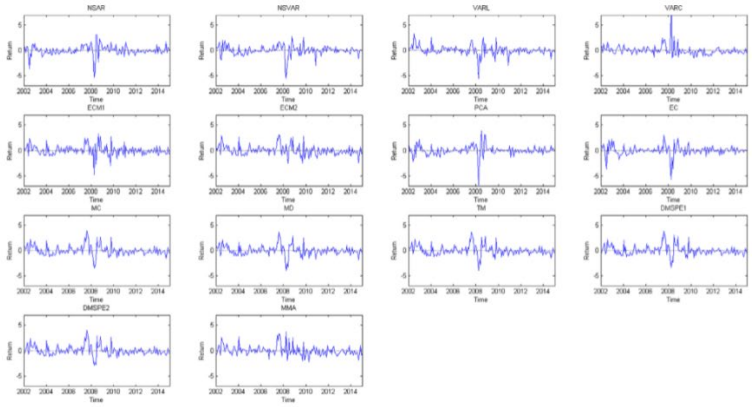

FIGURE 3 Time series of monthly portfolio return: 1-day-ahead forecast. This graph plots the monthly return of portfolios that are based on the 1-day-ahead forecast of implied volatility by 14 different models [Color figure can be viewed at wileyonlinelibrary.com]

4. Robustness Checks

4.1 Out-of-sample forecast during the recent financial crisis

Our data covers the recent financial crisis period. One question is whether the crisis has any impact on the implied volatility predictability. We examine the performance of out-of-sample forecast between December 2007 and June 2009, the recession period indicated by the National Bureau of Economic Research (NBER). Table 6 presents the results of the statistical and economic significance during this period. Panel A reports the R^2OS statistics. In general, the results of 1-day-ahead forecasts during the financial crisis are close to those for the full sample period. Overall, there are nine models that outperform the benchmark model at the 5% significance level in predicting the implied volatility 1 day ahead. However, the results of 5-day-ahead and 20-day-ahead forecasts are weaker compared with the full sample period. Only two models are significant for the 5-day-ahead forecast, and none of the 20-day-ahead forecasts is significant. This result is different from the finding of stronger predictability during the recession period on stock market (Rapach et al., 2010) and corporate bond market (Lin et al., 2014). Rapach et al. (2010) and Lin et al. (2014) focus on risk premium forecast. They use macroeconomic variables and aggregate market variables to forecast the return at monthly or longer horizons, and impose the non-negative restriction to the forecast. Risk premium tends to be more predictable during crisis period. On the other hand, we are interested in how fast implied volatility reflects new information and focus on short horizon predictability using historical implied volatility surface information. We are testing a different question and the results are not comparable. One possible reason is that during a crisis period, investors are more sensitive to information available in the markets. As a result, it takes less time for the option market to absorb new information.

Panel B of Table 6 reports the economic significance results. Different from the statistical result, the economic significance of predictability actually strengthens. For example, the option trading strategy using 1-day-ahead forecasts based on model VARC generates a 33.90% gain on Leland's alpha. The gain on Leland's alpha slightly decreases to 31.18% when 100% effective option spread is used. They are much higher than those reported in Table 5. This shows that historical information is more economically important during a crisis period, which is consistent with Loh and Stulz(2014) who find that analysts tend to make poor forecasts during the crisis, but that the forecasts become more influential once the forecasts are adjusted.

Figure 4. Time series of monthly portfolio return: 5-day-ahead forecast.

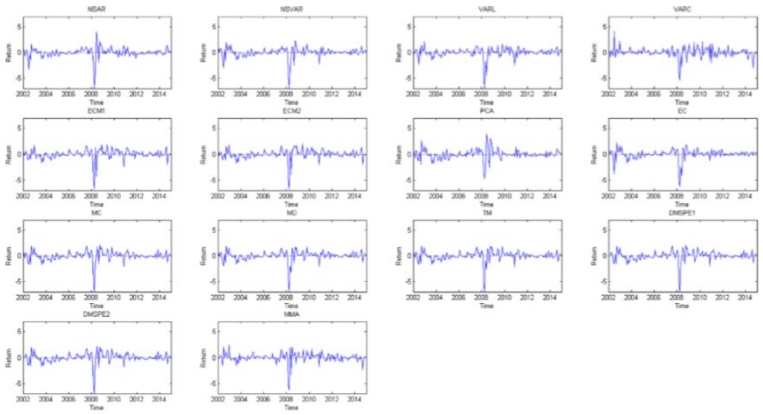

FIGURE 4 Time series of monthly portfolio return: 5-day-ahead forecast. This graph plots the monthly return of portfolios that are based on the five-day-ahead forecast of implied volatility by 14 different models [Color figure can be viewed at wileyonlinelibrary.com]

Table 6. Predictability of implied volatility during the financial crisis

	Model													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Maturity days	NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
Panel A. R^2_{OS}														
	One day ahead (%)													
30	−2.71	−0.92	−1.50	7.66[a]	3.71[a]	4.22[a]	0.07	−0.33	4.23[a]	2.96[a]	3.59[a]	4.36[a]	4.30[a]	6.28[a]
91	−7.48	−1.15	−0.05	7.87[a]	3.73[a]	5.15	−1.81	−3.07	4.08[a]	3.37[a]	3.65[a]	4.36[a]	3.96[a]	7.31[a]
152	−10.87	−4.46	−0.46	7.83[a]	3.74[a]	5.25[a]	−5.76	−7.30	2.73[a]	1.46[b]	2.25[a]	3.11[a]	2.82[a]	7.54[a]
365	−36.33	−9.01	−0.78	9.36[a]	2.93[a]	4.45[a]	−7.04	−4.62	4.11[a]	1.98[b]	3.40[a]	4.70[a]	4.42[a]	9.75[a]
730	−7.46	−11.08	−3.14	11.37[a]	−3.36	−2.44	−14.30	−53.58	1.84[a]	−0.57	1.00[a]	2.77[a]	3.97[a]	12.94[a]
All	−6.90	−2.21	−1.05	7.94[a]	3.45[a]	4.36[a]	−1.97	−3.81	3.92[a]	2.69[a]	3.34[a]	4.17[a]	4.03[a]	7.09[a]
	Five days ahead (%)													
30	−0.54	−1.26	−10.48	6.08[a]	−3.37	−1.63	0.98	−3.10	0.97	−1.46	−0.21	1.06	1.92	4.56
91	−8.12	−6.19	−10.81	3.90[b]	−3.79	−2.11	−0.98	−6.53	−1.17	−4.12	−2.05	−1.11	−0.12	2.99
152	−7.22	−4.28	−11.02	4.39[b]	−4.24	−2.59	0.51	−6.11	−0.35	−3.10	−1.37	−0.34	0.90	3.54
365	−23.44	−7.57	−12.64	3.64[c]	−6.32	−6.62	−0.51	−7.49	−1.34	−5.86	−2.97	−1.39	0.37	1.71
730	−6.20	−9.37	−10.76	2.04	−5.85	−8.26	−5.16	−24.68	−0.87	−5.31	−2.53	−0.85	2.79[c]	2.55
All	−4.67	−3.41	−10.77	5.09[a]	−3.83	−2.37	0.18	−5.24	0.11	−2.66	−1.02	0.18	1.26[c]	3.84[a]
	Twenty days ahead (%)													
30	−2.06	−6.05	−19.86	−15.71	−17.21	−18.72	−1.71	−7.70	−8.99	−9.42	−9.94	−8.76	−6.90	−5.58
91	−6.33	−7.46	−18.34	−9.32	−17.30	−18.98	−0.08	−7.53	−8.48	−10.44	−10.14	−8.31	−6.50	−4.04
152	−7.14	−6.32	−18.58	−8.47	−18.35	−20.47	1.92	−7.59	−8.26	−10.50	−10.15	−8.07	−6.10	−2.64
365	−15.42	−6.35	−17.10	−4.07	−19.80	−22.41	5.50	−7.79	−7.30	−9.92	−9.38	−7.16	−4.45	0.58
730	−5.74	−0.59	−7.98	−2.38	−13.03	−14.76	10.93[a]	−2.31	0.16	−3.99	−2.40	0.21	4.37	7.57[c]
All	−4.98	−6.21	−18.58	−11.67	−17.41	−19.14	0.31	−7.41	−8.24	−9.62	−9.65	−8.04	−6.01	−3.75

(Continues)

	Model													
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Maturity days	NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
Panel B. Economic significance: Gain on Leland's alpha														
	One day ahead													
MidP	7.33[b]	2.10	4.48	33.90[b]	19.52	24.87[c]	7.21	4.18	19.71[b]	15.57	19.23[c]	21.44[b]	19.88[b]	28.84[b]
10% effective spread	7.32[b]	2.09[b]	4.45[b]	33.87[b]	19.49	24.84[b]	7.19[b]	4.16[b]	19.69[b]	15.55[b]	19.21[b]	21.42[b]	19.86[b]	28.81
25% effective spread	7.29[b]	2.01[b]	4.31[b]	33.73[b]	19.35[b]	24.70[b]	7.07[b]	4.04[b]	19.59[b]	15.44[b]	19.11[b]	21.32[b]	19.76[b]	28.68[b]
100% effective spread	6.77[b]	0.57[b]	1.74[b]	31.18[b]	16.78[b]	22.24[b]	5.02[b]	1.94[b]	17.90[b]	13.56[b]	17.32[b]	19.51[b]	18.00[b]	26.25[b]
	Five days ahead													
MidP	1.19	−4.36	−6.11	−1.92	1.23	2.76	4.57	−4.52	1.82	−3.14	−0.50	1.33	4.03	0.26
10% effective spread	1.18	−4.37	−6.12	−1.95	1.21	2.75	4.56	−4.53	1.81	−3.15	−0.52	1.31	4.01	0.24
25% effective spread	1.17	−4.42	−6.21	−2.07	1.11	2.65	4.48	−4.61	1.75	−3.22	−0.59	1.25	3.95	0.13
100% effective spread	0.87	−5.33	−7.73	−4.23	−0.66	0.98	3.03	−6.05	0.59	−4.39	−1.84	0.06	2.78	−1.83
	Twenty days ahead													
MidP	1.32	−0.29	−4.28	−6.49	−2.34	−3.74	1.83	−2.71	−0.05	−1.03	−0.95	0.00	0.95	1.92
10% effective spread	1.32	−0.30	−4.29	−6.51	−2.35	−3.75	1.82	−2.72	−0.05	−1.04	−0.95	−0.01	0.94	1.91
25% effective spread	1.29	−0.45	−4.51	−7.01	−2.55	−3.93	1.61	−2.92	−0.20	−1.20	−1.12	−0.16	0.79	1.67
100% effective spread	1.17	−0.91	−5.20	−8.56	−3.19	−4.51	0.94	−3.56	−0.67	−1.72	−1.63	−0.63	0.32	0.89

This table reports the predictability of implied volatility during the financial crisis period. Panel A reports the R^2_{OS} statistics, while Panel B reports the economic significance results. AR(1) model is used as the benchmark to calculate the R^2_{OS} statistics. A positive R^2_{OS} statistic indicates that the prediction model outperforms the benchmark model. The statistical significance for the R^2_{OS} statistic is based on the p-value of the MSPE-adjusted statistic. The Hodrick (1992) standard error is used for the p-value calculation to account for the impact of overlapping residuals. Panel B reports the gain on Leland's alpha of each model during the recent financial crisis. On date t, we long (short) an option if the forecast volatility for that maturity at date $t + h$ is larger (smaller) than the current volatility. We consider options with maturities of 30, 91, 152, 365, and 730 days. Following Constantinides et al. (2013), we construct option portfolios targeting these maturities. We rebalance the portfolio daily and repeat the trade in the out-of-sample period. We delta-hedge our option portfolio. We first use the mid price (MidP) that does not assume any transaction costs to calculate the gain on Leland's alpha. We then assume the effective option spread to be 10%, 25%, and 100% of quoted spread. [a, b, c] denote significance at the 1%, 5% and 10% level, respectively. The financial crisis period is between December 2007 and June 2009.

4.2 Out-of-sample forecast of put option

Another question is whether the findings using call options could be extended to put options. To answer this question, we run our tests using implied volatility surface of put options. We use the ATM put options and the put options with = 0.40 and = 0.60.

The top panel of Table 7 reports the R^2OS statistics and the following panels report the gain on Leland's alpha of different horizons. For simplicity, we only present the results of all maturity and moneyness. The implied volatilities of put options are statistically predictable up to 20 days. Such predictability is stronger than that of call options. Model VARC, ECM1, ECM2, and combination forecasts continue to perform well.

Table 7. Out-of-sample forecast of implied volatilities of put options

	Model													
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
		NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
	One day ahead	−7.70	−1.97	1.12[a]	3.32[a]	2.71[a]	2.72[a]	−6.51	−7.45	2.29[a]	2.17[a]	2.32[a]	2.54[a]	2.67[a]	3.77[a]
R^2_{OS}	Five days ahead	−6.26	−0.58	−0.12	4.66[a]	2.83[a]	2.74[a]	−0.63	−2.26	2.92[a]	2.04[a]	2.39[a]	3.07[a]	4.10[a]	5.38[a]
	Twenty days ahead	−5.38	−3.46	−5.57	−3.71	−5.79	−6.44	0.79[a]	−3.77	−1.12	−2.36	−2.20	−1.03	2.42[a]	2.56[a]
		One day ahead													
	MidP	1.00	2.41	9.83[a]	12.05[a]	10.27[a]	9.65[a]	3.20[b]	2.78[c]	6.13[a]	7.48[a]	6.39[a]	6.31[a]	6.65[a]	11.97[a]
Gain on	10% effective spread	1.00	2.41	9.83	12.05[a]	10.27[a]	9.65[a]	3.20[b]	2.78[c]	6.13[a]	7.48[a]	6.39[a]	6.31[a]	6.65[a]	11.97[a]
Leland's alpha	25% effective spread	1.01	2.40	9.85[a]	12.07[a]	10.27[a]	9.64[a]	3.20[b]	2.77[c]	6.13[a]	7.48[a]	6.39[a]	6.31[a]	6.65[a]	11.98[a]
	100% effective spread	−0.32	1.29	6.46[a]	10.79[a]	9.89[a]	10.62[a]	−0.21	0.51	7.81[a]	7.54[a]	7.88[a]	8.21[a]	8.19[a]	12.82[a]
		Five days ahead													
	MidP	0.23	0.57	3.00[a]	5.16[a]	3.84[a]	3.76[a]	1.89[b]	1.49	2.15[b]	1.85[b]	2.19	2.23[b]	3.11[a]	5.23[a]
Gain on	10% effective spread	0.23	0.57	3.00[a]	5.16[a]	3.84[a]	3.76[a]	1.89[b]	1.48	2.15[b]	1.85[b]	2.19[b]	2.23[b]	3.10[a]	5.23[a]
Leland's alpha	25% effective spread	1.01	2.40	9.85[a]	12.07[a]	10.27[a]	9.64[a]	3.20[b]	2.77	6.13[a]	7.48[a]	6.39[a]	6.31[a]	6.65[a]	11.98[a]
	100% effective spread	−1.32	−0.89	0.06	1.85	1.38	1.55	−0.15	−1.16	0.67	0.14	0.42	0.71	1.51[c]	2.23[c]
		Twenty days ahead													
	MidP	−1.00	0.08	0.90	0.51	0.61	−0.20	0.67	0.28	−0.21	0.16	0.04	−0.19	0.70	0.73
Gain on	10% effective spread	−0.99	0.07	0.90	0.51	0.61	−0.20	0.67	0.28	−0.21	0.16	0.04	−0.19	0.69	0.72
Leland's alpha	25% effective spread	−0.97	0.06	0.90	0.52	0.60	−0.21	0.66	0.26	−0.22	0.15	0.03	−0.21	0.68	0.71
	100% effective spread	−1.61	−1.19	−0.96	−1.74	−0.97	−1.29	−0.11	−1.24	−1.05	−1.11	−1.10	−1.06	−0.54	0.57

This table reports the out-of-sample forecast of implied volatilities of put options by the 14 models. The top panel report the results of R^2_{OS}, while the following panels reports the results of the gain on Leland's alpha at different horizon: For simplicity, we only report the results of all maturity and moneyness. [a, b, c] denote significance at the 1%, 5%, and 10% level, respectively. The sample period is from 1996 to 2015, while the out-of-sample forecast starts from 2002 an ends in 2015.

The predictability of implied volatilities of put options is also of economic significance. For

the one-day-ahead forecast, model VARC generates a gain on Leland's alpha of 12.05% if MidP is used, and 10.79% if 100% effective option spread is used. Both of them are significant at the 1% level. The economic significance of 5-day-ahead forecast is still strong. Model VARC generates a gain on Leland's alpha of 5.16% if MidP is used, and 1.85% if 100% effective option spread is used. They are stronger than those of call options. Overall, the results using put option data strengthen our findings that implied volatility surface contains useful information for the forecast of implied volatilities.

4.3 Out-of-sample forecast with other benchmark

Recently, Egloff et al. (2010) and Johnson (2017) show that slope is an important predictor of implied variance. As a robustness check, we replace the benchmark model of AR(1) with the two-factor model that uses level and slope, and re-run all the tests. Unreported results show that the earlier well-performing models, such as VARC, ECM1, ECM2, and combination forecast, have significantly positive R^2OS up to 1 week.[13] The overall R^2OS of VARC model is 12.47% for the 1-day ahead forecast, and is significant at the 1% level. The results of ECM1, ECM2 and combination forecast are similar and also significant at the 1% level. These models lose predictive power after 1 week.

Results of economic significance analysis also suggest that VARC, ECM1, ECM2, and combination forecast outperform the two-factor benchmark model. The gain on Leland's alpha of the 1-day ahead forecast using VARC is 6.11% and significant at the 1% level. Results continue to be significant for the five-day-ahead forecast, and become insignificant after 1 week.

Our empirical analysis suggests that for the short-horizon implied volatility forecast, a flexible model framework such as VARC and others is able to use the surface information more efficiently, and provides a better out-of-sample result. On the other hand, when the forecast horizon is beyond 1 week, more flexible models generate more noise, and simple models such as AR and two-factor model start to function better. This finding has useful implication for the portfolio management.

4.4 Option data with a different range

We use options with between 0.40 and 0.60 in our empirical analysis. Literature shows that the most liquid options are ATM as well as +0.25 and −0.25 options, which also contain valuable information.[14] To test whether our results are robust to the use of data with a different range , we re-run our analysis using the option data with between 0.30 and 0.70, which covers the moneyness between 25% and 75%.

Table 8 reports the results. Panel A and Panel B report the result of call and put options, respectively. We report the overall R^2OS and the gain on Leland's alpha for the forecast of 1 day ahead, 5 days ahead, and 20 days ahead. Results clearly show that implied volatility is still predictable when the data with between 0.30 and 0.70 are used. The results are close to those using the data with between 0.40 and 0.60. For the 1-day-ahead forecast of call options, there are ten models with significant R^2OS and gain on Leland's alpha. For the 5-day-ahead forecast of call option, there are nine models with significant R^2OS and three models with significant gain on Leland's alpha. Results become insignificant for the 20-day-ahead forecast. The results of put option in Panel B show a similar pattern.

13The results are available upon request.
14See for example, Carr and Wu (2007).

Table 8. Predictability of implied volatility with between 0.30 and 0.70

		Model													
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
		NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
Panel A. Call options															
	One day ahead	−8.00	−0.78	7.92[a]	10.32[a]	8.88[a]	9.22[a]	−5.37	−11.20	9.75[a]	10.09[a]	9.98[a]	10.50[a]	10.72[a]	13.34[a]
R^2_{OS}	Five days ahead	−5.59	−0.46	2.54	7.20[a]	5.16[a]	5.19[a]	−0.40	−4.04	6.18[a]	5.73[a]	5.89[a]	6.43[a]	7.77[a]	8.68[a]
	Twenty days ahead	−7.74	−3.29	−5.73	−6.35	−6.07	−6.40	0.74	−3.39	−0.77	−1.94	−1.58	−0.55	3.19[c]	2.45[b]
		One day ahead													
	Mid price	0.08	1.20	10.79[a]	10.92[a]	12.80[a]	12.92[a]	−0.15	1.46	8.25[a]	9.23[a]	8.99[a]	9.33[a]	9.50[a]	14.27[a]
Gain on	10% effective spread	0.08	1.20	10.79[a]	10.92[a]	12.80[a]	12.92[a]	−0.15	1.46	8.25[a]	9.23[a]	8.99[a]	9.33[a]	9.50[a]	14.27[a]
Leland's alpha	25% effective spread	0.05	1.20	10.77[a]	10.84[a]	12.77[a]	12.91[a]	−0.21	1.40	8.22[a]	9.21[a]	8.96[a]	9.30[a]	9.47[a]	14.26[a]
	100% effective spread	−0.03	1.19	10.72[a]	10.57[a]	12.70[a]	12.85[a]	−0.39	1.22	8.13[a]	9.15[a]	8.89[a]	9.22[a]	9.40[a]	14.25[a]
		Five days ahead													
	Mid price	−0.87	−1.02	0.54	2.71[b]	1.41	1.52	0.16	−0.74	0.57	0.56	0.48	0.59	1.66[b]	2.94[b]
Gain on	10% effective spread	−0.87	−1.02	0.54	2.71[b]	1.41	1.52	0.16	−0.74	0.57	0.56	0.48	0.59	1.66[b]	2.94[b]
Leland's alpha	25% effective spread	−0.88	−1.02	0.54	2.70[b]	1.41	1.52	0.15	−0.75	0.57	0.56	0.48	0.59	1.66[b]	2.93[b]
	100% effective spread	−1.02	−0.96	0.57	2.43[c]	1.42	1.52	0.00	−0.90	0.54	0.57	0.47	0.56	1.64[b]	2.88[b]
		Twenty days ahead													
	Mid price	−1.17	−1.30	−0.71	−1.26	−1.03	−1.12	−0.21	−1.55	−1.05	−1.11	−1.12	−1.07	−0.20	0.17
Gain on	10% effective spread	−1.17	−1.30	−0.71	−1.27	−1.03	−1.12	−0.21	−1.55	−1.05	−1.11	−1.12	−1.07	−0.20	0.17
Leland's alpha	25% effective spread	−1.18	−1.29	−0.70	−1.29	−1.02	−1.12	−0.21	−1.55	−1.05	−1.10	−1.12	−1.07	−0.20	0.17
	100% effective spread	−1.37	−1.18	−0.65	−1.61	−0.93	−1.01	−0.30	−1.60	−0.98	−1.05	−1.04	−1.01	−0.16	0.22

(Continues)

Table 8(continue). Predictability of implied volatility with between 0.30 and 0.70

		Model													
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
		NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
Panel B. Put options															
	One day ahead	−13.75	−2.85	4.57[a]	5.47[a]	4.96[a]	5.60[a]	−8.41	−11.83	4.91[a]	5.72[a]	5.50[a]	5.43[a]	5.30[a]	6.19[a]
R^2_{OS}	Five days ahead	−12.58	−3.78	1.84[a]	5.74[a]	2.75[a]	2.68[a]	−1.38	−6.13	2.95[a]	2.35[a]	2.64[a]	3.30[a]	5.00[a]	6.82[a]
	Twenty days ahead	−7.82	−8.22	−14.00	−2.81	−14.97	−16.06	0.04	−8.82	−5.49	−8.02	−7.30	−5.27	−1.23	0.69[b]
		One day ahead													
	Mid price	0.22	1.82	9.63[a]	11.41[a]	9.10[a]	8.89[a]	2.91[a]	2.82[c]	5.95[a]	7.77[a]	6.18[a]	5.79[a]	6.40[a]	11.39[a]
Gain on	10% effective spread	0.23	1.82	9.63[a]	11.41[a]	9.10[a]	8.89[a]	2.91[c]	2.82[c]	5.95[a]	7.77[a]	6.18[a]	5.79[a]	6.40[a]	11.39[a]
Leland's alpha	25% effective spread	0.24	1.82	9.66[a]	11.43[a]	9.11[a]	8.89[a]	2.91[c]	2.82[c]	5.96[a]	7.78[a]	6.19[a]	5.80[a]	6.41[a]	11.39[a]
	100% effective spread	0.49	1.77	10.19[a]	11.75[a]	9.34[a]	9.02[a]	2.96[b]	2.84[c]	6.02[a]	7.95[a]	6.33[a]	5.92[a]	6.51[a]	11.45[a]
		Five days ahead													
	Mid price	0.05	0.14	2.16[c]	4.16[a]	2.29[c]	2.21[c]	2.50[a]	2.09[b]	1.50[c]	1.92[b]	1.64[c]	1.63[c]	2.97[a]	4.81[a]
Gain on	10% effective spread	0.05	0.14	2.16[c]	4.16[a]	2.29[c]	2.21[c]	2.50[a]	2.09[b]	1.50[c]	1.92[b]	1.64[c]	1.63[c]	2.97[a]	4.81[a]
Leland's alpha	25% effective spread	0.07	0.12	2.18[c]	4.18[a]	2.30[c]	2.22[c]	2.50[a]	2.08[b]	1.51[c]	1.92[b]	1.64[c]	1.63[c]	2.97[a]	4.81[a]
	100% effective spread	0.37	−0.11	2.47[c]	4.51[a]	2.37[c]	2.27[c]	2.50[a]	2.01[b]	1.53[c]	1.94[b]	1.68[c]	1.67[c]	3.00[a]	4.87[a]
		Twenty days ahead													
	Mid price	−0.62	−0.04	0.49	1.27	0.18	−0.02	0.62	0.21	0.18	0.02	0.14	0.16	1.68[a]	1.97[a]
Gain on	10% effective spread	−0.62	−0.04	0.50	1.28	0.18	−0.02	0.62	0.21	0.18	0.02	0.14	0.16	1.68[a]	1.97[a]
Leland's alpha	25% effective spread	−0.60	−0.05	0.52	1.29	0.19	−0.01	0.61	0.20	0.18	0.03	0.14	0.15	1.67[a]	1.97[a]
	100% effective spread	−0.23	−0.30	0.84	1.62	0.35	0.09	0.54	0.10	0.18	0.04	0.12	0.15	1.63[a]	2.04[a]

This table reports the predictability of the implied volatility with Δ between 0.30 and 0.70. Panel A and B report the result of call and put options respectively. AR(1) model is used as the benchmark to calculate the R^2_{OS} statistics and gain on Leland's alpha. A positive R^2_{OS} statistic indicates that the prediction model outperforms the benchmark model. The statistical significance for the R^2_{OS} statistic is based on the *p*-value of the MSPE-adjusted statistic. The Hodrick (1992) standard error is used for the *p*-value calculation to account for the impact of overlapping residuals. Gain on Leland's alpha is used to measure the economic significance. On date *t*, we long (short) an option if the forecast volatility for that maturity at date $t + h$ is larger (smaller) than the current volatility. We consider options with maturities of 30, 91, 152, 365, and 730 days. Following Constantinides et al. (2013), we construct option portfolios targeting these maturities. We rebalance the portfolio daily and repeat the trade in the out-of-sample period. We delta-hedge our option portfolio. We first use the mid price (MidP) that does not assume any transaction costs to calculate the gain on Leland's alpha. We then assume the effective option spread to be 10%, 25%, and 100% of quoted spread. [a, b, c]denote significance at the 1%, 5%, and 10% level, respectively.

4.5 Gain on alpha from a different asset pricing model

We use the gain on Leland's alpha as the economic significance measure. Leland's alpha only considers the impact of market risk on the option portfolio return. In order to test whether the economic significance is robust to the choice of asset pricing model, we run the regression of Chen, Roll, and Ross (1986) five factor model on long-short option portfolio return to get the gain on alpha. We construct long-short option portfolios following the option trading strategies as described in section 2 for each model. We calculate the monthly cumulative option portfolio return of each predictive model, and then the difference of the option portfolio return between

the predictive model and the benchmark model. We then run the time series regression of the option portfolio return difference on the five factors of Chen et al. (1986),

$$r_{i,t} - r_{0,t} = Alpha + \beta_{MP} MP_t + \beta_{DEI} DEI_t + \beta_{UI} UI_t + \beta_{UPR} UPR_t + \beta_{UTS} UTS_t + \varepsilon_{it} \quad (10)$$

where $r_{i,t}$ is the option portfolio return of predictive model iin month t, $r_{0,t}$ is the option portfolio return of the benchmark model in month t, MP_t, DEI_t, UI_t, UPR_t, and UTS_t are industrial production growth, changes in expected inflation, unexpected inflation, risk premium, and term structure factor in month t, respectively.[15] We are interested in whether the intercept, Alpha, is significant after controlling for the five factors.

Table 9 reports the results of 1-day-ahead forecast. We report the results of call and put options with between 0.40 and 0.60 (upper panel) and between 0.30 and 0.70 (bottom panel). Results strongly show that implied volatility predictability is economically significant after controlling for the five factors of Chen et al. (1986). For the call option with between 0.40 and 0.60, there are 10 models with significant gains on alpha if mid-price is used to calculate the option return. Results change little if 100% effective spread is used.

Table 9. Gain on alpha of option portfolio return using Chen et al. (1986) five factor model

		Model													
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
		NSAR	NSVAR	VARL	VARC	ECM1	ECM2	PCA	EC	MC	MD	TM	DMSPE1	DMSPE2	MMA
		Options with Δ between 0.40 and 0.60													
	Mid price	0.29	1.01	6.31[b]	13.28[a]	10.78[a]	12.24[a]	1.53	2.03	7.33[a]	7.08[a]	7.53[a]	7.84[a]	7.75[a]	14.74[a]
	10% effective spread	0.29	1.01	6.31[b]	13.28[a]	10.78[a]	12.23[a]	1.52	2.02	7.33[a]	7.07[a]	7.53[a]	8.04[a]	7.94[a]	14.93[a]
Call	25% effective spread	0.29	0.99	6.29[b]	13.25[a]	10.76[a]	12.22[a]	1.49	2.00	7.31[a]	7.06[a]	7.51[a]	8.31[a]	8.21[a]	15.20[a]
	100% effective spread	0.17	0.80	6.01[b]	12.67[a]	10.41[a]	11.94[a]	1.02	1.55	7.07[a]	6.83[a]	7.27[a]	9.51[a]	9.43[a]	16.29[a]
	Mid price	2.13	4.27[b]	14.33[a]	14.74[a]	13.13[a]	12.17[a]	5.79[a]	5.08[b]	8.61[a]	10.22[a]	8.65[a]	8.87[a]	9.19[a]	15.13[a]
	10% effective spread	2.14	4.27[b]	14.34[a]	14.74[a]	13.14[a]	12.17[a]	5.79[a]	5.09[b]	8.62[a]	10.22	8.65[a]	9.08[a]	9.40[a]	15.35[a]
Put	25% effective spread	2.14	4.27[b]	14.38[a]	14.78[a]	13.16[a]	12.19[a]	5.80[a]	5.10[b]	8.62[a]	10.23[a]	8.67[a]	9.42[a]	9.73[a]	15.70[a]
	100% effective spread	2.24	4.23[b]	15.14[a]	15.41[a]	13.60[a]	12.49[a]	5.99[a]	5.33[a]	8.80[a]	10.46[a]	8.89[a]	11.21[a]	11.50[a]	17.76[a]
		Options with Δ between 0.30 and 0.70													
	Mid price	0.64	0.83	12.15[a]	13.58[a]	14.86[a]	14.77[a]	0.87	3.67[c]	9.21[a]	9.12[a]	9.51[a]	10.05[a]	9.94[a]	16.00[a]
	10% effective spread	0.64	0.82	12.14[a]	13.57[a]	14.86[a]	14.77[a]	0.87	3.66[c]	9.21[a]	9.12[a]	9.51[a]	10.23[a]	10.13[a]	16.19
Call	25% effective spread	0.63	0.81	12.12[a]	13.54[a]	14.83[a]	14.74[a]	0.84	3.63[c]	9.19[a]	9.09	9.49[a]	10.50[a]	10.39[a]	16.46
	100% effective spread	0.47	0.58	11.66[a]	12.91[a]	14.32[a]	14.30[a]	0.33	3.03	8.80[a]	8.70a	9.09[a]	11.57[a]	11.44[a]	17.55[a]
	Mid price	1.24	3.85[b]	14.25[a]	15.32[a]	13.28[a]	12.55[a]	4.99[a]	5.74[a]	8.73[a]	11.19[a]	9.09[a]	8.71[a]	9.36[a]	14.57[a]
	10% effective spread	1.24	3.85[b]	14.26[a]	15.33[a]	13.28	12.55[a]	4.99[a]	5.75[a]	8.73[a]	11.19[a]	9.09[a]	8.93[a]	9.58[a]	14.78[a]
Put	25% effective spread	1.25	3.85[b]	14.32[a]	15.37[a]	13.32[a]	12.58[a]	5.00[a]	5.76[a]	8.74[a]	11.21[a]	9.11[a]	9.27[a]	9.91[a]	15.12[a]
	100% effective spread	1.48	3.91[b]	15.30[a]	16.00[a]	14.00[a]	13.08[a]	5.25[a]	6.09[a]	8.99[a]	11.64[a]	9.46[a]	11.19[a]	11.82[a]	17.10[a]

This table reports the gain on alpha of long-short option portfolio return based on the five factor model of Chen et al. (1986). We construct long-short option portfolios following the option trading strategies as described in section 2 fo each model. We calculate the monthly cumulative option portfolio return of each predictive model, and then the difference of the option portfolio return between the predictive model and the benchmark model. We then run the tim series regression of the option portfolio return difference on the five factors of Chen et al. (1986).

$r_{i,t} - r_{0,t} = \text{Alpha} + \beta_{MP}\text{MP}_t + \beta_{DEI}\text{DEI}_t + \beta_{UI}\text{UI}_t + \beta_{UPR}\text{UPR}_t + \beta_{UTS}\text{UTS}_t + \varepsilon_{it}$ where r_{it} is the option portfolio return of predictive model i in month t, r_{0t} is the option portfolio return of the benchmark model in month t, MP_t, DEI_t UI_t, UPR_t, and UTS_t are industrial production growth, changes in expected inflation, unexpected inflation, risk premium and term structure factor in month t respectively. We consider options with maturities of 30, 91, 152, 365, and 73 days. Following Constantinides et al. (2013), we construct option portfolios targeting these maturities. We rebalance the portfolio daily and repeat the trade in the out-of-sample period. We delta-hedge our option portfolio. We first us the mid price (MidP) that does not assume any transaction costs to calculate the option return. We then assume the effective option spread to be 10%, 25%, and 100% of quoted spread. [a, b, c]denote significance at the 1%, 5%, and 10% level, respectively.

Results of put option are stronger than those of call option. Using data with between 0.30 and 0.70 generates a similar pattern. These results suggest that there exist significant economic gains of implied volatility predictability form using the information of historical implied volatility surface.

5. Stochastic Volatility Model

Our finding that implied volatility surface contains information for the prediction of implied volatilities is consistent with the literature of multi-factor stochastic volatility model. To test this

15MPt , DElt and Ult are obtained from Federal Reserve Bank of St Louis, while UPRt and UTSt are downloaded from Amit Goyal's website.

hypothesis, we calibrate the two-factor stochastic volatility option pricing model (9) to the implied volatility data. Following Christoffersen et al. (2009) we calibrate the option pricing formula to the weekly data of ATM calls and puts.[16]

Figure 5 plots the time series of the two variance factors for the calls (the upper panel) and puts (the bottom panel). The variance factors fluctuate a lot over time, and reach a peak during the crisis period. The first factor is much more persistent than the second factor. Indeed, the mean β values of calls (puts) are 0.21 (0.13) and 3.21 (1.70) for the first factor and the second factor, respectively. We therefore call the first factor the long-term variance factor while the second factor is the short-term variance factor.

We then run the univariate regressions

$$\sigma_t^2(\tau) = \alpha(\tau) + \beta_1(\tau)V_{1t} + \varepsilon_t(\tau), \tag{11}$$

$$\sigma_t^2(\tau) = \alpha(\tau) + \beta_2(\tau)V_{2t} + \varepsilon_t(\tau), \tag{12}$$

and the bivariate regression

$$\sigma_t^2(\tau) = \alpha(\tau) + \beta_1(\tau)V_{1t} + \beta_2(\tau)V_{2t} + \varepsilon_t(\tau), \tag{13}$$

to investigate the relationship between these two extracted variance factors and the implied volatilities. V_{1t} and V_{2t} are the two variance factors in Eq. (9), while $\varepsilon_t(\tau)$is the residual of the regression for the τ-day implied variance.

Figure 5. Extracted variance factors

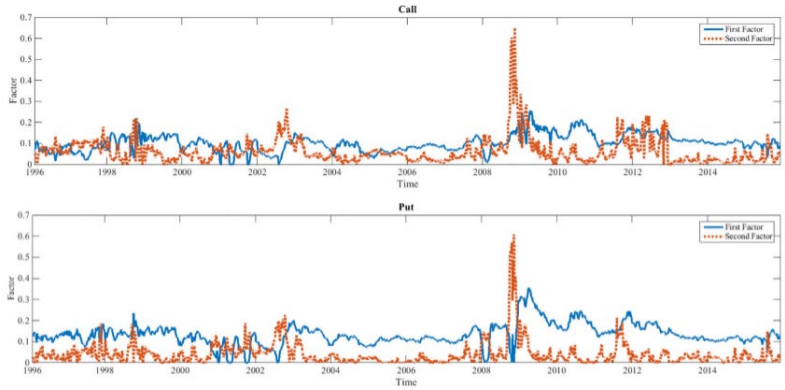

FIGURE 5 Extracted variance factors. This graph plots the time series of two extracted variance factors calibrated from the two-factor stochastic volatility option pricing model. The top panel plots the time series of two extracted variance factors for ATM calls, while the bottom panel plots the time series for ATM puts [Color figure can be viewed at wileyonlinelibrary.com]

Table 10 reports the regression results of the ATM calls and puts. Most implied volatilities are affected by both factors with significant t statistics. Short-maturity implied volatilities are more related to the short-term variance factor, while long-maturity implied volatilities are more related to the long-term variance factor. For example, the long-term variance factor only explains 6% of the variances of the 30-day call's implied volatility, but its explanatory power for the 730-day call's implied volatility increases to 43%. Meanwhile, the adjusted R^2 of the short-term variance

16Appendix 2 reports the calibration results in each year for calls and puts respectively.

factor on 30- and 730-day calls' implied volatilities are 72% and 30%, respectively. Results of ATM puts are similar. Consistent with our hypothesis, long-maturity implied volatilities contain more information about the long-run equilibrium of variance, while short-maturity implied volatility contains more information about short-term variance.

Table 10. Relationship between implied volatility and the extracted long-term and short-term variance factors

	ATM call					ATM put				
	Long-term factor		Short-term factor			Long-term factor		Short-term factor		
Maturity (days)	β_1	*t*-stats	β_2	*t*-stats	Adj. R^2	β_1	*t*-stats	β_2	*t*-stats	Adj. R^2
30	0.25	4.09			0.06	0.09	1.26			0.01
			0.54	13.31	0.72			0.67	28.12	0.83
	0.23	7.92	0.53	14.83	0.78	0.24	14.40	0.71	32.55	0.92
91	0.28	5.97			0.13	0.16	2.82			0.06
			0.39	14.45	0.62			0.49	17.11	0.70
	0.27	10.36	0.39	15.93	0.74	0.27	15.61	0.54	22.05	0.88
182	0.30	8.34			0.23	0.19	4.25			0.12
			0.29	12.60	0.51			0.36	12.17	0.57
	0.29	13.33	0.29	13.19	0.72	0.28	17.22	0.41	16.05	0.83
365	0.31	10.63			0.33	0.19	5.16			0.17
			0.22	10.80	0.40			0.29	9.85	0.47
	0.31	15.90	0.22	10.81	0.72	0.26	17.36	0.33	13.09	0.78
730	0.31	13.19			0.43	0.17	5.81			0.19
			0.17	9.71	0.30			0.22	8.78	0.40
	0.31	18.31	0.16	8.98	0.72	0.23	16.75	0.26	11.74	0.73

This table reports the results of regressing the squared implied volatilities of different maturities on the extracted long- and short-variance factors. We calibrate a two-factor stochastic volatility option pricing model to the weekly data of ATM options each year from 1996 to 2015, using an iterative two-step optimization procedure as in Christoffersen, Heston and Jacobs (2009). The *t*-statistics are adjusted by Newey-West standard errors.

Another interesting finding is that the explanatory power of the two variance factors is higher for short-maturity implied volatilities. For example, the adjusted R^2 of the 30-day call's implied volatility on the two variance factors is 78%, while it is only 72% for the 730-day call's implied volatility. We have similar results for ATM puts. These suggest that the two-factor stochastic volatility model better captures the prices of short-maturity options than long-maturity options.

6. Conclusion

In this paper, we test the out-of-sample predictability of S&P 500 index option implied volatilities. In particular, we evaluate 14 different models that are based on historical implied volatility surface information. We investigate both statistical and economic significance. To examine how long this predictability lasts, we also compare the results at different forecast horizons. We obtain several interesting results.

Using out-of-sample R^2OS statistics as the statistical measure, we find that several models that use the entire historical implied volatility surface information could predict the implied volatility significantly in the out-of-sample period. These models could forecast the implied volatility up to 1 week ahead for the call options, and up to 20 days ahead for the puts.

Using the gain on Leland's alpha as the economic significance measure, we find that the predictability is of economic significance. The models that use the information of implied volatility surface generate positive gain on Leland's alphas relative to the benchmark model,

even after transaction costs are accounted for. During the recent financial crisis, the predictability is weakened but the economic significance becomes stronger. In particular, the VAR(1) model on volatility changes performs well in hedging against the downside risk during the crisis.

By calibrating a two-factor stochastic volatility model to option data, we extract a long-term and a short-term variance component. By regressing different implied volatilities on these two components, we find that short-maturity implied volatilities are more related to the short-term variance factor, while long-maturity volatilities are more related to the long-term variance factor. This helps explain why using them jointly improves the forecast performance.

Our findings have several interesting implications. Our results show the importance of historical implied volatility information up to 1 week. We carry out delta-neutral trading strategies and document the economic significance of option market predictability. The results of significantly positive abnormal returns provide insight of profitable investment opportunities for hedge fund managers, and show an economically effective way of using historical implied volatility curve information for practitioners.

Our results are consistent with Bakshi et al. (1997) and the emerging component volatility models. Both short-term and long-term volatilities should be considered in option pricing models to fully capture the price influence.

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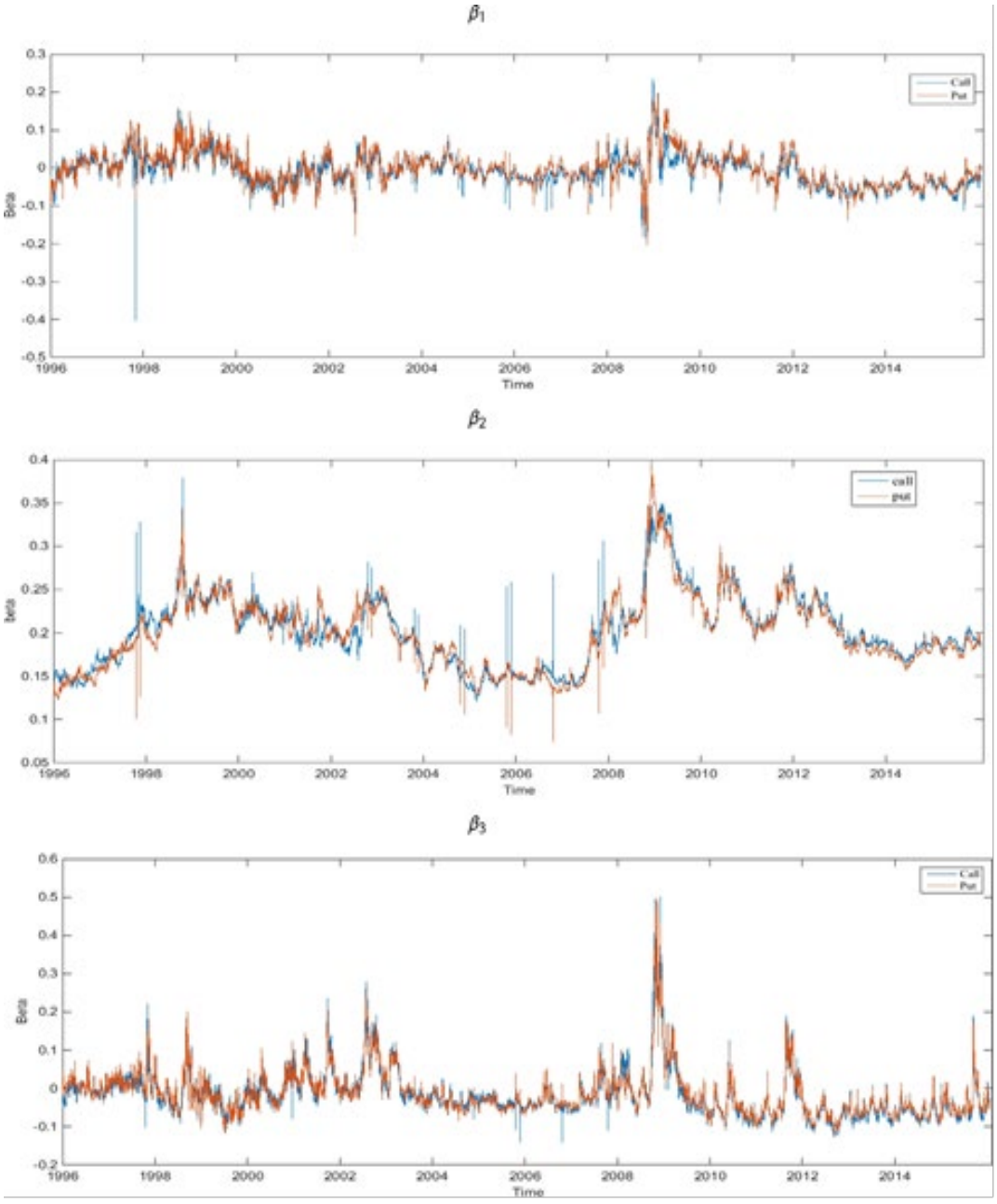
Appendix

A. Coefficients of NS model

This graph plots the time series of β_{1t}, β_{2t}, and β_{3t} that are calibrated from the ATM implied volatility curve information using the NS model [Color figure can be viewed at wileyonlinelibrary.com]



B. Calibration results of two-factor stochastic volatility option pricing model

This appendix reports the calibration results of the two-factor stochastic volatility option pricing model of Christoffersen et al. (2009).

	Call								Put							
Year	a_1/b_1	b_1	a_2/b_2	b_2	σ_1	$\sigma_2(\times 100$	ρ_1	ρ_2	a_1/b_1	b_1	a_2/b_2	b_2	σ_1	$\sigma_2(\times 100$	ρ_1	ρ_2
1996	0.08	0.25	0.03	1.07	0.02	0.09	−0.82	−0.60	0.07	0.00	0.10	0.74	0.03	0.40	−0.87	−0.69
1997	0.04	0.24	0.06	1.82	0.02	0.10	−0.83	−0.66	0.10	0.24	0.08	1.18	0.02	0.37	−0.84	−0.67
1998	0.00	0.25	0.08	0.88	0.03	0.05	−0.81	−0.65	0.05	0.24	0.10	1.67	0.04	0.06	−0.84	−0.67
1999	0.00	0.25	0.07	2.73	0.04	0.07	−0.90	−0.68	0.08	0.18	0.08	3.63	0.05	0.58	−0.83	−0.68
2000	0.10	0.24	0.03	1.08	0.02	0.07	−0.83	−0.67	0.10	0.13	0.08	0.94	0.02	0.05	−0.83	−0.67
2001	0.08	0.22	0.03	3.59	0.01	0.05	−0.80	−0.60	0.10	0.11	0.07	0.97	0.02	0.05	−0.87	−0.69
2002	0.08	0.2	0.05	3.97	0.00	0.05	−0.79	−0.65	0.10	0.18	0.07	1.52	0.02	0.05	−0.86	−0.73
2003	0.00	0.07	0.04	3.71	0.01	0.05	−0.93	−0.70	0.09	0.06	0.07	1.43	0.03	0.10	−0.84	−0.76
2004	0.00	0.25	0.06	0.88	0.03	0.05	−0.83	−0.71	0.02	0.20	0.08	2.16	0.04	0.05	−0.85	−0.68
2005	0.00	0.25	0.07	9.99	0.11	0.06	−0.71	−0.50	0.03	0.08	0.07	1.75	0.04	0.05	−0.81	−0.70
2006	0.04	0.15	0.03	3.32	0.03	0.05	−0.84	−0.70	0.10	0.14	0.08	1.62	0.04	0.64	−0.86	−0.69
2007	0.02	0.05	0.04	4.94	0.02	0.35	−0.83	−0.73	0.10	0.10	0.08	1.21	0.03	0.05	−0.81	−0.71
2008	0.00	0.17	0.07	6.54	0.00	0.07	−0.79	−0.56	0.10	0.25	0.11	1.33	0.04	0.05	−0.83	−0.72
2009	0.00	0.25	0.10	0.96	0.03	0.05	−0.82	−0.72	0.01	0.19	0.14	1.73	0.05	0.08	−0.82	−0.73
2010	0.00	0.25	0.08	3.35	0.07	0.07	−0.78	−0.56	0.07	0.00	0.10	3.22	0.07	0.41	−0.86	−0.71
2011	0.00	0.22	0.08	2.67	0.04	0.05	−0.84	−0.65	0.10	0.03	0.11	2.23	0.06	0.08	−0.84	−0.61
2012	0.00	0.25	0.08	3.87	0.03	46.26	−0.83	−0.83	0.07	0.00	0.14	2.09	0.07	12.88	−0.90	−0.55
2013	0.10	0.19	0.04	2.65	0.05	0.09	−0.85	−0.73	0.06	0.00	0.12	1.26	0.05	0.62	−0.89	−0.68
2014	0.09	0.25	0.04	4.69	0.05	2.97	−0.83	−0.71	0.10	0.18	0.09	1.85	0.05	0.78	−0.85	−0.70
2015	0.02	0.25	0.07	1.38	0.04	0.05	−0.79	−0.73	0.10	0.24	0.10	1.53	0.04	0.43	−0.85	−0.69

IMI News

- On January 3, Macro-Finance Salon (No. 111) was held in RUC. Li Peide, honorary professor of the University of Hong Kong, delivered a keynote speech entitled with "The Misunderstanding of 'Positive Non-Intervention': The Causes and Consequences of the Hong Kong Banking Crisis in 1965". The salon was chaired by He Ping, professor at the School of Finance. Professor Wang Jue, the leader of the Economic History Department of the School of Economics at RUC and Cai Ruhai, Dean of the Training College of the Central University of Finance and Economics, attended the seminar and made comments.
- On January 5, Young Economists Roundtable on Money and Finance (No. 1) was held during the 2019 IMI New Year Symposium. The meeting was themed on "A New Journey after 40 Years of Reform and Opening Up". Guo Biao, Li Lin, Liu Chenjie, Wang Zuogang and Zhong Hong delivered keynote speeches. Leading experts and scholars from government sectors and academia, and representatives of advanced enterprises also attended this meeting.
- On January 5, the New Year Symposium in Memory of the 40th Anniversary of the Reform and Opening-up and Roundtable on Money and Finance·Winter 2018 was held jointly by the School of Finance of RUC, the Financial Policy Research Center, and IMI. Over 80 experts and scholars, including members of IMI Advisory Board, IMI Academic Committee members, research fellows, guests from the financial management systems, research institutes and the financial industry attended the symposium and discussed the topic— "A New Journey after 40 Years of Reform and Opening-up".
- On January 5, Seminar on China Wealth Management Jinjialing Index (2018) was held at Renmin University of China. The seminar was hosted by the School of Finance of Renmin University of China, Qingdao Finance Office, Qingdao Jinjialing Financial District Management Committee, and IMI and the Wealth Management Center of Renmin University of China. Zhuang Yumin, Dean of the School of Finance of Renmin University of China, and Wang Jinling, deputy director of the Qingdao Finance Office, delivered speeches respectively, introducing the background of the compilation of China's wealth management Jinjialing Index and the development of Qingdao's wealth management financial reform pilot zone. During the roundtable discussion, the guests had a heated discussion on the content of the report and the development of the wealth management industry.
- On January 12, Macro-Finance Salon (No. 112) and the book launch for China's Choice in the Global Financial Turbulence was held in Renmin University. The author Mr. Wang Yongli, member of IMI Academic Committee and former vice president of Bank of China, gave a keynote speech to share his motivation for writing the book, as well as its main contents. Wei Benhua, Guan Qingyou, Zhang Jie and Tu Yonghong also attended the discussions. The salon was presided over by Prof. Song Ke, deputy director of IMI.
- On January 17, Federal Minister of Finance and Vice-Chancellor of Germany Mr. Olaf Scholz was invited to make a keynote speech entitled 'The Challenge of Digitalization and Social Transformation in Germany and China' on Macro-Finance Salon (No.113). In his speech, Mr. Olaf Scholz pointed out that young people should learn to cope with the challenges brought up by the digital economy. In the panel discussion, Olaf Scholz, Wu Xiaoqiu, Fabian von Heimburg, Li Zhifei and other guests discussed topics including the digital economy and social transformation.
- On February 26, Macro-Finance Salon (No. 114) and Workshop on Emerging Countries in

Global Financial Governance was held in Renmin University. Prof. C. Randall Henning from American University and Prof. Andrew Walter from Melbourne University presented their papers “Regional Financial Arrangements and the International Monetary Fund” and “Fragmentation and Resilience in Global Economic Governance: Emerging Countries and Financial Regulatory Standard-Setting” respectively. Discussants include Wei Benhua, Zhang Zhixiang, Zheng Liansheng and Xiong Aizong. The meeting was chaired by Di Dongsheng, Associate Dean, School of International Studies, Renmin University.

- On March 9, Young Economists Roundtable on Money and Finance (No. 2) hosted by International Monetary Institute (IMI) was held in RUC. This was a closed-door seminar. Wang Qi, Assistant General Manager of China Fund Management Co.,Ltd., Li Jun, Head of third-party investment of Sunshine Asset Management Co., Ltd., and Ma Yong, IMI Senior Research Fellow and professor from the School of Finance, Renmin University of China, delivered keynote speeches. The seminar centered on the theme of “Credit Expansion and Asset Price” and was chaired by Zhou Wenyuan, IMI Research Fellow, Convener of the Youth Roundtable on Money and Finance and Managing Director (Chief Research Fellow) of Guotai Junan Transaction Investment Committee.
- On March 15, the expert consultation meeting on "The RMB Internationalization Report 2019" was successfully held in Renmin University of China. Chen Yulu, Wei Benhua, Guo Jianwei, Sun Lujun, Zhang Xiaopu, E Zhihuan, Chen Weidong, Qu Fengjie, Tu Yonghong and other guests attended the meeting and gave valuable comments on the report. Major members of the RMB Internationalization Report Research Group participated in the meeting. The meeting was hosted by Zhang Jie, director of IMI.
- On March 21, Macro-finance Salon (No.115) was held in Renmin University. Mr. Zhu Haibin, Managing Director and China’s Chief Economist of J.P. Morgan delivered a speech under the theme of China’s Economic Outlook: 2019 and Beyond. The meeting was attended by Mr. Cao Lu, vice president of J.P. Morgan (China), Mr. Wei Benhua, former deputy administrator-in-bureau of the State Administration of Foreign Exchange, Professor Wang Changyun, dean of Hanqing Advanced Institute of Economics and Finance, IMI researchers Liu Hongwei and Tian Xinming etc. Mr. Zhang Zhixiang, former director general of the International Department of the People’s Bank of China hosted the meeting.
- On March 23, The Inauguration Ceremony and Annual Forum of the Fixed Income Clearing Corporation Branch of Renmin University of China’s Alumni Association (FICCRUC) were held in Rulun Lecture Hall, sponsored by School of Finance of RUC, IMI, and FICCRUC. Zhuang Yumin, co-chairwoman of IMI and dean of School of Finance of RUC, presided over the forum. Wu Xiaoqiu and Du Peng, vice presidents of Renmin University of China, attended the forum as well as guests from other prestigious universities and more than 600 alumni from banking, insurance, securities, trusts and funds sectors.
- From March 25 to March 28, Carsten Schneider, the Vice Chairman of SPD fraction in the German Bundestag, visited China at the invitation of the International Department, Central Committee of CPC. Mr. Schneider had an unofficial dialogue with IMI experts on the afternoon of May 25, which was organized by Beijing representative office of Friedrich-Ebert-Stiftung. During the discussion, Chinese and foreign guests discussed macroeconomic and financial issues in China and Europe, especially Germany, as well as the current hot topics regarding international finance, trade, etc. The experts present exchanged their views and the discussion was a complete success.
- On March 28, Macro-Finance Salon (No.116) was held in the afternoon at RUC. Dr. Zhu Taihui, Senior Research Fellow of National Institution for Finance and Development and Head of the Editorial Office of Financial Regulation Research, delivered a speech titled

"Initial Estimation and Policy Discussion on China's Financial Cycle". Participants include Ma Yong, Professor of School of Finance, RUC, and IMI Research Fellows Peng Yuchao, Tian Xinming, Lin Nan and Xiu Jing. The Salon was chaired by Bian Weihong, Division Head of International Finance Institute, Bank of China.

Call for Papers

International Monetary Review

International Monetary Review is an internal academic magazine sponsored by International Monetary Institute. Following the principle of including both Chinese and western merits with precise and practical academic spirit, International Monetary Review focuses on the cutting-edge theoretical researches in internationalization of RMB, reform of international monetary system, regional monetary and financial cooperation, China's international financial strategies, and other macro-financial theories and policies.
We welcome submissions by scholars, experts and practitioners in financial industry. Papers and articles should center on key financial issues and follow academic standard and scientific methodology. We welcome quality articles based on data analysis and theoretical model and other insightful articles with standard writing.

Prepare your article

General rule: Submitted manuscripts should be double-spaced texts in 10.5 point font, and formatted for paper of standard size with margins of at least 20mm on all sides. Pages should be numbered, and an abstract (of no more than 200 words), as well as keywords and complete author affiliations, should be included in the paper in the title page. A regular article should not exceed 50 pages.
Mathematics: Equations must be identified by consecutive Arabic numbers in parentheses on the right. Expressions should be aligned and compound subscripts and superscripts clearly marked if there is any potential for confusion.
Figures: Figures must be of professional quality and ready for reproduction. They should be numbered consecutively. Black-and-white versions of figures are required for printing purposes, but color figures can also be supplied for online dissemination.
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