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Governance Innovation

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Idris Ademuyiwa and Pierre L. Siklos

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About Global Economy

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Acronyms and Abbreviations

BIS	Bank for International Settlements
CI	confidence interval
DFM	dynamic factor model
EMEs	emerging market economies
G20	Group of Twenty
GFC	Great Financial Crisis
GPRs	geopolitical risks
IMF	International Monetary Fund
PVAR	panel vector autoregression
S5	systemically important five economies (China, the euro zone, Japan, the United Kingdom and the United States)
WTI	West Texas Intermediate
VAR	vector autoregression

Executive Summary

Recent events have the potential to reverse the positive macroeconomic performance of the global economy and trigger a slowdown in both global growth and international trade. In particular, the implications of ongoing trade disputes that have undermined trust in the existing multilateral cooperation system and the incentive for countries to align with ongoing global policy coordination efforts. A compelling case for a mutually beneficial resolution of these tensions can be made by emphasizing the interdependence of the Group of Twenty (G20) economies — the G20 being the premier repository of international cooperation in economic and political matters. This study also considers the state of trade globalization, with an emphasis on the performance of the G20.

The emergence of geopolitical risks (GPRs), that is, events that heighten tensions between countries and therefore threaten global economic performance, is an attempt to quantify the potential economic impact of the nexus between politics and economics. In the presence of heightened political risks, negative economic effects become more likely.

Nevertheless, there is no empirical evidence investigating the links between the real economy, trade, the state of the financial sector, commodity prices and GPRs. Moreover, there is no evidence on these links that has a sample of countries that make up the G20. This paper begins to fill this gap.

Relying on descriptive and statistical evidence, the conclusion is drawn that GPRs represent a significant factor that threatens global economic growth and economic performance, in the G20 countries in particular. Ultimately, however, GPRs reflect other factors, including threats stemming from trade tensions and large swings in commodity prices. If policy makers focus on attempts to mitigate the negative economic impact of trade and commodity price shocks, this may well produce a decline in GPRs. Trade and commodity price shocks have the potential, especially when combined with changing GPRs, to reduce economic growth in the G20 economies.

The extent to which the G20 can retain the mantle it designated for itself of "premier forum for international cooperation"[1] is in question. In the past few summits, trade, and economic tensions more generally, have played important roles on the agenda, but without a credible resolution of ongoing disagreements.

Introduction

Globally, economic headwinds appear to be intensifying. The ongoing trade dispute between the world's two largest economies — the United States and China — as well as the on-and-off one brewing between the United States and some of its major trading partners — Canada, Mexico, the European Union and Japan — are the key issues attracting policy makers' attention. Simultaneously, the combined impact of the slowing euro zone and Chinese economies suggests that systemically important economies once again threaten the ongoing recovery 10 years after the twin financial crises (i.e., the global financial and euro sovereign debt crises) impacted the global economy. Another equally important coincidence is the pending withdrawal of the United Kingdom from the European Union.

Taken together, these events have the potential to reverse the recent positive macroeconomic performance of the global economy and trigger a slowdown in both global growth and international trade. Only last year (2018) did the International Monetary Fund's (IMF's) World Economic Outlook began to forecast growth rates that match pre-2008 levels (IMF 2018). By early 2019, however, the IMF changed its outlook and began to downgrade global economic growth prospects (IMF 2019). These developments effectively imply the emergence of potential shocks of the kind not seen since the Great Financial Crisis (GFC) of 2008-2009.[2] This time there is little prospect of a return to the widely admired Great

1 The G20 leaders agreed on this wording at the Pittsburgh summit in September 2009. See https://g20.org/en/summit/faq/ .

2 The events of 2008-2009 are also often referred to as the "Global" Financial Crisis that began in some of the systemically important economies. This paper refers to the systemic five (S5), which represent the world's largest economies (China, the euro zone, Japan, the United Kingdom and the United States). The reference to "shocks," when used by economists, refers to how unanticipated events can have economic consequences.

Moderation, experienced from the mid-1980s until the GFC, because of the macroeconomic stability that accompanied it (Bernanke 2004).

Discussions dealing with recent trade disputes and the pending Brexit deal have focused mainly on the potential economic impact on the affected economies. However, equally important are the implications of trade disputes for trust in the existing multilateral cooperation system and the incentive for countries to align with ongoing global policy coordination efforts. Indeed, the G20 has been viewed as a forum to provide for greater cooperation among a larger number of countries that, together, account for the overwhelming proportion of global economic output. A compelling case for a mutually beneficial resolution of these tensions can be made by emphasizing the role of spillovers and interdependence across economies. Indeed, it is partly for this reason that the IMF began publishing spillover reports in 2011.[3] Despite this development, doubts have been raised about the effectiveness of the G20, perhaps nowhere more so than in the United States, which is, arguably, the most important member (see Nelson 2018).

Crucially, existing studies typically focus purely on economic spillovers (for example, those stemming from divergent monetary and fiscal policies, see Lombardi, Siklos and St. Amand 2018). For instance, if a central bank in one country chooses to raise its policy rate, this will have repercussions on that country's exchange rate thereby impacting its trade with the rest of the world. The more highly integrated the global economy, the greater the effect of one country's policy choice on economic developments in the rest of the world. This is especially true of the large, so-called systemically important economies, such as the United States, China, the euro zone and Japan.

Political risks are generally ignored or downplayed in formal analyses. Occasionally, there is acknowledgement that these risks exist, but they are subsumed under the heading of "uncertainty" about economic policy outcomes. There is no attempt, for example, to make the distinction between economic policy uncertainty — that is, uncertainty stemming from how policies are introduced and implemented, from political risks. Yet, as recent events noted above make clear, political risks interact with economic ones and, even if they increase policy uncertainty, excluding them from existing empirical analyses risks leaving out an important driver of economic outcomes. The tide may be turning as economists are beginning to take more seriously the economic consequences of GPRs (Caldara and Iacoviello 2018), an indicator of political tensions that rise or fall over time between countries or regions of the globe and are believed to have macroeconomic consequences. Indeed, some of the recent interest in the nexus between politics and economics has partly been sparked by the influential work of Dani Rodrik (2010) who calls attention to an inconsistency between the desire of democratic values to spread, the protection of sovereignty and more globalization.[4] Thus, global economic integration inevitably implies a decline in sovereignty. Hence, a country cannot simultaneously have complete sovereignty and also be fully integrated into the world economy.

The combination of political and economic tensions primarily, though not exclusively, in the form of a rise in trade barriers, since the GFC is also partly reflected in the behaviour of commodity markets, which are often seen as a bellwether for the economic outlook — in part because they reflect underlying demand for goods and services and, more recently, because of the financialization of these markets (see Cheng and Xiong 2014). Political risks have long been known to roil commodity markets. As a result, both asset returns and volatility are impacted (see, for example, Balcilar et al. 2018). Similarly, there is a very large body of literature that links oil prices to inflation and economic performance (see, for example, Feldkircher and Siklos 2019).

With the current level of global economic and financial interconnectedness, the payoffs from adverse policy actions in systemically important economies will be transmitted to other economies regardless of the primary targets of such policies. The addition of GPRs as another source of shocks with negative global economic consequences, with clear evidence to support this connection, should further convince policy makers to retreat from protectionist responses and instead seek solutions and policies that

3 See www.imf.org/en/Publications/SPROLLs/Spillover-Reports.

4 Cleverly, he refers to this as the "political trilemma" after the economic trilemma, which is well-known to economists. The latter posits that a fixed exchange rate, full capital mobility and monetary policy independence are incompatible.

promote global economic cooperation. This paper will show that there is a clear connection between global economic integration and improvements in economic performance. The G20 response to the global financial crisis of 2008-2009 provides an example of how global cooperation softened the potential economic consequences of the largest financial shock since the Great Depression of the 1930s (Angeloni and Pisani-Ferry 2012). Generally, unless nations are willing to give up much of their sovereignty — a highly unlikely scenario — economic cooperation in some form will ease the inevitable spillover of economic shocks that are the by-product of significant global economic integration.

The G20 economies, which account for close to 90 percent of global output, more than 80 percent of global trade and two-thirds of the world's population, are particularly susceptible to the transmission of global shocks of all kinds. For example, in 2018, all members of the G20, apart from Turkey, had either the United States or China, or both, as one of their top three export destinations.[5] Similarly, European countries — most notably the United Kingdom, France and Germany — are among the five largest importers from the other G20 economies. Just as economic performance within the G20 is varied, so are the political risks given the significant differences in political systems.[6] If any of the disputes discussed above worsens, triggering a global recession, the G20 will be the primary recipient of negative shocks. Empirical evidence is necessary to investigate the potential trade spillovers in the G20, conditional on the presence of political risks.

An important objective of this study is to investigate the level of susceptibility of G20 economies to trade and geopolitical shocks. In addition, this paper considers how the interaction between commodity price shocks and GPRs combine to impact macroeconomic outcomes. Specifically, we estimate the impact of trade, commodity and geopolitical shocks in a panel of G20 economies. The existing literature has investigated both spillover effects across countries and the effect on export performance of different trading partners' demand shocks. Many of the relevant studies have focused on the United States and, increasingly, on China since its accession to the World Trade Organization in 2001.

Yet, surprisingly, relatively little attention has been paid to understanding the level of economic interdependence within the G20. There is especially a dearth of studies investigating and comparing different channels of economic spillovers within the G20 and the effect of spillovers emanating from the other S5 economies (apart from the United States and China), despite their importance to global macroeconomic performance. Equally important, as far as the authors are aware, there are no studies that incorporate the role of GPRs in models that also examine how other key economic factors interact with each other. It is our belief that such empirical investigation is timely considering recent events.

The rest of the paper is structured as follows. In the next section a brief literature review is provided. Then there is a discussion of the data and a presentation of some stylized facts. This is followed by a description of the methodology before the empirical findings are discussed in a separate section. The paper concludes with a summary and the policy implications that can be derived.

Commodities, Trade and Political Risks: What Do We Know?

While this study overlaps several strands of the empirical literature in macroeconomics, it is most closely related to the issue of cross-border spillovers as defined in the previous section.

Even if the G20 is the "primary forum for international economic cooperation among its members,"[7] economists have generally shied away from examining its economic impact and success in ensuring global economic activity.

5 In fact, when we extend the analysis to the top five export destinations, both the United States and China are two of the major export markets for all other G20 economies.

6 This is referring to the significant range in the degree to which democratic institutions prevail among the G20 members. See, for example, the World Bank Governance Indicators at https://info.worldbank.org/governance/wgi/#home.

7 See https://international.gc.ca/gac-amc/campaign-campagne/g20/index.aspx?lang=eng.

This is slowly changing. Adam Triggs (2018), for example, considers the G20's effort at cooperation in the economics sphere and concludes that the efforts to date have been mixed (see, for example, Angeloni and Pisany-Ferry 2012).[8] The G20 reacted strongly and collectively in response to the global financial crisis, as noted above, but there is growing acceptance of the view that the desire for collective action has waned (Cooper 2010; *Financial Times* 2019). More importantly, for the policy questions considered in this paper, current account imbalances are returning to pre-crisis levels and there are few signs that negative spillovers from member economies' policies have been contained. Typically, there are no explicit references in leaders' declarations of a role for the G20 in mitigating GPRs.

Since the 1970s and 1980s, the role of commodity prices, especially oil prices, in explaining economic cycles has received considerable attention and there is a wealth of empirical evidence suggesting that they matter for macroeconomic outcomes including inflation, employment and wage growth (see, for example, Kilian 2008; 2014). While Robert B. Barsky and Lutz Kilian (2004) also argue that monetary policy is an important predictor of oil prices, they find that the main channels of transmission are expectations of stronger inflation and economic growth. Thus, for example, monetary authorities may respond to changes in commodity prices[9] depending on how large and persistent the changes in commodity prices are, the level of the economies' dependency on the commodity (whether as a net commodity exporter or importer) and how inflation expectations are formed, among other factors. There is no consensus on the relative strength of the channels identified above, but evidence of their existence, together with the demand and precautionary demand shocks that are determinants of oil prices (see Kilian 2009), provides some support for the endogenous treatment of oil prices in some economic models.

Prior to the GFC, the conventional or textbook view was that a currency depreciation would boost exports and lead to a decline in imports with a subsequent improvement in the balance of trade. However, as trade is mainly invoiced in US dollars, exchange rate pass-through effects have declined, and emerging market economies (EMEs) have become more financially integrated into the global economy (as discussed below), it is no longer clear that a currency depreciation improves a country's competitiveness. It is this financial dimension that has changed policy makers' attitudes toward exchange rate fluctuations with more preference shown for exchange rate stability (Bank for International Settlements [BIS] 2019). As reported by Plamen Iossifov and Xuan Fei (2019), cross-country studies find that the conventional view remains valid while country-specific evidence concludes that the link between exchange rates and trade has weakened. Clearly, to the extent that both sets of studies contain an element of truth, this is likely to create the opportunity for even greater tensions inside groups such as the G20.

Politics and institutional factors play significant roles in economic cycles because economic outcomes are often influenced by political considerations. Indeed, there is older literature highlighting the concept of the political business cycle (see, for example, Dubois 2016), but support for the concept of politicians exploiting the business cycle has waned since the theory assumes institutions are static. The spread of independent central banks and inflation targeting also makes it more difficult to identify political cycles. Instead, it is the emergence of GPRs, that is, events that heighten tensions between countries and, hence, threaten to spill over into the global economy. This creates a nexus between politics and economics, as discussed by Dario Caldara and Matteo Iacoviello (2018, 2). In the presence of heightened political risks, economic uncertainties become exacerbated and economic

8 An objective assessment of how well the G20 has matched deeds with words is provided by looking at the compliance reports published by the University of Toronto Munk School G20 Information Centre at www.g20.utoronto.ca/analysis/index.html#compliance. Robert Lavigne and Subrata Sarker (2013) argue that international arrangements whose objective is to enhance policy cooperation, let alone coordination (for example, the G20), tend to miss commitments made except under crisis conditions. An important reason is the absence of enforcement mechanisms (see, for example, Plosser 2018). Even the IMF can only "nudge" countries into action (as is the case with the G20 Mutual Assessment Process; see, for example, Faruqee and Srinivasan (2012). See Barry Eichengreen (2014) for a history of international economic cooperation.

9 An often-cited case is the decision by the European Central Bank to raise key interest rates in May 2008, just before the global financial crisis began, citing persistently high commodity prices.

agents' decisions become less predictable.[10] Unsurprisingly perhaps, GPRs have negative global economic consequences. Equally important, while economic variables are endogenously related to each other, Caldara and Iacoviello (ibid.) make the case that GPRs are more likely to be exogenous, although this is a testable proposition.

In a study examining the behaviour of output in 190 countries in response to financial and political shocks, Valerie Cerra and Sweta Chaman Saxena (2008) show that output losses are attributable to political crises. Similarly, Jeroen Klomp and Jakob De Haan (2009) provide evidence that some dimensions of political instability and policy uncertainty increase economic volatility. These results are in line with findings from earlier studies of the relationship between economic volatility, political risk and institutions (see, for example, Rodrick 2010; Acemoglou et al. 2003). Martin T. Bohl, Philip Michaelis and Pierre L. Siklos (2016) examine another institutional arrangement — the exchange rate regime. They conclude that while exchange rate regime flexibility in the G20 has increased since its creation, members with pegged regimes or ones with limited exchange rate flexibility fare worst when there is a financial crisis. Interestingly, since the GFC, there have been few changes in exchange rate regimes. The pre-crisis momentum, aided in part by the view that floating regimes have the virtue that they cushion against external shocks and this is a valuable source of policy sovereignty in a global economy that is more highly integrated, appears to have been halted (see, for example, Ilzetzki, Reinhart and Rogoff 2019).[11] Instead, there is a preference for more stable exchange rate fluctuations, which need not be incompatible with a floating regime but are seen as a sign of a preference for a managed floating exchange rate regime.

Arguably, the effect of political risk is more visible in financial markets and international financial flows, including domestic stock markets, investment flows and cross-border debt and equities flows. For example, in a panel regression involving 49 emerging economies, Lehkonen and Heimonen (2015) find that lower political risks are associated with higher stock market returns. These results conform with findings from other studies (see, for example, Diamonte, Liew and Stevens 1996; Perotti and van Oijen 2001; Dimic, Orlov and Piljak 2015). Marco Lo Ducca and Livio Stracca (2015) consider the influence of the G20 on bond and equity markets, among other financial assets, and conclude that the group has limited impact on their performance. In contrast, Boris Cornède and Oliver Denk (2015) conclude that while the growth of financial markets has been a key driver of G20 economic growth, the financial crisis has revealed that there is "too much" finance and this has slowed overall growth in the group. The financial sector may also, of course, influence commodity prices. The link between commodity prices and financial sector activities became more pronounced as trading in financial derivatives based on commodity price movements — that is, following the so-called financialization of commodity markets — led to increasing and more volatile commodity prices, especially between 2003 and 2008 (see, for example, Cheng and Xiong 2014). The debate about the wider economic effects of the financialization of commodity markets remains inconclusive.[12]

Monetary policy spillovers, including the effects of unconventional monetary policy, have understandably received significant attention in the literature since the GFC (see Kearns, Schrimpf and Xia 2018; Lombardi, Siklos and St. Amand 2018). Unexpected changes in monetary policy in systemically important economies may restrict other countries' control over domestic prices, put pressure on their currencies and amplify their domestic leverage and debt burden, especially in

10 Caldara and Iacoviello (2018, 2) define these risks as ones that are "associated with wars, terrorist acts, and tensions between states that affect the normal and peaceful course of international relations." Heikki Lekhonen and Kari Heimonen (2015) provide a comparable definition. They define political risks as the risk of unanticipated transformation in national and international business environments due to political changes. Hence, such risks are interpreted as shocks much like the economic shocks that economists investigate. These changes may come from government policies, the polity or political stability, domestic institutions and conflicts (both domestic and geopolitical). The emphasis in this study is that these changes affect the economic environment.

11 A typical illustration is the following leaders' statement from the 2011 Cannes summit: "We affirm our commitment to move more rapidly to enhance exchange rate flexibility to reflect underlying economic fundamentals, avoid persistent exchange rate misalignments and refrain from competitive devaluation of currencies." See www.g20.utoronto.ca/analysis/commitments-11-cannes.html#communique.

12 For example, Kenneth J. Singleton (2014) finds supporting evidence while Lutz Kilian and David Murphy (2014), James Hamilton and Jing Wu (2015), and V. V. Chari and Lawrence J. Christiano (2017) find no support for financialization. Although Kilian and Murphy (2014) do not find evidence supporting financialization in the 2003 to 2008 period, they did find evidence for earlier periods.

countries with high foreign currency debt to GDP ratios. Jonathan Kearns, Andreas Schrimpf and Fan Dora Xia (2018) find that long-term interest rates in 47 advanced and emerging economies respond strongly to monetary shocks from the US Fed and only mildly to shocks emanating from the European Central Bank, the Bank of England and the Bank of Japan. The strength of these spillovers depends mainly on a country's level of financial openness. Findings by Mateo Iacoviello and Gaston Navarro (2019) show that this is especially the case for EMEs.

Boris Hofmann and Elöd Takáts (2015) show that US interest rate spillovers to 30 emerging and small advanced financially open economies are economically significant, irrespective of their exchange rate regimes. These results underscore the role of financial integration or globalization in amplifying monetary spillovers.[13] Finally, the rise of China as a systemically important economy, whose size and influence are beginning to match the current role that the United States plays, cannot be ignored. For example, Patrick Blagrave and Esteban Vesperoni (2016) examine the effect of China's economic transition on export growth in 46 advanced and developing economies, while Christina Kolerus, Papa M. N'Diaye and Christian Saborowski (2016) and Davide Furceri, João Tovar Jalles and Aleksandra Zdzienicka (2016) investigate the impact of China's growth shocks on the global commodity market and global output, respectively. M. Ayan Kose et al. (2017) provide comprehensive analysis and review of comparable studies on the United States while Hongyi Chen and Pierre L. Siklos (forthcoming 2019) is another recent study of the growing importance of economic shocks originating from China.

When they occur, financial shocks typically have significant and long-lasting real and potential output effects (Cerra and Saxena 2008; Reinhart and Rogoff 2009). These shocks can be driven by either demand or supply of credit factors, or both.[14] Most studies focus on financial shocks emanating from the United States — which remains the most important source of financial spillover both globally (see, for example, Bayoumi and Bui 2010; IMF 2013; Kose et al. 2017) and regionally (see, for example, Canova 2005; Beaton and Decrosches 2011; Yamamoto 2014).[15] More recently, however, developments in China suggest that it may have large indirect spillover effects on global risk aversion and financial markets around the world (see Mwase et al. 2016).

Data and Stylized Facts

Most of the data for this study are from publicly available databases (for example, national central banks, the Organisation for Economic Co-operation and Development's main economic indicators, the IMF, the BIS, and the Federal Reserve Economic Database). See the appendix for detailed data sources. Some forward-looking variables (for example, inflation and real GDP growth forecasts) are also publicly available (i.e., the IMF's World Economic Outlook). However, Consensus Economics forecasts are not available for distribution and can only be accessed through a subscription. Although a variety of political indicators are available,[16] the Geopolitical Risk Index developed by Caldara and Iacoviello[17] was used primarily because it covers a wide variety of countries and regions. Moreover, unlike other indicators of the genre, it is available at a sufficiently high sampling frequency (i.e., monthly) to reliably use in an empirical investigation of the kind conducted in this study. The GPR Index is

13 They also align with more recent findings from 19 internationally coordinated empirical analyses of cross-border transmission of monetary policy through banks from the United States, the euro area, Japan and the United Kingdom (see Buch et al. 2018). These results are from disaggregated bank-level analyses conducted by different researchers across 17 countries who are part of the International Banking Research Network.

14 The literature on the modelling of the relationship between financial frictions and business cycle dates at least to the seminal paper by Bernanke and Gertler (1989).

15 Generally, the extant literature finds only modest effects of financial shocks arising from the euro area and the United Kingdom on the rest of the world. In fact, Tamin Bayoumi and Trung Thanh Bui (2010) show that financial shocks from the United Kingdom are only significant for financial markets in the euro area. See also IMF (2013).

16 For example, the World Bank has created a database of political institutions from which we can construct a political risk indicator (see https://info.worldbank.org/governance/wgi/#home). The Polity IV project provides a score for governments that ranges from the most to the least democratic (see www.systemicpeace.org/polity/polity4.htm). Another source is the political risk group (https://www.prsgroup.com/).

17 See www2.bc.edu/matteo-iacoviello/gpr.htm.

also a more holistic indicator, in real time, of GPRs. Apart from the conventional usage of GPR, which includes power struggles between states that are unresolvable through peaceful and democratic processes (for example, the risks associated with conflicts, wars, terrorist acts and other political tensions), the GPR Index also captures the risk associated with unanticipated changes to normal international relations and the international business environment (for example, climate change, the GFC, Brexit and trade conflicts). It encompasses the risk that these events materialize (threats), and the risks associated with an escalation of existing events. The GPR Index is constructed based on a text search of the electronic archives of several major newspapers worldwide. Keywords indicating political threats of domestic and international varieties, ranging from changes in political regimes to terrorism and war, are potential candidates for inclusion in the Index.[18] However, it is worth noting that no single measure of geopolitical risk is exhaustive (Caldara and Iacoviello 2018).

The sampling frequency of the data considered in our study ranges from daily to annual with most of the key time series usually obtained at the quarterly frequency. Where required, we convert all relevant data to the quarterly frequency to better align our results with the relevant literature on macroeconomic spillovers. Conversion of daily and monthly data is done via arithmetic averaging while annual data are converted to the quarterly frequency via interpolation.[19] Most of the time series are in annualized growth rate form to ease interpretation. Some series, such as interest rates are already in percent.[20] We collected data for the 1980–2018 period because of missing or incomplete data; the actual sample used in the empirical exercise typically begins in the 1990s before any transformations are applied. As noted previously, our results pertain to the G20.[21]

The G20 is a diverse group of economies. Its membership includes the so-called S5 as well as several smaller and more open economies. Several G20 members are commodity exporters (for example, Argentina, Australia, Brazil and Canada), while commodity imports play a large role in other economies both large and small (for example, China and India). Finally, half of its members are considered EMEs with the other half being advanced economies.[22] The diversity of the G20, in addition to the Group of Seven, represents an important attempt to provide a more inclusive arrangement to deal with common economic (and political) challenges. Our focus is on how trade, GPRs and commodity shocks impact the group. This implies that individual countries or economic area responses are not considered. However, while many studies explore how individual economies are affected by the kinds of shocks considered here, much less is known about their impact on the G20 as a bloc. One aim of this study is to fill this gap.

To obtain a sense of the overall state of play facing the G20, some stylized facts are presented in Figures 1 though 4. Figure 1 plots two aggregate indicators of the level of globalization in trade (top section) and finance (bottom section) since 1970. The indexes, developed by the KOF Swiss Economic Institute, aggregate a variety of series used by observers to measure the intensity with which countries trade with each other in both goods and services and financial instruments (Gygli et al. 2019; Dreher 2006).[23] Thus, the trade globalization index combines data on trade (i.e., exports and imports), trade regulations (i.e., tariffs), as well as other variables to define the overall state of trade globalization. Based on this index, the reversal in the tide toward globalization, often associated with trade, precedes the GFC, at least for China and Canada. In contrast, in both the United States and the G20, globalization rose until it was temporarily

18 A codebook outlining the precise guidelines followed is also available from Caldara and Iacoviello (2018).

19 The basic idea is to fill the gap due to missing observations by fitting a hypothetical function that links observations at both ends of the gap. Many algorithms to do so are available including the so-called Chow-Lin method (Chow and Lin 1971) that is frequently used.

20 Economists continue to debate the form in which macroeconomic and financial times series ought to be analyzed. The fact that this is an ongoing area of research indicates that a consensus has not yet been reached. Part of the difficulty is that some shocks are transmitted through the economy at a faster rate than others (for example, monetary versus financial). See, *inter alia*, Hamilton (2018) and Schüler (2019).

21 Because of missing data for Saudi Arabia, this member country is excluded from the data set. More up-to-date information about the G20 is available from www.g20.utoronto.ca/.

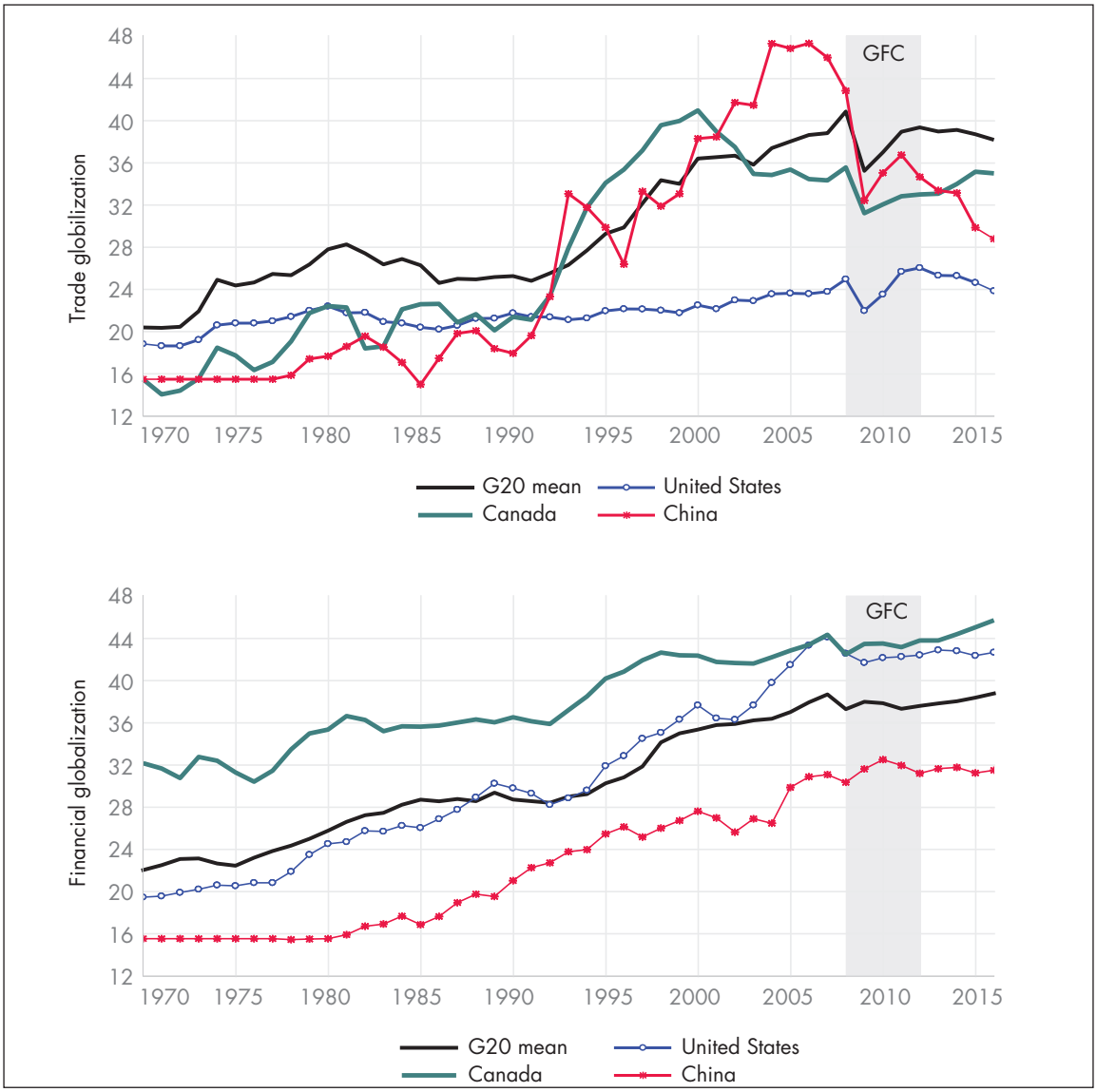
22 According to the definition of the IMF's World Economic Outlook.

23 The indicators, as well as a detailed description of their content, are available at www.kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html.

reversed during the GFC and the economic slump that accompanied it. Although there is a reversal of sorts beginning in 2009, the rising trend observed since the 1970s is no longer in evidence. Indeed, well before the recent focus on trade disputes, there are hints of a retreat from the trend toward greater global integration in trade, with Canada an exception to this development.

It is, of course, worth noting that the events of 2008–2012 were sparked by a financial crisis with global implications. Accordingly, mirroring the trade globalization index is an index of financial globalization in the bottom portion of Figure 1. Financial globalization consists of the combined influence of international debt, the holding of foreign exchange reserves, foreign direct investment, and the degree of cross-border restriction on the movement of funds and investment. Unlike trade globalization, the rise of financial globalization was merely slowed by the GFC. Any hints that financial de-globalization is imminent does not appear to be present in the data.

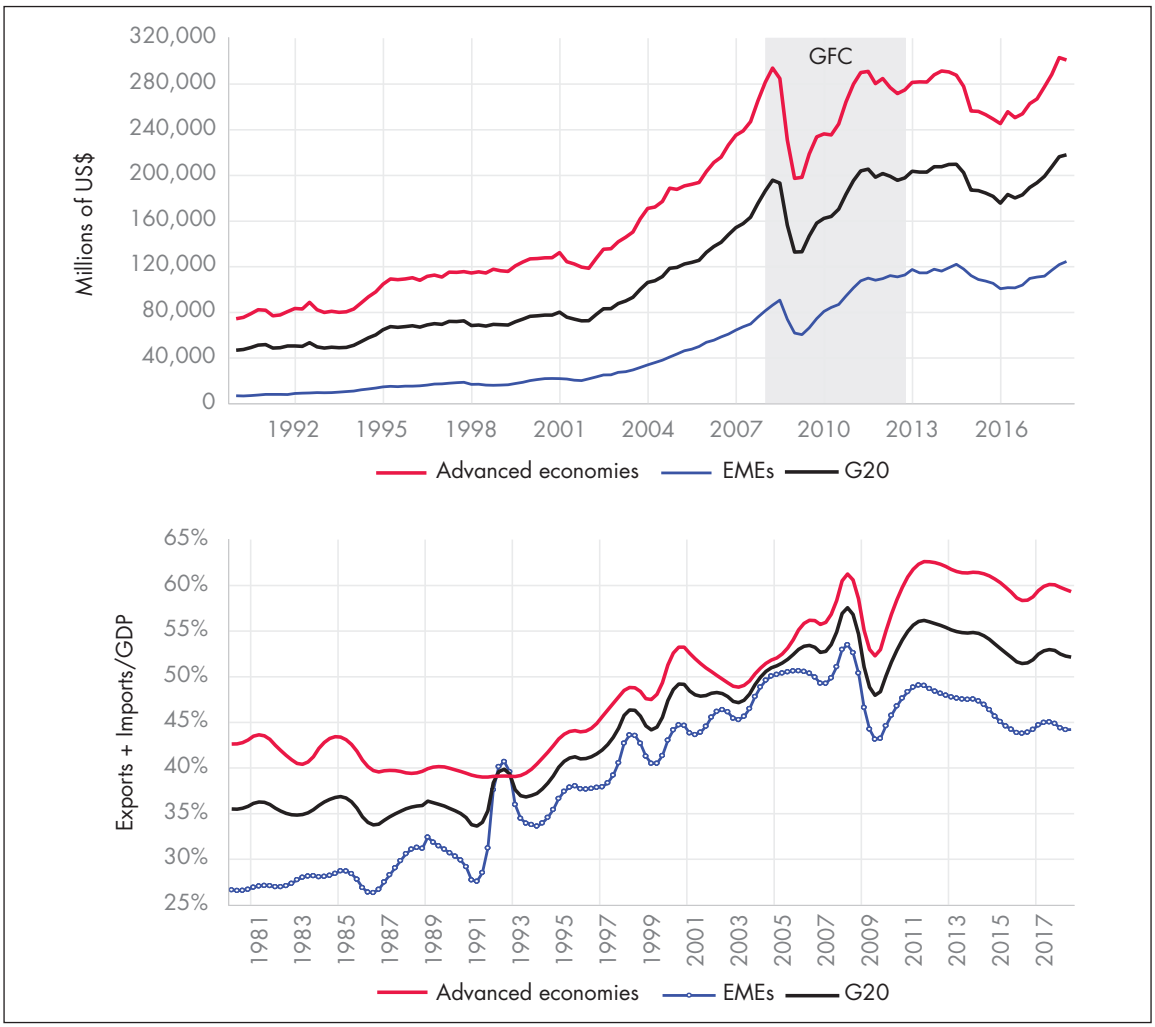
Figure 1: The Progress of Globalization since 1970



Data source: www.kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-globalisation-index.html.
Note: The G20 consists of 19 economies (Saudi Arabia is excluded due to data limitations).

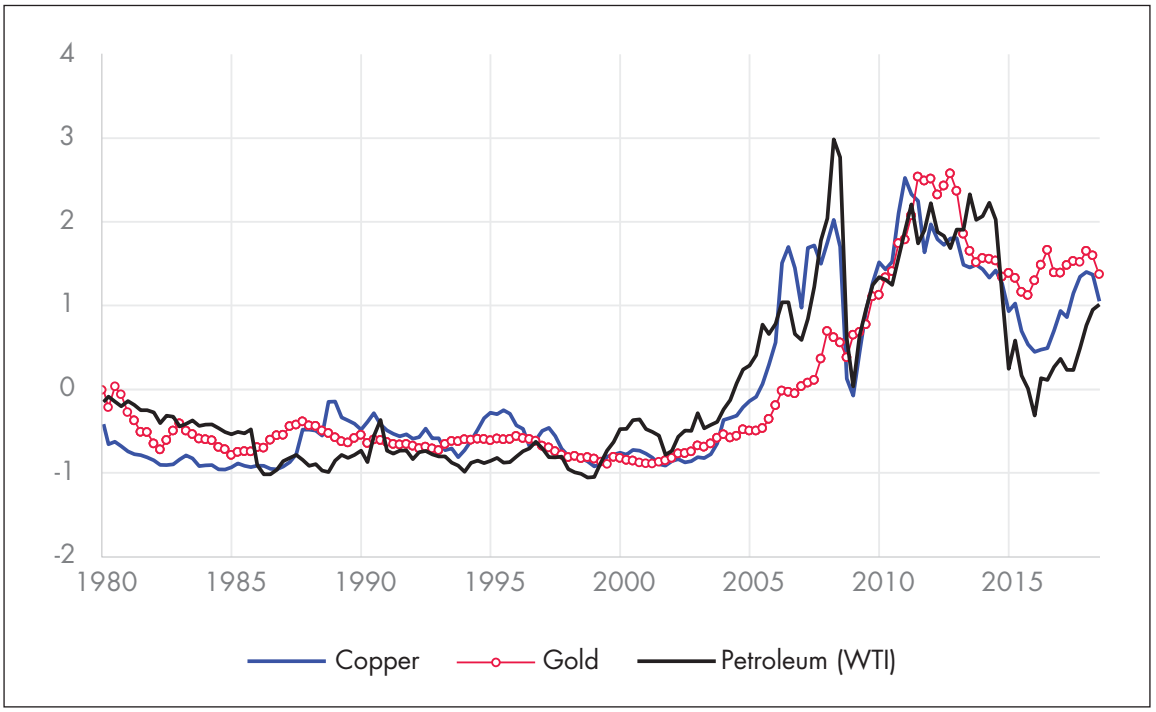
The record of trade in goods and services at a more basic level is shown in Figure 2, which plots for the 1990–2017 period, for the G20 and its advanced and emerging market members, exports of goods and services, and the degree of trade openness. The latter indicator is the share of exports plus imports to a country's GDP. As is true of Figure 1, the heyday of trade globalization is evident and, although the value of exports (in US dollars) resumes its rise after the interruption during the GFC, a rising trend is no longer as much in evidence or at least it is no longer sustained since the GFC. Global integration has slowed but has not entirely ceased. Indeed, trade openness since 1980 (bottom portion of Figure 2) further reinforces the message found in both the narrower and broader indicators of global trade. Nevertheless, it is worth remarking that the 1980s resemble the most recent period in terms of trade integration even if overall economic conditions are vastly different today. The early 1980s were another period of slow growth, although with considerably higher inflation than the global economy is currently experiencing.

Figure 2: Developments in Trade in the G20 since 1990



Data source: http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B.
Notes: See Figure 1 for the definition of the G20. The advanced economies in the G20 are: Australia, Canada, France, Germany, Italy, Japan, Korea, the United Kingdom, the United States and the European Union. Emerging market members of the G20 are: Argentina, Brazil, China, India, Indonesia, Mexico, Russia, South Africa and Turkey. Exports, imports and GDP are in US dollars.

Figure 3: Price Developments in Selected Commodities since 1980



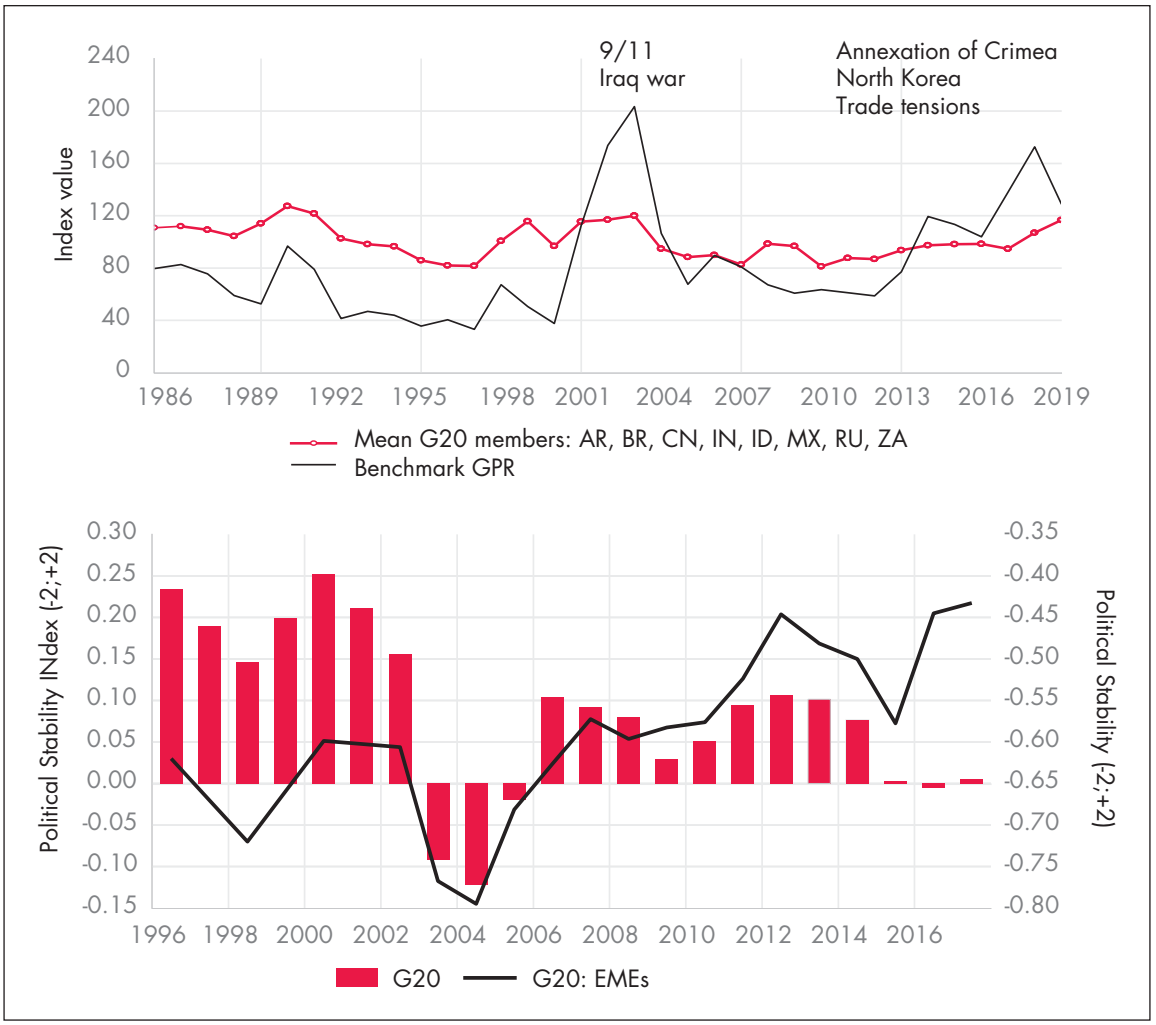
Data source: World Bank Commodity Price Data (The Pink Sheet).
Notes: The data are normalized, that is, the series are demeaned and divided by the standard deviation of the series so that all prices are comparable. Original data are in US dollars (per barrel for petroleum [West Texas Intermediate or WTI], gold is per ounce and copper per metric ton).

Arguably, one of the distinctive characteristics of global economic developments over the past two decades has been the rapid rise and volatility in commodity prices as shown in Figure 3 for three key commodities — namely petroleum, gold and copper.[24] Gold, for example, is sometimes used as an indicator of political conditions in its role as a refuge when other financial asset values are under threat. Petroleum and copper are, of course, critical commodities in a wide variety of goods produced globally and are affected by and impact political risks. The large fluctuations in prices begins toward the end of the so-called era of the Great Moderation mentioned earlier, and show no signs of abating. There is also the rapid rise that begins in the early 2000s, temporarily offset by the sharp drop during the GFC, assisted by the combined impact of the financialization of commodity markets and the growing importance of China in global economic activity.

Finally, Figure 4 (top portion) displays a version of the GPR indicator used in the empirical analysis below. The benchmark version consists of terms drawn from the electronic archives of 11 newspapers in the United States, the United Kingdom and Canada. Country-specific GPR index values were also generated by Caldara and Iacoviello (2018) for a sample of countries and an average was computed for the G20 members shown in the figure. The GPR for the eight EMEs that are members of the G20 display no clear trend, although the fluctuations over time are sizeable. In contrast, the benchmark indicator is sharply impacted by political events that have global implications such as September 11, 2001 and the Iraq War. However, equally noticeable is the rising trend in GPR since around 2012, which is, again, well before the recent attention paid to this phenomenon. By way of comparison we plot the political stability indicator from the World Bank Worldwide Governance Indicators as the bottom plot of Figure 4. These data are available at an annual frequency and only since 1996 until

24 This is a phenomenon that extends to most commodities traded in global markets. See, for example, Siklos (2018).

Figure 4: Geopolitical Risks: Global and the G20



Notes: Top graphs consists of raw GPR data that are monthly and annualized by arithmetic averaging and obtained from https://www2.bc.edu/matteo-iacoviello/gpr.htm. Bottom graph is annual data from World Bank Governance Indicators obtained from https://info.worldbank.org/governance/wgi/#home.

2017, which is the latest available observation as this paper was written. Nevertheless, we see broadly the same patterns as in the top portion of Figure 4 with rising political instability around the period of the war in Iraq followed by a more recent renewed decline in political stability in the last few years. Turning to the emerging market member countries of the G20, a steady rise in political stability beginning in 2005 that is also interrupted temporarily between 2012 and 2016 can be observed.

An Empirical Evaluation of the Interplay between Trade, Geopolitical Risks and Commodities[25]

Economists are fond of emphasizing the interdependence and interconnectedness of economic forces. This is reflected in the belief that many macroeconomic and financial variables are endogenously related to each other, to use a synonym of sorts for interdependence. Acceptance of this view, however, also makes it challenging to disentangle the effects of an unexpected movement in one variable, that is shocks, on others, since movements in the variables of interest are inter-related and jointly determined. Therefore, assumptions must be made to identify the effects we are looking for. In the present study, for example, we are interested in how trade, GPRs, as quantified by the indicator described earlier, and commodity price shocks interact when they have the potential to influence or be influenced by the other macroeconomic and financial variables in the system. More precisely, we can answer questions such as: If there is a geopolitical risk shock this quarter, how is trade affected? How are commodity prices affected?

The procedures followed in this study are no different except that, wherever possible, we test, via statistical means, whether the assumptions made are reasonable ones given the data at our disposal. In a few other cases, we adopt assumptions that several other studies have adopted not only because they have stood the test of time, but also because doing so offers the readers a basis for comparison with our findings against ones reported in other related studies. Essentially, the assumptions made boil down to deciding that some variables are more endogenous than others. Translated into the language of economic shocks, this means that we impose the requirement that some variables affect all the others considered in our model, but these other variables are themselves less affected by the others. Therefore, again the language of economists, some variables are less endogenous than others.[26]

The next challenge was to decide how to define the variables that enter the model used to estimate the impact of the shocks whose effects we are interested in examining. Table 1 illustrates some aspects of the approach adopted. It lists a series of variables that are deemed to capture the main sources of influence on the economies being investigated. Thus, real variables are ones that reflect aggregate conditions in the real economy. These include the usual candidates such as inflation and economic growth (i.e., real GDP growth) as well as some forward-looking variables, namely inflation and growth forecasts. The latter capture the fact that when policy makers make decisions today it is at least partly based on an expectation of what the current policy stance is expected to imply for the economy as a whole. The connection between inflation and economic growth lies at the heart of all economic models since it reflects the enduring belief that, depending on the state of the economy, policy makers must make a choice as a trade-off exists between the two.[27] Next, the trade group of variables includes many already discussed — namely, the balance of trade (i.e., the current account) as a fraction of the size of each economy, export growth, trade openness and the real exchange rate. The latter, of course, is a measure of global competitiveness.

Financial variables include debt indicators, housing prices and the size of foreign currency reserves. The latter is a tool that can also be used not only to help finance imports from abroad but also a device to influence a country's exchange rate, and, finally, the slope of the yield curve — that is, the spread between short- and long-term interest rates on government bonds. The yield curve has a long history as a variable believed to be a harbinger of future economic

25 See the appendix for technical details of the methodologies described in this section.

26 In more technical language this is known as the Cholesky decomposition. This refers to the idea that shocks in the first variables in the model are contemporaneously related to all other variables in the model. Shocks from the last variable in the model do not impact any of the other variables that come before. Interestingly, we tried different variable orderings to determine the sensitivity of the results and the ones discussed below are largely invariant to such changes. Hence, the results obtained are robust.

27 This trade-off is often described as the Phillips curve relation. It is frequently used by central bankers, not without controversy, to explain when a rise in inflation threatens growth or, more recently, why continued low inflation gives them room to allow policy rates to remain low.

Table 1: Variable Classifications

Real	Trade	Financial	Monetary	Commodities	Global Political
Real GDP growth	Current account to GDP	Central government debt to GDP	**Central bank policy rate/ shadow rate**	**Energy, food, seeds, livestock, industrials, metals**	**Geopolitical risk**
Consumer price inflation	Export growth	**Credit to private non-financial sector to GDP**	Domestic-US short-term interest rate differential		
One year ahead inflation forecast	**Trade openness**	Equity prices	Central bank assets to GDP		
One year ahead real GDP growth forecast	Real exchange rate	Housing prices	UMP Indicator		
		Slope of yield curve			
		Foreign exchange reserves			

Notes: Data sources are provided in the main text with more details in the Appendix linked to the publication's page. Commodity prices consist of an aggregate of prices for commodities in the commodity groups listed above. More details are also found in Siklos (2018). UMP stands for unconventional monetary policies and these are a series of dummy variables described in Ademuyiwa, Siklos and St. Amand (2018). In part, for this reason, shadow policy interest rates are used once policy rates at central banks in the United States, the United Kingdom, the euro zone and Japan were close to or reached zero. The relevant data are from www.frbatlanta.org/cqer/research/shadow_rate.aspx and www.rbnz.govt.nz/research-and-publications/research-programme/additional-research/measures-of-the-stance-of-united-states-monetary-policy/comparison-of-international-monetary-policy-measures. The slope of the yield curve is the difference between a short-term and a long-term interest rate. The variables highlighted in bold characters are the ones used in a model that consists primarily of observable, as opposed to generated, variables.

activity and inflation and, therefore, may provide some indications about the future course of interest rates.[28] Monetary variables represent the next group. These seek to convey the influence of monetary policy. Hence, a central bank's policy rate, the differential between domestic and foreign short-term interest rates, the size of central bank assets to GDP, and indicators that identify dates when four of the central banks in our sample intervened in financial markets to stem the negative impact of the GFC.[29] The list under this category is a fairly standard one in recent empirical studies of the impact of the GFC. Additional details can be found in Domenico Lombardi, Pierre L. Siklos and Samantha St. Amand (2018), and Idris Ademuyiwa, Siklos and Amand (2018).

The category labelled commodity prices combines a large group of commodities that are traded internationally into one indicator. We combine these, in the manner described below, to derive an economy-specific measure of commodity

28 How powerful an indicator the yield curve is remains in doubt. See, for example, Menzie D. Chinn and Karen K. Kucko (2015).

29 They are: the United States, the euro zone, the United Kingdom and Japan. The variable is set to 1 when a central bank launches some large intervention (e.g., purchase of long-term government bonds, private sector assets) that is unconventional in nature.

prices.[30] Finally, as discussed above, we utilize the Caldara and Iacoviello (2018) indicator of GPRs.

In attempting to understand how trade, GPRs and commodity markets interact with each other and how shocks from these sources impact each other, we proceed in two steps. First, we combine each variable listed under five of the six categories in Table 1 to generate an indicator of developments in the real, trade, financial, monetary and commodity sectors of each economy. In doing so, we follow a commonly used methodology to generate the principal "factor" representing each category listed in the heading of Table 1 save the GPR proxy, which is used in raw form.[31] Each factor is constructed as a linear combination of the variables listed in the columns of Table 1. The principal advantage of this methodology is its recognition that potentially several variables, and not just one, are better suited to capturing changes in macroeconomic and financial conditions. For example, instead of resorting to real GDP growth alone, this methodology recognizes that many inter-related economic variables can describe an economy's overall economic performance. The same logic applies to the other factors considered.[32]

We generate two sets of these factors. The first set is estimated over the full sample while another set is time-varying in recognition of the fact that policy makers do not have perfect foresight and, for example, would not know with certainty how the various factors might evolve in the future at any given decision point.[33] In addition, the nature of economic relationships may have changed over time and our approach implicitly controls for this possibility.

In the second stage, data from the 19 G20 economies are stacked, allowing us to specify and estimate a model where the factors described above are treated as interdependent in the manner noted above, as well as permitting interdependence among the countries.[34] We rely on this kind of specification to estimate, for the G20, how trade, geopolitical and commodity price shocks affect each other.[35]

A criticism that can be levelled at the approach taken thus far is that the constructed variables (i.e., the factors we estimate) are not observed. In other words, the various estimated factors represent an amalgam of various macroeconomic and financial indicators and not some of the individual ones that, for instance, policy makers might observe. Accordingly, we also experiment with another model consisting primarily of series directly observed by policy makers and the public. Producing the relevant estimates provides another check on the results obtained when many more economic indicators are used simultaneously.

The relevant variable choices are highlighted in bold characters in Table 1. For example, instead of creating a factor that represents the state of real economic activity over time, we use real GDP growth. Similarly, we use trade openness to capture the influence of trading patterns, the growth of credit to represent financial conditions

30 Internationally traded commodities are priced in US dollars. These were converted into domestic currency units by multiplying prices by the nominal exchange rate.

31 Indeed, in a previous CIGI paper, Ademuyiwa, Siklos and St. Amand (2018) used a similar technique to address an altogether different policy question than the one considered here.

32 In a world of proliferating data with more new variables that indicate the behaviour of different sectors of the economy, it is advantageous to include as many of these indicators in a parsimonious way in statistical analysis. This helps avoid problems associated with missing variables in estimations, and allows for more reliable analysis of the phenomenon in question. One prominent example of studies that have adopted this approach is Bernanke, Boivin and Eliasa (2005), which uses the factor-augmented vector autoregression to estimate the effect of US monetary policy.

33 The time-varying element is obtained by estimating the factors, via principal component analysis (see also footnote 24) for a fixed sample of five years (10 years for the financial factors since the cycle for financial conditions is believed to be considerably longer than for other macroeconomic variables). Each sample is then advanced four quarters at a time and then re-estimated (eight quarters for financial variables). Since this procedure generates overlapping samples, the overlapping data are averaged to produce the time-varying factor estimate used in estimating the various models considered.

34 In technical terms we estimate our model in a cross-sectional or panel setting (i.e., a panel vector autoregression). See the appendix for additional details as well as Chen and Siklos (2019), and references therein.

35 To conserve space, we focus on the G20 as a group. In principle, we can also provide estimates for individual economies in our data set, but this is beyond the scope of the present study.

in an economy while the policy rate[36] is the variable used to evaluate the stance of monetary policy. We retain, however, the commodity factor as our indicator of commodity prices.

Once the model is estimated, we proceed to estimate how a shock (i.e, an unexpected change) in one variable, such as a rise in GPRs, impacts other variables of interest. This is graphically represented via impulse response functions, which are the statistical equivalent of asking what the multiplier effect is of a change in GPRs, using the same example as before, on other economic variables.[37] These kinds of calculations can be done for the endogenous variables in the models (i.e., the ones that are inter-related) as well as any shocks considered external to the model, for example, in the case when we are interested in asking how the rest of the G20 responds to an economic shock from the United States or China.[38]

Empirical Evidence

Figures 5 and 6 show the impulse responses to selected shocks when the variables are the factors described above.[39] The vertical axes of the figures below are akin to the multiplier effect each quarter after the shock hits the G20 economies, up to 10 quarters into the future.

Figure 5 is split into two parts. We begin with the discussion of the four impulse responses shown in the top half of the figure. The top left graph of Figure 5 reveals that an increase in GPR leads to a decrease in commodity prices in the G20. This is consistent with Chien-Chiang Lee, Chi-Chuan Lee and Donald Lien (2019) who find that higher political risks have negative effects on the crude oil and heating oil markets. They attribute this to the response of risk-averse commodity traders who seek to reduce their exposures to the political risk by reducing demand for the commodity. However, notice that the impact becomes insignificant after fewer than four quarters and is, therefore, temporary. As we see below, however, while these lower commodity prices can benefit some economies (i.e., commodity importers) at the expense of others (for example, commodity exporters), there are negative spillovers in trade and the real economy that can impact all G20 economies.

The bottom left figure shows that an increase in commodity prices results initially in heightened GPRs. Since the effects that are estimated are symmetric, this also implies that lower commodity prices reduce GPR. However, this effect is also short-lived as the relationship becomes significantly negative for the next three quarters before vanishing. While existing studies have found a positive relationship between commodity prices and GPR in developing countries (see the section above titled Commodities, Trade and Political Risks: What Do We Know?), it is expected that increased commodity prices and exports revenue in commodity-producing economies will provide greater financial resources that are needed to address concerns about potential security and political risks in such economies (see, for example, Cali 2015).

The top right graph of Figure 5 shows the response of trade openness to GPR and commodity price shocks. There is no significant impact on trade openness from a rise in GPR. However, the bottom right impulse responses suggest that an increase in commodity prices increases trade openness within the G20. The impact is quite large (up to 0.3 percent after two quarters) and continues for up to five quarters.

More impulse response results from the foregoing analysis are shown in the bottom half of Figure 5. The top left part of the figure shows that the effect of a shock to trade openness on commodity prices is insignificant for the first half of the 10 quarters

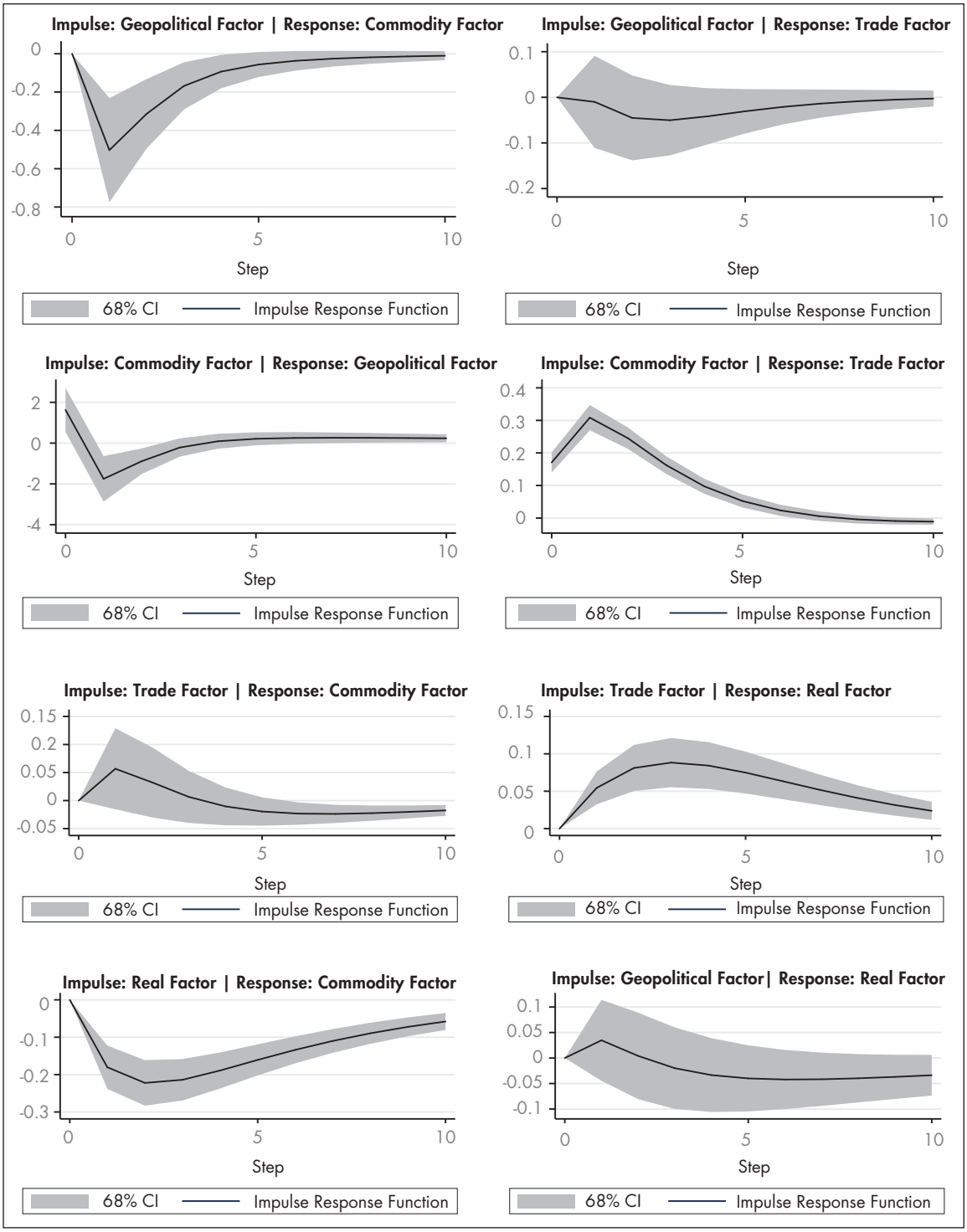
36 The shadow policy rate is used in countries where unconventional monetary policies were implemented during and after the GFC, since policy rates either were prevented from becoming negative as in the United Kingdom and the United States, or did not fully reflect the amount of monetary easing in place (i.e., the euro zone and Japan).

37 Following the usual convention, a shock is defined as an unexpected change equivalent to one percent or one standard deviation in the variable of interest. This makes it easier to interpret the results. Moreover, since the shock is an estimate, confidence bands are estimated around the impulse responses so that we can determine whether the estimates obtained are significant or not in a statistical sense.

38 To distinguish this type of impulse response from the ones extracted for the endogenous variables the expression "dynamic" multiplier is used.

39 As pointed out earlier, there are a total of six variables or factors whose interactions are estimated. This implies that a total of 36 (six times six) impulse responses are possible for each model estimated. However, to conserve space, only the shocks discussed in the previous sections are examined. All other results are relegated to an accompanying appendix.

Figure 5: The Response of Trade, Commodity and Geopolitical Shocks



Notes: The impulse responses are estimated from the panel vector autoregression when all six factors (i.e., real, financial, monetary, trade, commodity prices and GPRs; see Table 1) are endogenously related to each other. For each section, the source of the shocks is the impulse factor while the recipient or impacted factor is the response factor. CI means confidence interval.

horizon before becoming significantly negative. Given the results shown in the top half of Figure 5, this confirms the feedback-type effects wherein commodity and trade openness shocks reinforce each other. One plausible explanation for this is that as economies become more open to trade the net effect on commodity prices is negative.[40]

The impulse response shown in the top right of the bottom half of Figure 5 reveals, as expected, that more trade openness improves real economic outcomes in the G20. This is attributable to the well-known gains from trade. However, this effect is offset by the finding, as shown in the bottom-left graph of the lower half of Figure 5, that improvements in real economic outcomes in the G20 reduce trade openness. The impact persists over 10 quarters and displays, therefore, a persistence not seen in the other shocks considered thus far. This finding also appears counterintuitive as one expects positive real shocks to potentially spill over into greater trade openness. Nevertheless, it is worth reminding readers that the estimated impact is an average across the G20 and not individual member economies. It is possible, of course, that better economic conditions may create an environment that promotes less dependence on foreign trade. For example, not all G20 members are commodity exporters, an important component of international trade. Hence, it is not surprising that the benefits from trade are uneven both across countries and across time. Finally, rising GPRs do result in negative real economic outcomes, with the effect becoming significant only after eight quarters.

The bottom line is that GPR shocks alone only have temporary effects. It is the combination of commodity price and trade shocks that spill over into the real economy and can lead to higher GPR that is the real concern. Stated differently, by focusing on economic shocks, policy makers in the G20 stand a better chance to mitigate the negative effects of GPR shocks.

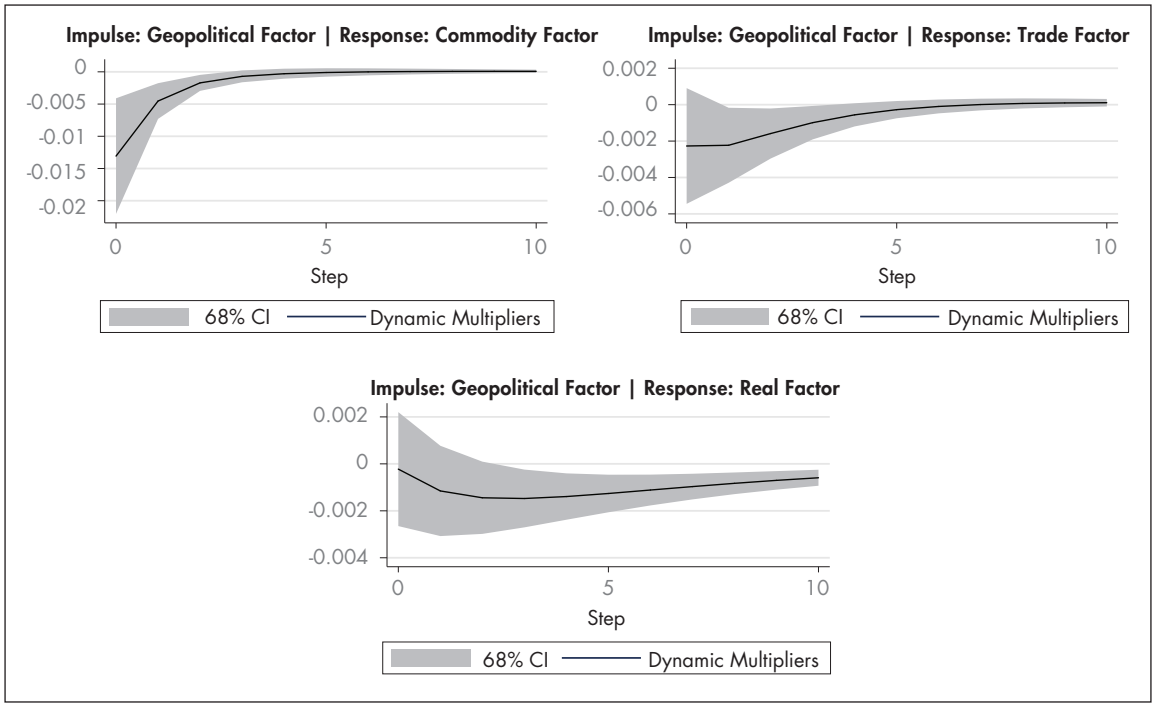
In Figure 5, GPR shocks were assumed to be endogenous. For completeness we also consider the case where GPRs are assumed to be exogenous, as found by Caldara and Iacoviello (2018). To investigate the impact of GPR shocks, we generate the dynamic multiplier effects of GPR on the same factors previously considered. The results are shown in Figure 6. Notice that even if we modify our assumption about the role of GPR, we find that a positive shock to GPR leads to a reduction in commodity prices, and a lagged negative effect on the real factors (the effect becomes negative after about three quarters). As before, we find no evidence of a significant effect of a shock to GPR on trade openness. Hence, the assumption that GPR shocks come from outside the system does not appear to change the earlier results shown in Figure 5.

We check the sensitivity of our results to changes in the model specification. Instead of using unobservable factors, we estimate a variant of the model with some observable variables often used to capture the different channels of economic spillovers in the literature. The results are depicted in Figure 7 and support earlier findings with few exceptions. For example, although we continue to find that there is no significant relationship between GPR and trade openness (see Figure 5), the same insignificance now extends to real GDP growth in contrast to the results also shown in Figure 5. Moreover, the finding that a positive shock to commodity prices leads to more trade openness and the negative bi-directional relationship between GPR and commodity prices are reiterated. However, unlike the previous result, more trade openness does not have a significant effect on output growth.

Furthermore, we also check the robustness of our results by examining the specific effect of shocks to the United States, China and other systemically important economies on the G20. We estimate three variants of the model where all G20 factors are assumed endogenous while the factors for the United States, China and the global factors (i.e., proxy generated from the S5 group) are assumed exogenous, respectively. The results are depicted in Figures 8 to 10. The results largely support our earlier findings albeit with more nuances. The effect of a shock to GPR in the United States on the G20 is significant and more pronounced than similar shocks from China. While there are no significant relationships between shocks to GPR in China and trade openness, real

40 This also suggests that the supply side of commodity markets overtakes an increase in demand in response to more global trade. However, without separately "identifying" the supply and demand responses to a trade shock, we cannot be certain that this interpretation is correct.

Figure 6: The Impact of Geopolitical Shocks on Trade, Commodity Prices and the Real Economy



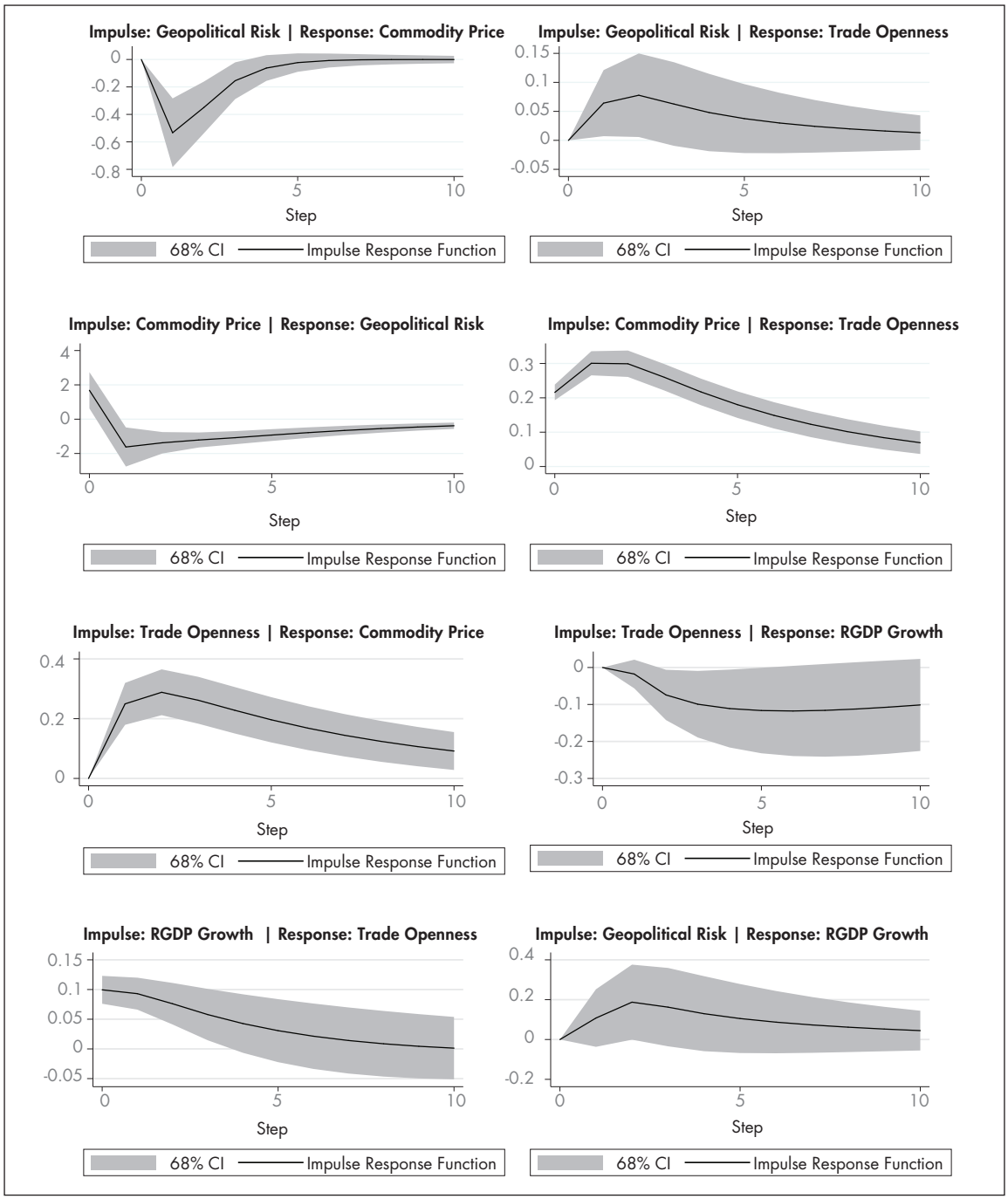
Notes: The dynamic multiplier effects reported here are estimated from the panel vector autoregression when five factors (i.e., real, financial, monetary, trade and commodity prices) are assumed endogenous while the GPR factor is assumed exogenous. For each section, the source of the shocks is the impulse factor while the recipient or impacted factor is the response factor. CI means confidence interval.

economic outcomes and commodity prices in the G20, similar shocks emanating from the United States have short-lived negative effects on trade openness in the G20 and a lagged (although it becomes persistent afterwards, starting in the third quarter and lasting more than two years) negative effect on real outcomes in the G20. When we extend the analysis to check the effect of shocks to GPR in all the S5 (as a group), the results in Figure 10 show a strong negative relationship with trade openness in the G20, even though it also disappears after about one year.[41]

If one believes that real economic outcomes represent a combination of factors, as argued here, then standard models are unable to pick up a link between trade, GPRs, commodity price shocks and real economic performance, at least as far as the G20 are concerned. A much broader view is required. Hence, we have shown that there are good economic reasons for G20 policy makers to collaborate on mitigating the impact of the economic shocks we have considered here.

41 While the focus here is the relationship between GPR, trade openness, commodity prices and real outcomes, other researchers will also be interested in the effects of other types of shocks, say financial or monetary shocks, on different G20 factors. The full impulse response results are provided in the appendix.

Figure 7: Alternative Estimates of the Impact of Trade, GPRs and Commodity Price Shocks



Note: The model consists of observable series. They are: real GDP growth, trade openness index, bank credit to private non-financial sector, monetary policy rate or shadow policy rates (where appropriate), commodity prices and GPR.

Figure 8: Dynamic Multiplier Effects of US GPR Shocks on Selected G20 Factors

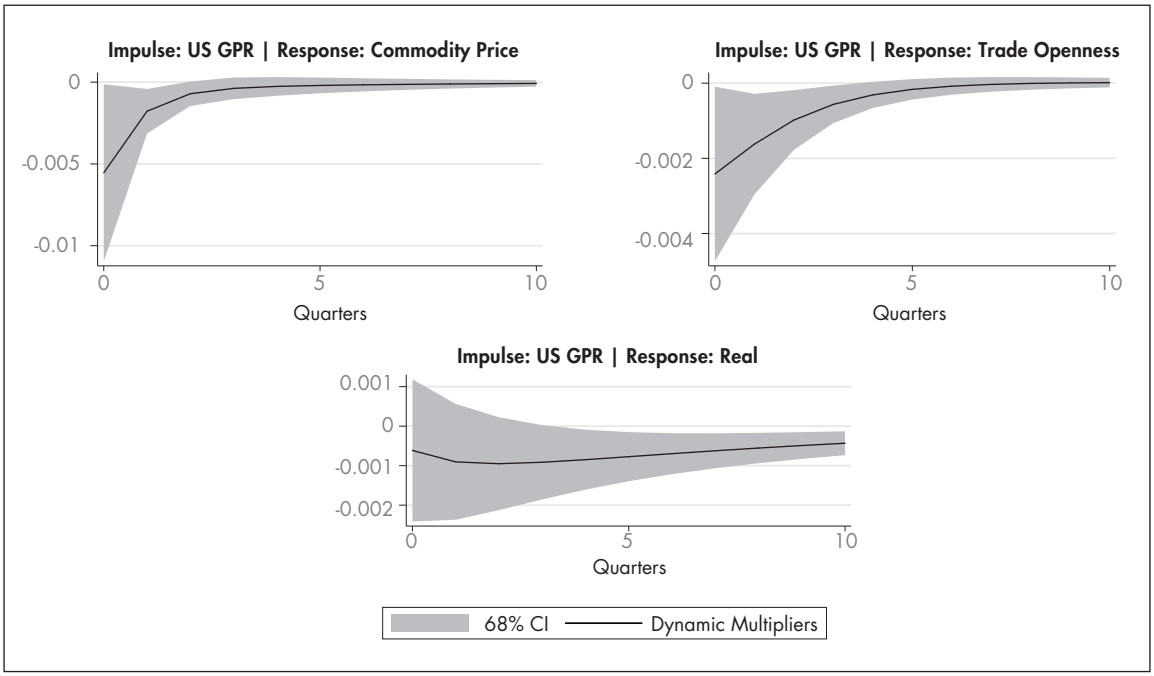
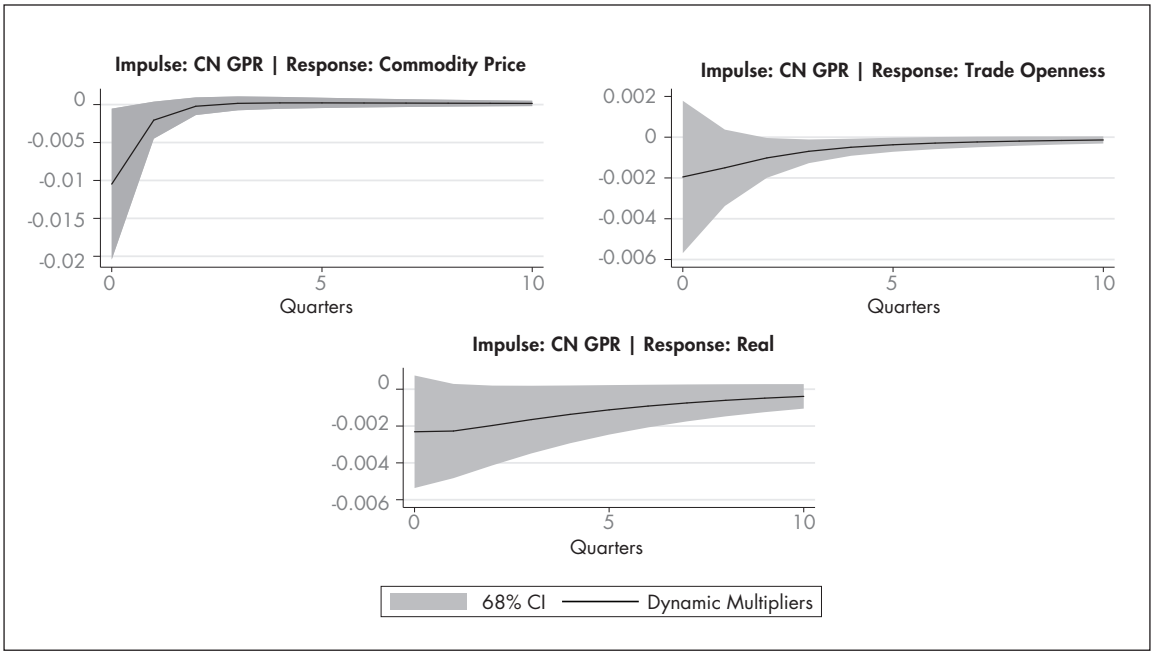
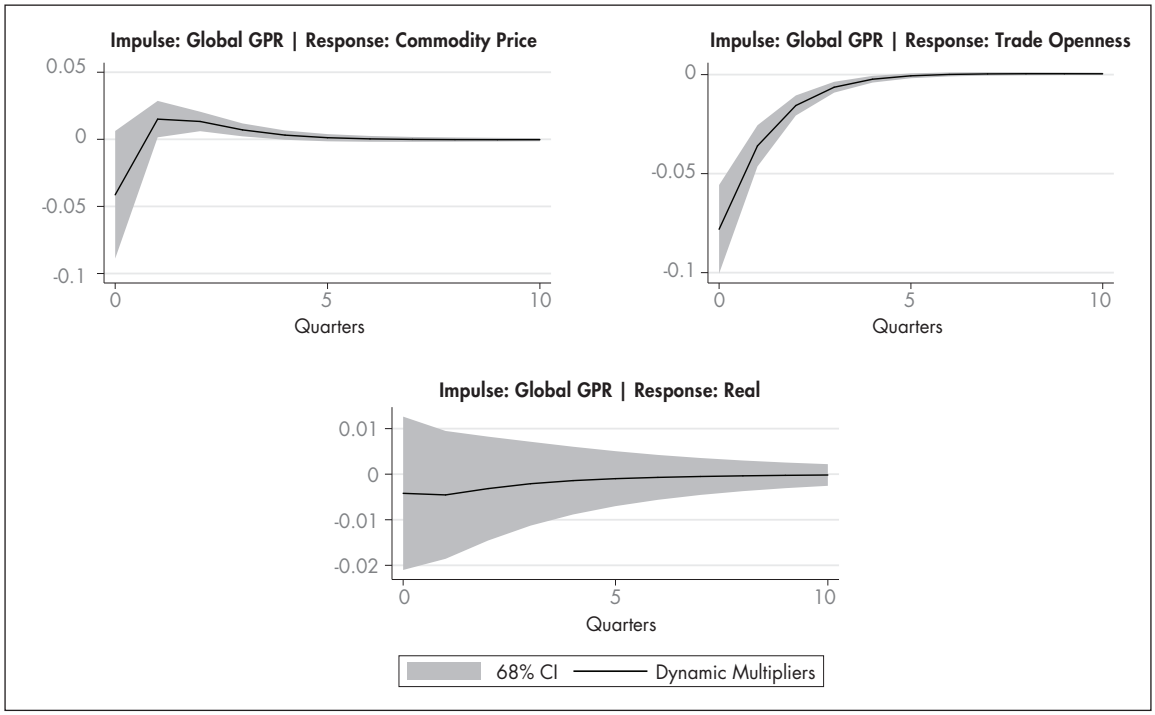


Figure 9: Dynamic Multiplier Effects of China GPR Shocks on Selected G20 Factors



Notes: The dynamic multiplier effects reported here are estimated from the panel vector autoregression (PVAR) when all the G20 factors (i.e., real, financial, monetary, trade, commodity prices and GPR) are assumed endogenous while the factors for the United States are assumed exogenous. For each section, the source of the shocks is the impulse factor while the recipient or impacted factor is the response factor. CI means confidence interval. Similar analysis is conducted with China and all S5 (combined) factors as exogenous variables in Figures 9 and 10, respectively.

Figure 10: Dynamic Multiplier Effects of Global (S5) GPR Shocks on Selected G20 Factors



Note: See notes for Figures 8 and 9.

Conclusions and Policy Implications

Growing concerns over GPRs are understandable as they threaten the ongoing recovery from the GFC of a decade ago. Moreover, given the global economic importance of the G20, it would seem natural for this group, as the premier forum for economic cooperation, to consider the economic consequences of rising GPRs.

Based on the economic analysis conducted in this study it appears that GPRs represent an element that economists and policy makers have given insufficient attention. In the language of central bankers, GPRs represent a contributor, in combination with trade and financial shocks, to the headwinds that contribute to the overall low global economic growth alongside modest to low inflation rates.[42] However, these kinds of shocks can amplify other shocks considered in this study — namely, trade and commodity price shocks.

Our quantitative estimates suggest that trade and commodity price shocks ought to be the principal source of concern for policy makers. Although the G20 economies are very diverse, since the group includes both net importers and exporters of commodities, negative trade shocks contribute to reducing real economic activity throughout the G20. Ensuring that negative shocks of this kind are mitigated ought to be reason enough to encourage cooperation among members.

The G20 leaders' declaration at the Buenos Aires summit in December 2018 recognized the importance of trade "issues" and it also explicitly reaffirmed the principle that: "International trade and investment are important engines of growth, productivity, innovation, job creation and development. We recognize the contribution that

42 Central bankers use this term to refer to the combination of mainly economic factors that can reduce economic growth. Similarly, the expression "tailwinds" is employed to factors that jointly increase growth.

the multilateral trading system has made to that end. The system is currently falling short of its objectives and there is room for improvement."[43] Most other G20 summits, including the last one in Osaka in 2019, have expressed comparable sentiments. Based on evidence in this study covering the past two decades, there is clearly room for improvement as our estimates indicate that trade and commodity shocks, together with rising GPRs, have the potential to reduce positive global economic growth.

Finally, it should also be noted that since commodities are priced in US dollars, the exchange rate is another source of potential shocks to the global economy. The impact of this institutional arrangement is difficult to capture in models of the kind used in this study and, hence, is challenging to quantify. Nevertheless, it would be remiss of the G20 to not explicitly recognize the impact of this feature of the international trading system. There is, at present, no obvious alternative to this arrangement, as the euro continues to deal with internal challenges within the common currency area while progress toward the internationalization of the Chinese renminbi has also retreated as a focus of concern relative to trade and broader geopolitical concerns. It will be interesting to see the extent to which the G20 retains the mantle of "premier forum for international cooperation" and a source of deep worry if it is lost sight of.

Authors' Note

The opinions in the paper are those of the authors and not of CIGI. An earlier version of this paper was presented at the Canadian Economics Association Conference in Banff, Alberta in June 2019. The authors are grateful to two anonymous peer reviews that improved the paper.

43 The full declaration can be found at www.g20.utoronto.ca/2018/2018-leaders-declaration.html.

Appendix

Factor Models, Principal Components and PVARs: An Outline

An empirical challenge is that there are several variables with some information content relevant to evaluating spillover channels, but there is no single index or variable that captures them all. To address this concern, the dynamic factor model (DFM) is estimated. The premise of the model is that the common dynamics of a large number of time series variables stem from a relatively small number of unobserved (or latent) factors, which in turn evolve over time (for more details about the model see Bai and Ng 2008; Stock and Watson 2010; 2016). The DFM can be specified as follows:

$$X_t = \delta_t(L)f_t + \varepsilon_t \quad ...(1)$$

$$f_t = \varphi(L)f_{t-1} + \mu_t \quad ...(2)$$

where X_t is a vector of observable time series variables that are explained by a vector of latent dynamic factors f_t with $\delta_t(L)$ representing the dynamic factor loadings. A single common factor can be estimated non-parametrically using the principal components analysis and this factor follows a time series process, which is commonly taken to be a vector autoregression (VAR). In other words, we extract common information contents (or factors) from different sets of variables whose changes reflect the dynamics of different sectors of the economy. So, equation (2) can then be estimated as a VAR with the different common factors (i.e., monetary factor, financial factor, real factor, trade factor and commodity factor), each of which is considered endogenous. In the case of the G20 countries in our sample, we stack the countries' factors together and estimate a PVAR.

We adopt the Michael Abrigo and Inessa Love (2015) panel VAR package "*pvar*" and other accompanying commands in Stata to conduct our estimations. The default Generalized Methods of Moments PVAR estimation removes panel-specific fixed effects using the Helmert transformation, while the package permits us to select the optimal lag length for each estimation and check that the PVAR estimates are stable. Our sample is mostly balanced with at least 1,425 observations; representing 75 observations for each of the 19 cross-sections. We use 68 percent confidence interval — as is the practice in extant literature on this topic, and we estimate using 200 Monte Carlo simulation draws. Based on Cholesky decomposition, the ordering of the factors is as follows: commodities, real, trade, financial, monetary, geopolitical risk factors. We tried three other ordering options and derived similar results. The full impulse response graphs (both for the factor estimation and the estimates from using observable time series variable) are presented below. Similarly, the Granger causality test of the factor estimation results are also depicted.

Figure A1: Full Impulse Response Graph for PVAR Using Factors

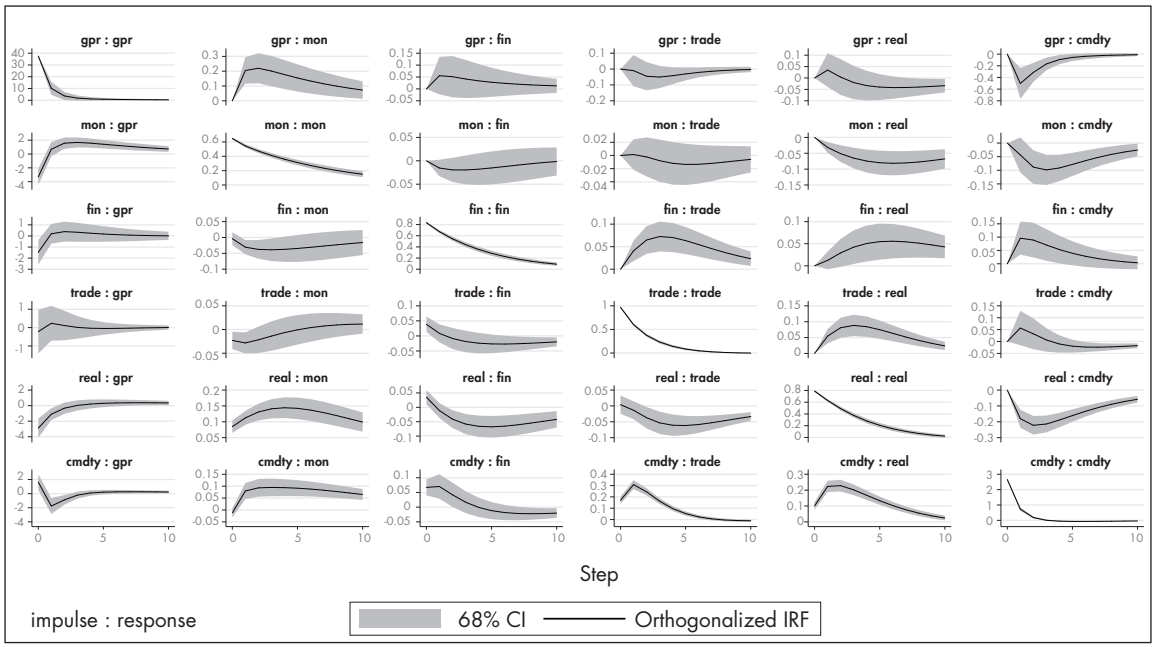
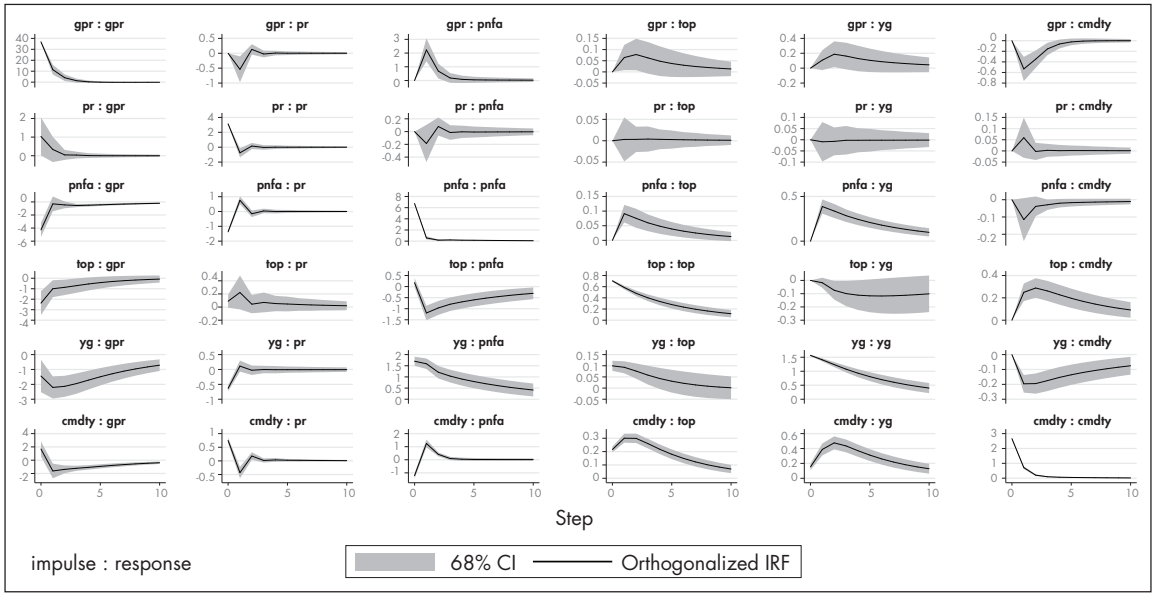


Figure A2: Full Impulse Response Graph for PVAR Using Observable Variables



Notes: For Figure A1, the impulse responses are estimated from the PVAR when all six factors (i.e., real, financial, monetary, trade, commodity prices and geopolitical risks) are endogenously related to each other. For each section, the source of the shocks is the impulse factor while the recipient or impacted factor is the response factor. CI means confidence interval. For Figure A2, the results are from the PVAR when observable variables are used.

Figure A3: Dynamic Multiplier Effects of US Shocks on G20 Factors

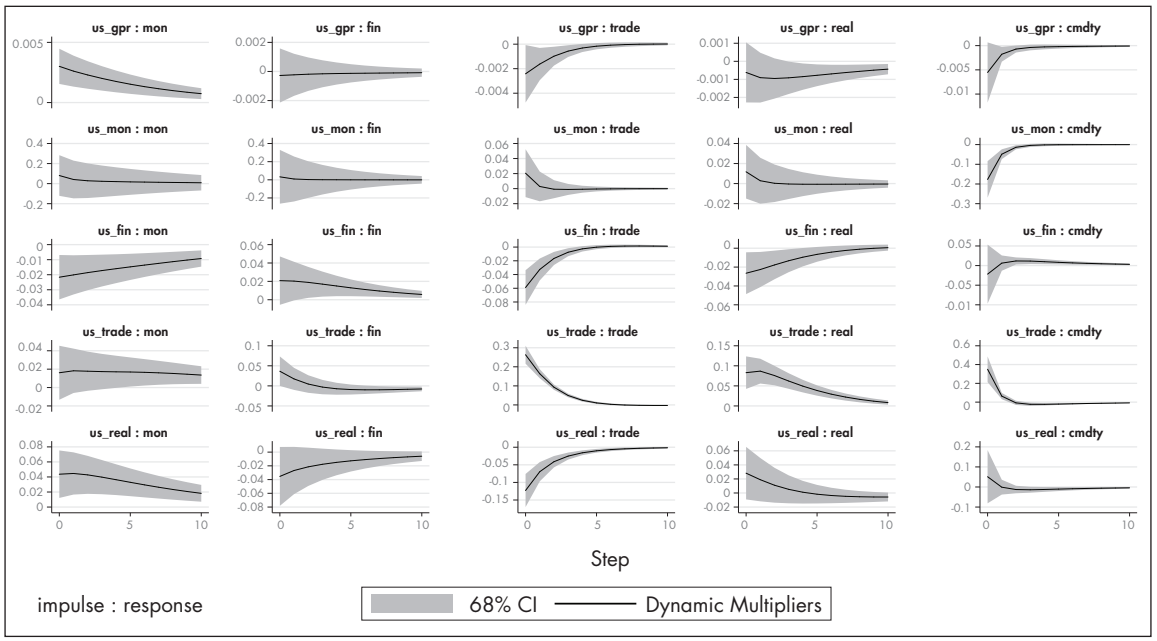
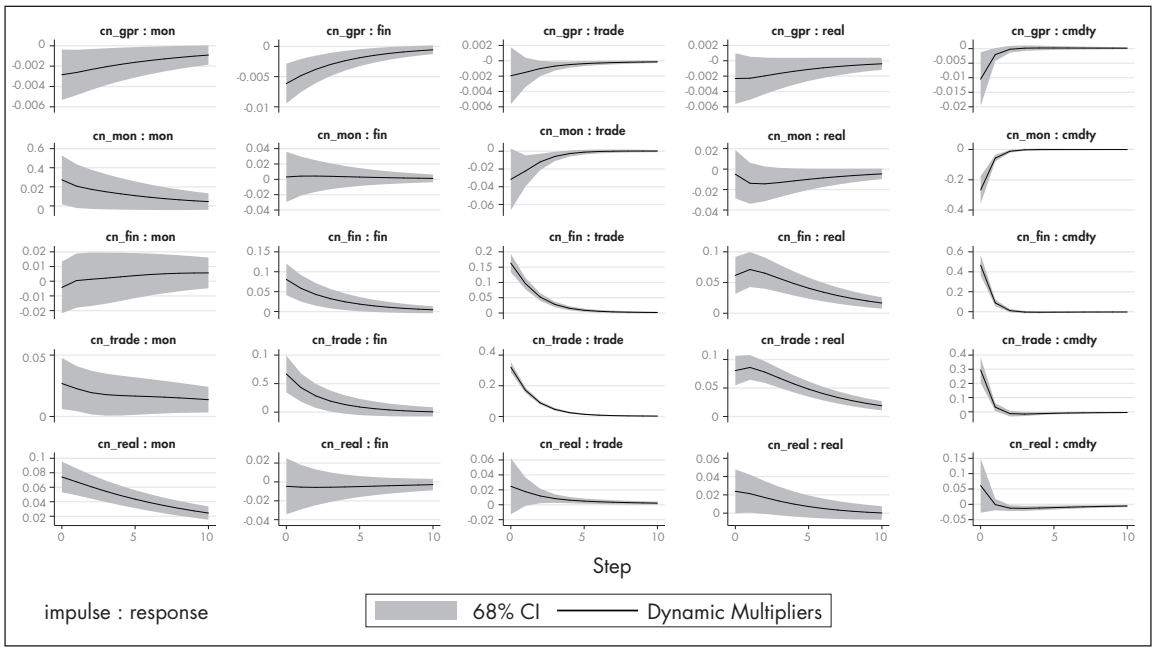
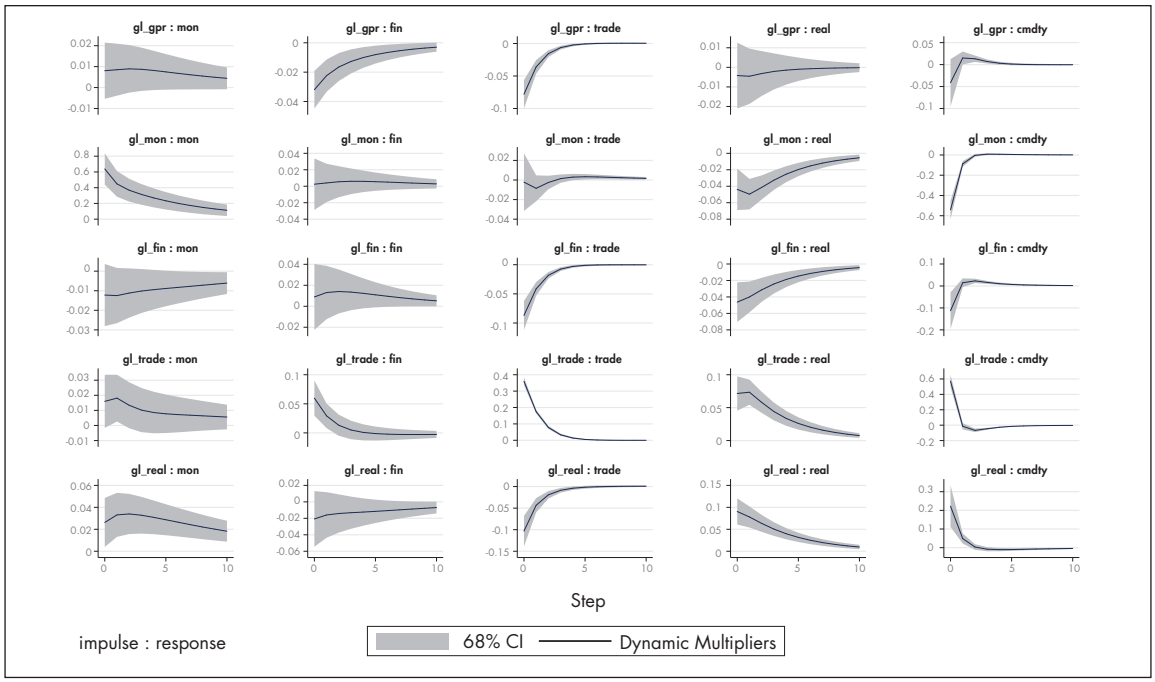


Figure A4: Dynamic Multiplier Effects of China Shocks on G20 Factors



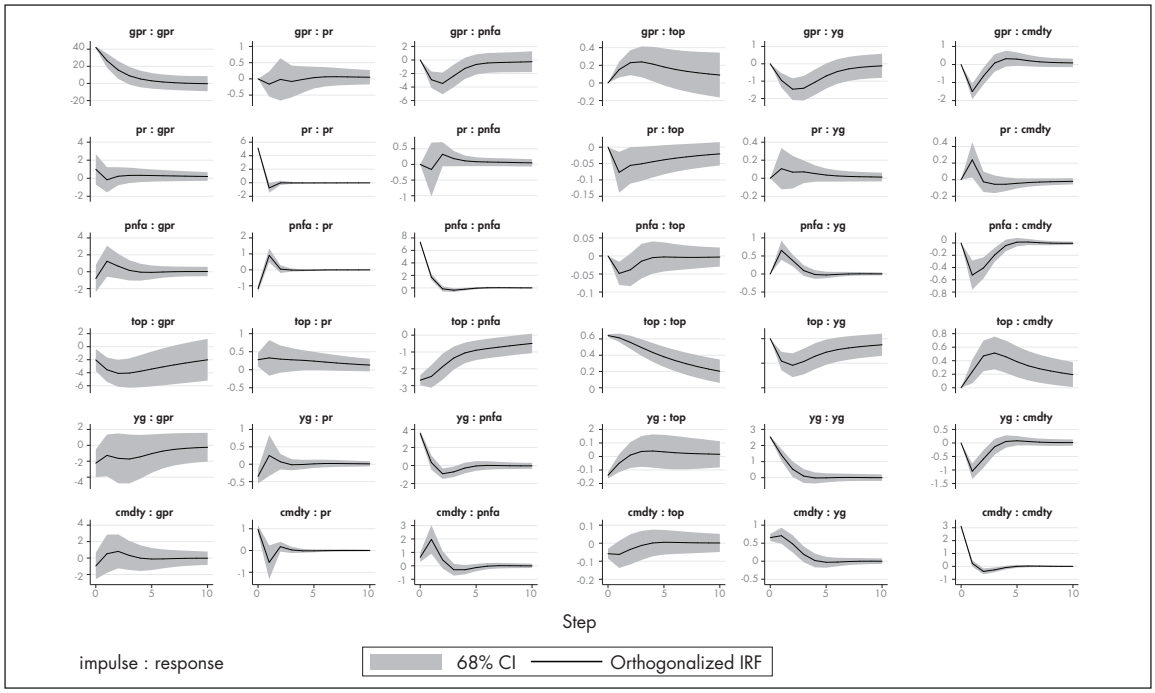
Notes: The dynamic multiplier effects reported here are estimated from the PVAR when all the G20 factors (i.e., real, financial, monetary, trade, commodity prices and geopolitical risk) are assumed endogenous while the factors for the United States are assumed exogenous. For each section, the source of the shocks is the impulse factor while the recipient or impacted factor is the response factor. CI means confidence interval. Similar analysis is conducted with China and all S5 (combined) factors as exogenous variables in Figures A4 and A5, respectively.

Figure A5: Dynamic Multiplier Effects of Global (S5) Shocks on G20 Factors



Note: See notes for Figure A3 and A4.

Figure A6: Full Impulse Response Graph for PVAR Using Observable Variables (1985 to 2006)



Notes: As in Table A2, the impulse responses here are estimated from the PVAR when all six observable variables are assumed endogenously related to each other. For each graph, the source of the shocks is the impulse variable (the first variable) while the recipient or impacted factor is the response variable (the second variable). CI means confidence interval.

Estimated Full Sample and Time-varying Factors for the G20 Countries[1] Commodity Factors – (Full Sample [FC] or Score for Component 1 and Time-varying Factors [FCV])

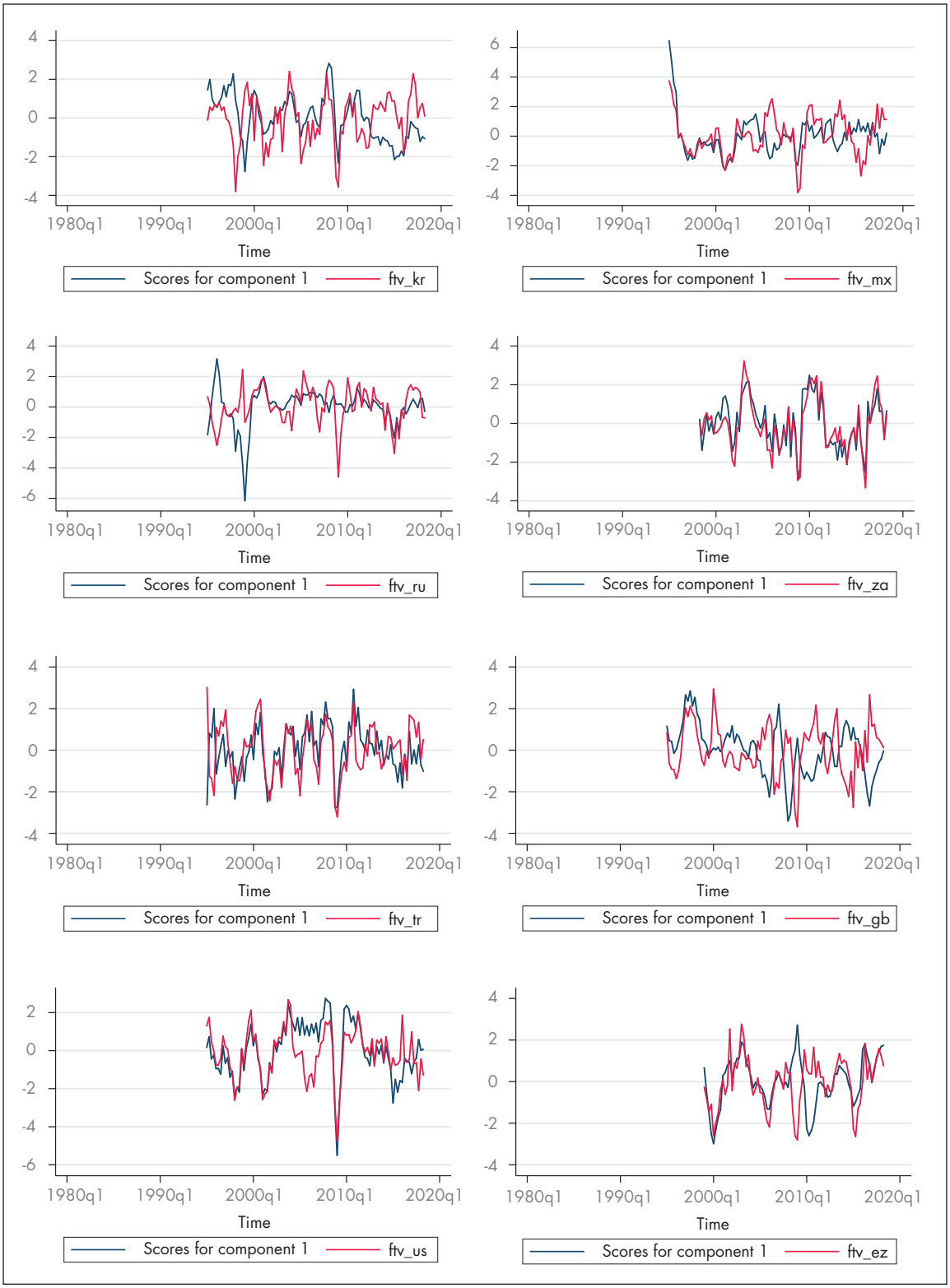
1 In all cases, the last two letters after the underscore sign are the G20 country's ISO codes.


15
10
5
0
-5
-10
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
fcv_kr
20
10
0
-10
Scores for component 1
fcv_mx
30
20
10
0
-10
Scores for component 1
fcv_ru
10
5
0
-5
-10
Scores for component 1
fcv_za
Scores for component 1
fcv_tr
Scores for component 1
fcv_gb
-15
-20
Scores for component 1
fcv_us
fc_ez
fcv_ez

Real Factors – (Full Sample [FR] or Score for Component 1 and Time-varying Factors [FRV])


4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_kr
6
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_mx
6
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_ru
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_za
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_tr
2
0
-2
-4
-6
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_gb
6
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_us
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
frv_ez

Trade Factors – (Full sample [FT] or Score for Component 1 and Time-varying Factors [FTV])


4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_kr
6
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_mx
4
2
0
-2
-4
-6
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_ru
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_za
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_tr
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_gb
2
0
-2
-4
-6
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_us
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ftv_ez

Financial Condition – (Full Sample [FF] or Score for Component 1 and Time-varying Factors [FFV])


5
0
-5
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_kr
6
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_mx
4
2
0
-2
-4
-6
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_ru
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_za
4
2
0
-2
-4
-6
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_tr
4
2
0
-2
-4
-6
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_gb
4
2
0
-2
-4
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_us
4
2
0
-2
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
ffv_ez

Monetary Condition – (Full Sample [FM] or Score for Component 1 and Time-varying Factors [FMV])


3
2
1
0
-1
-2
1980q1
1990q1
2000q1
2010q1
2020q1
Time
Scores for component 1
fmv_kr
6
4
2
0
-2
Scores for component 1
fmv_mx
-4
Scores for component 1
fmv_ru
Scores for component 1
fmv_za
Scores for component 1
fmv_tr
Scores for component 1
fmv_gb
-6
Scores for component 1
fmv_us
fm_ez
fmv_ez

Table A1: Panel Granger Causality Test

Equation variable	Excluded variable	chi2	df	Prob. > chi2
cmdty				
	real	11.84	1.00	0.00
	trade	0.43	1.00	0.51
	fin	1.60	0.10	0.21
	mon	2.79	1.00	0.10
	gpr	3.28	1.00	0.07
	ALL	17.41	5.00	0.00
real				
	cmdty	19.58	1.00	0.00
	trade	6.50	1.00	0.01
	fin	0.54	1.00	0.46
	mon	3.70	1.00	0.05
	gpr	0.20	1.00	0.66
	ALL	33.88	5.00	0.00
trade				
	cmdty	34.41	1.00	0.00
	real	0.78	1.00	0.38
	fin	3.50	1.00	0.06
	mon	0.00	1.00	0.98
	gpr	0.01	1.00	0.92
	ALL	46.26	5.00	0.00
fin				
	cmdty	0.45	1.00	0.50
	real	3.58	1.00	0.06
	trade	1.11	1.00	0.29
	mon	0.45	1.00	0.50
	gpr	0.44	1.00	0.51
	ALL	6.18	5.00	0.29

Equation variable	Excluded variable	chi2	df	Prob. > chi2
mon				
	cmdty	9.81	1.00	0.00
	real	15.64	1.00	0.00
	trade	0.12	1.00	0.73
	fin	1.71	1.00	0.19
	gpr	5.33	1.00	0.02
	ALL	23.32	5.00	0.00
gpr				
	cmdty	4.76	1.00	0.03
	real	0.61	1.00	0.44
	trade	0.16	1.00	0.69
	fin	0.57	1.00	0.45
	mon	6.21	1.00	0.01
	ALL	12.59	5.00	0.03

Note: Ho: Excluded variable does not Granger-cause Equation variable, while Ha: Excluded variable Granger-causes Equation variable. Ha is alternative hypothesis; Ho is null hypothesis.

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