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Monetary, fiscal and demographic interactions in Japan: impact and a comparative assessment

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September 2022

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Abstract

Macroeconomic models used to downplay demographic and fiscal factors. For Japan, narratives suggest that its experience is unlike that of other large economies persisted. I revisit how demographic and fiscal shocks impact Japan, the Euro Area and the US since 1990. Several models and methodologies are used to investigate macro-financial factors, including demographic and fiscal variables. Many, but not all, of the shocks examined have comparable impact across all three economies considered. This is true for monetary policy and the response of global inflation to ageing and demographic shocks. The response of real economic activity to several of the shocks considered is also comparable. Perhaps most notably, demographic and fiscal factors have significant real economic impact although the size of the response does differ across the three economies examined. Japan may not be like other systemically important economies in all respects but it does offer lessons for other large economies.

Keywords

Japan, monetary and fiscal policy, Eurozone, USA, demographic and global factors, panel VAR, local projections

JEL classifications: E31, E37, E44, E58, E62, E63, J11

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Introduction

Low inflation was the challenge of the first two decades of the 2000s. However, as this is written, high inflation is the existential threat facing major advanced economies. One has to go back to the early 1990s, or earlier, to observe inflation rates of 4% or more. Japan's experience has sometimes been thought of as the 'canary in the coal mine' since problems of low inflation, an ageing demographic, and high levels of government debt portend similar pressures elsewhere in the advanced world over the past few years.

The continuing fascination with Japan's economic performance, and the decisions taken by the policy authorities, owes as much to the search for lessons learned, and mistakes to avoid, as it does to the growing realization, at least at the macroeconomic level, that Japan may not be so different from other large systemically important economies after all. Stated somewhat differently, policy makers in the Eurozone, the U.S., and possibly China someday, are likely to wonder whether Japanification, as the combination of apparent low growth, or stagnation, and mild deflation is sometimes referred to, is set to eventually overtake these economies, in spite of attempts to avoid this fate.

Even the ongoing national responses to the COVID-19 pandemic, and its economic consequences, raise policy questions that can find echoes in the experience of Japan not only because, once again, the Japanese government was initially accused of premature over-confidence and a slow response to the current crisis (e.g., Kalinova, 2020), but also because (partially) man-

made (e.g., Fukushima nuclear meltdown) as well as natural phenomena (i.e., earthquakes) have regularly tested authorities' policies in that country over time.

Past research has tended to focus largely on how the monetary policy authority (viz., the Bank of Japan; hereafter BoJ) has navigated through the shocks that have hit the Japanese economy over the past three decades. Academics and other interested observers were aware, of course, that other economic and non-economic forces were also at play in the story of Japan's 'lost decades'. The volume published by Callen and Ostry (2003) almost twenty years ago in 2003 attests to this. However, consistent with the prevailing view that central banks were ascendant, and largely dominated the task of business cycle stabilization, fiscal policy played a secondary role though, as some have stressed (e.g., see Koo 2003, 2008, 2015, 2018; Aramaki, 2018), one that effectively stood in the way of monetary policy from reaching its notional aims.

Japan remains one of the largest economies in the world in spite of its travails over the past few decades. Together with the US and the Eurozone, these three economies share a common monetary policy strategy experience with emphasis placed on inflation control while retaining idiosyncratic elements at the institutional level.¹ The following section briefly reviews the macroeconomic experience of the three economies with an emphasis on Japan whose records is, on balance, less well understood than those of the US and the Eurozone. That said, I aim to be brief because the existing literature is voluminous. Instead, the strategy adopted below is to draw attention to some highlights that will, it is hoped, help with the interpretation of the econometric results to be presented later.

Next, a model is specified that goes beyond the standard variables used, for example, to explore the impact of monetary policy, by incorporating separate roles for demographic and fiscal factors. After introducing the data, the model is then estimated to determine how the three economies respond to demographic and fiscal shocks. I am also interested, however, in the overall importance played by monetary policy in the expanded model considered as well as what drives inflation. To provide some perspective data from the Euro Area and the United States are used in addition to the focus on the Japanese experience. Two separate sets of econometric methodologies are employed to test the sensitivity of the findings. The paper also relies on two different ways of

¹ China's rise cannot be ignored. However, the economic and institutional differences make it a difficult fit in a comparative exercise of the kind conducted in this paper.

expressing the variables enter the estimated models, including some allowance for time-varying effects. The paper concludes with a summary and some policy implications are also drawn.

Briefly, and despite the views of some observers that the Japanese is unique, many of the shocks examined have comparable effects across all three economies considered. This is true both for monetary policy and the response of global inflation to demographic shocks. Similarly, the response of aggregate economic activity to several of the shocks considered is also comparable. Overall, demographic and fiscal factors have significant real economic impact in all three economies and, while the size of the response does differ across the three economies examined, they can dwarf the impact of monetary policy.

1. Japan's Macroeconomic Experience and the Missing Ingredients

Discussions about the macroeconomic performance of Japan since the 1990s often highlight its sluggish economic growth and mild deflation. There is a rich literature, often authored by academics and policy makers outside of Japan, reminding readers of the need to avoid following their example lest we forget what it takes for an economy to fall into the 'lost decade' or secular stagnation traps. Bernanke (2000), and Krugman (1998), are well-known examples of earlier US views on Japan but there are also Japanese academics, professional observers, and policy makers with first-hand knowledge who have also admitted that mistakes were made when looking in the rear-view mirror (inter alia, Koo, 2015; Aramaki, 2018; Wakatabe, 2015; Schnabl, 2015; Shirakawa, 2021). To be fair, some of the critics either recanted their views or discounted the possibility that their economies would suffer the same fate only to later change their minds (e.g., Krugman, 2014a,b; Gertler, 2017; Wolf, 2017; Summers and Stanbury, 2019).

Interpreting Japanese economic growth is sensitive to the metric used (e.g., aggregate or per capita, domestic, PPP, or US dollar basis). However, Japan's economic performance does not fare as badly as some contend (e.g., Siklos, 2021).² Turning to inflation, there is little doubt that headline CPI has been persistently lower in Japan than in any other advanced economies (e.g., see Kuroda, 2016) though the gap begins to disappear after 2015. The gap, however, is more noticeable

² Even in the case of total factor productivity (TFP) the message is decidedly mixed. While TFP for the Euro Area has been sluggish Japan does not fare as badly as the US except for the 1990s. By the mid-2000s the US catches up to the other two economies. See the appendix.

when core inflation rates are compared (see the appendix). That said, differences in economic performance between Japan and two other systemically important advanced economies that make up the G3, namely the US and the Euro Area, are dwarfed by the many similarities, in the macroeconomic experience of the G3. It is more accurate to state that, over the past decade or so, the other two economies caught up to Japan and could not entirely escape its fate. For example, Masaaki Shirakawa, former Governor of the Bank of Japan, laments the frequent unwillingness of outsiders, until recently, to draw the right lessons from the Japanese experience over the past three or more decades of economic history (Shirakawa, 2021).³ Beyond low growth and low inflation rates, similarities include low interest rates⁴ and the public policy response that includes various forms of financial sector rescues or bail-outs, together with central bank interventions that are labelled by the portmanteau term unconventional monetary policies (UMP).

What remains in question is how much of the responsibility rest with monetary policies and the extent to which other ingredients need to be considered to advance our understanding of what explains economic performance not only in Japan but elsewhere in major advanced economies. It is, therefore, worth pausing to ask what the recent economics literature dealing with Japan's macroeconomic performance, written by both domestic and outside observers (inter alia, see Aramaki, 2028; Koo, 2018; Bullard, 2010), has highlighted as areas with a negative balance of opinion about the Japanese experience. They include: (1) the link, if any, between (mild) deflation and low growth; (2) whether the Japanese authorities failed to act quickly or aggressively enough when problems emerged, or applied the wrong prescriptions when faced with a need to change the course of policy; (3) mis-identifying the most important shocks that hit the Japanese economy; (4) the degree to which institutional factors can be held responsible for seemingly below par economic performance; and (5) once the BoJ launched UMP long before others did in the early 2000s, whether these interventions met their stated goals.

While the jury is out concerning (1) whether there is good empirical evidence that the association between deflation and growth is largely driven by the Great Depression era (Borio et.al., 2015), there is a rough consensus that important elements of (2) are accurate. There continue

³ "...a number of countries have followed a path very similar to the one that Japan has taken. ...there seems to be no strong appetite among academics and policy makers for change in the intellectual framework of monetary policy..." (Shirakawa (2021), p. 371.

⁴ Again, this is mainly a feature of the almost 15 years since the GFC. Prior to that low central bank policy rates are a distinguishing feature of the Japanese experience, and this may have contributed to the formation of an ideology that sees Japan as performing differently from other advanced economies. See the appendix.

to exist considerable differences of opinion about the relative importance of supply versus demand shocks (i.e., (3)), there is some truth to (4), although UMP may have placed a floor on Japan's stagnation while having been singularly unsuccessful in boosting inflation (i.e., (5)). There is insufficient space to go into details here⁵ but, in addition to the works already cited, one can selectively add Romer, 2014; Lombardi et. al., 2018; Shirakawa, 2016; and Nakaso, 2001).

Monetary policy has undoubtedly played an important role in the story of Japan's macroeconomic policy over the past three decades. However, there are at least two other major sources of change in economic activity that have, until recently, received relatively less attention. They are: fiscal policy and demographic change.⁶

Among many Japanese, and some non-Japanese authors (e.g., Koo, 2018; Wakatabe, 2015; Aramaki, 2018; and Posen, 1998), fiscal policy has been mentioned as another candidate to explain Japan's economic predicament. Nevertheless, former Governor Shirakawa (2021), p. 311 recalls that, whereas some external observers drew attention to the role of fiscal policy, he did "...not know why Japanese economists have remained so quiet, nor have I understood how they have assessed the effectiveness of fiscal policy." Two forces may have been at play in generating this outcome. First, the stop-go nature of fiscal interventions, driven by fears of generating unsustainable debt in attempts to return to the high growth rates of the 1980s. Rising debt levels threatened, at least in the minds of some Japanese policy makers, to eventually cripple the economy. Indeed, we observe a slowdown in the rise of (gross) debt to GDP ratio around the time monetary policy becomes more aggressive (see the appendix).

How monetary and fiscal policy interact in Japan (and elsewhere) has been under-emphasized in large part because fiscal policy has tended to be passive elsewhere in the advanced world. This is changing (e.g., see Basseto and Sargent, 2020), and the ongoing pandemic will test the monetary-fiscal relationship as never before.⁷ Moreover, as explained by Eichengreen et. al. (2021) in their long sweep of debt history, Japan, like the other two economies that are the focus of the empirics in this paper, have had to deal with the skeptics who regularly warn that government debt levels are unsustainable. Yet, despite a new surge of government debt, as the authors put it,

⁵ Siklos (2021) provides an overview and many references.

⁶ A third would be the role of inequality which is beyond the scope of this paper.

⁷ The literature occasionally describes these phenomena by referring to the concepts of monetary and fiscal dominance. It is beyond the scope of this paper to go into details (see, however, Leeper and Leith, 2016). It is worth noting the same authors also claim that: "Japan is a complicated case." (op.cit., p. 2394) for reasons never really spelled out.

Stein's law ("if it can't go on forever, it will stop") has not yet been seen as fit to apply in Japan's case (see also below). Similarly, some of the same observers already cited above would comment on the possible role of institutions and their governance as catalysts for what has been perceived to be plodding responses to mounting economic problems. Here, coordination failures and lack of transparency or clarity in the respective roles of critical agencies, at pivotal moments in Japan's recent economic history, are also believed to have contributed to generating the 'lost decades'.

There is an uncomfortable relationship between two separate literatures, one that deals with how fiscal and monetary policy ought to optimally coordinate while the other debates whether, over time, fiscal or monetary policy dominate stabilization policy. One explanation is that, for decades, many academics and central bankers adhered to Tinbergen's principle wherein independent instruments must be used to achieve different goals. However, in times of crisis, central banks are there to act as lenders of last resort and it becomes difficult to observe rules set up to function in 'normal' times.

Although the ECB is technically forbidden to do so, work arounds have effectively permitted the appearance of becoming like other national central banks.⁸ Even in the case of Japan and the US there are limitations on the scope of lending though the range of financial asset types the BoJ is able to purchase is wider than either the Fed or the ECB. Indeed, the Fed's ability to lend in emergencies under "unusual and exigent" conditions were curtailed following legislation enacted in response to the GFC.⁹

More broadly, the separation principle refers to the separation of monetary policy, typically geared to a price stability objective, from activities and interventions aimed at preventing financial instability. However, this need not imply that monetary and financial stability should be entrusted to a single institution. Whether or not central banks ought to be responsible for goals beyond inflation control continues to be unresolved and is likely to be country and history specific.¹⁰ That said, part of the problem is the assumption that price stability is sufficient to ensure financial stability. While there is a long intellectual history suggesting that financial stability *depends* on price stability (e.g., see Schwartz, 1995) this is not the same as stating that one *causes* or is a sufficient condition to generate the other.

⁸ That said, several legal challenges were placed in the way of the ECB and, at the time of writing, not all were settled.

⁹ The details are contained in section 13(3) of the Federal Reserve Act. See Hennerich (2021).

¹⁰ See Bordo and Siklos (2018), and references therein.

The pandemic, in an era where monetary policy has been ultra-loose around the globe, has served to remind academics and policy makers that fiscal and monetary policies cannot always pretend to be two solitudes. This has led to a resurgence of interest in another old topic that pre-occupied policy makers decades ago (e.g., see Brimmer and Sinai, 1986), namely the question of monetary and fiscal coordination. Japan also serves as a reminder of the importance of this issue (e.g., see Koo, 2003), something that has also long been known, but as mentioned previously, lurked in the background. The zero or effective lower bound of central bank policy rates, combined with UMP, only serves to further highlight how the stance of monetary policy can influence fiscal space. Space limitations prevent a fuller analysis but, for the three economies in question, Leeper and Leith (2016), Orphanides (2017), Bassetto and Sargent (2020), Kobayashi and Ueda (2020), Bartsch et. al. (2021), Blinder (2021), Leeper (2021), Hofmann et. al. (2021), and Elenev et. al. (2021) address the main questions.

In the past few years, demographic factors have also been mentioned as contributing to deflation and low economic growth in Japan (e.g., Shirakawa, 2016; Sudo and Tazizuka, 2018) and, more recently, elsewhere. Indeed, as with monetary and fiscal policy, the debate has turned to asking whether Japan's experience offers a window into the future for other industrialized countries experiencing aging populations. Goodhart and Pradhan (2020, ch. 9) are clear that "...almost nothing from Japan's story is going to be applicable to most of the West as it ages...". A reading of Japanese monetary policy makers' views does not lead to the same conclusion (Shirakawa, 2017; Kuroda, 2019). Globalization, the shift away from permanent employment contracts, and rising participation rates among the over 65-year-old population, are some of the factors that may set Japan apart from the others.¹¹

Similarly, whereas monetary policy aimed at easing financial conditions, or so it was thought, regulatory forbearance combined with excessive caution hampered the ability of the Japanese banking system to contribute to stimulating economic activity. Here, the extant research is more conclusive (e.g., Kamada and Woo, 2000; Koo, 2003; Shizume, 2018). Indeed, there is evidence that Japan's experience does not necessarily stand out from the rest (e.g., see Juselius and Takáts, 2018). In any case, central bankers have come to admit that demographic forces may

¹¹ As with the other factors considered above this interpretation is in the eye of the beholder or, rather, is episode specific. For example, as shown in the appendix, gaps in the age dependency ratio between Japan, the Euro Area and the USA emerge after 2005. Between 1990 and the early 2000s the gaps are far less apparent.

well be consistent with Goodhart and Pradhan’s views, even if considerable uncertainty shrouds the actual future for inflation and economic growth since it is too early to tell whether and how the pandemic and global geopolitical events will shape the future outlook.

2. What Insights from Theory? A Mixed Bag

The foregoing developments are leading to a rethink of the role played by factors outside purely ones associated with monetary policy. Nevertheless, this is not to say that monetary policy has been entirely displaced as the source of Japan’s low growth – low inflation conundrum. Indeed, a considerable amount of blame is said to rest on the role of expectations, especially inflation expectations. Central bankers themselves are fond of insisting that higher inflation expectations are critical to ensuring that more inflation is eventually observed and that UMP and other measures to aggressively loosen monetary policy are the vehicles that are essential to raising these expectations.

Japan, which pioneered UMP beginning in the 1990s, has yet to deliver higher expectations and, among other explanations put forward, the Bank of Japan has emphasized the backward-looking nature of expectations formation (e.g., Bank of Japan, 2016). Even if this view is accepted, it is never made clear whose expectations matter. Since the evidence suggests that expectations of households differ greatly from ones generated by financial markets, professional forecasters, and central banks, drawing sweeping conclusions about expectations formation, something central bankers themselves have said are poorly understood, is unconvincing.¹² Moreover, these expectations are seemingly more fragile than many believe which also raises the possibility that the oft-mentioned aim to anchor expectations to an announced objective has not been an unalloyed success. Yet, there has been no major course correction in the pursuit of UMP. Casual evidence (see the appendix) also suggests that the EA and the USA have followed similar paths.

¹² It should be noted that theoretical models emphasize the role of long-term inflation expectations (e.g., 10-year ahead horizon) and not the short-term expectations discussed here. That said, there is growing dissatisfaction with what some believe is an over-emphasis on the role especially of long-run expectations (e.g., see Rudd, 2021; King, 2021). Inflation expectations of these groups are shown in the appendix and play separate roles in the empirical evidence to be discussed below. Real GDP growth expectations also play a role. At least two features concerning the behavior of inflation expectations are worth mentioning at this juncture. First, other than in the USA, household inflation expectations are not consistently higher than expectations generated by other groups or sectors. Second, even in Japan, deflation expectations are infrequent. No wonder former Governor Shirakawa laments that government, not Bank of Japan, declarations of deflation were among the “...most ill-advised government actions...” he could remember (Shirakawa, 2021; p. 97).

Also at the theoretical level, models not specifically aimed at the Japanese experience have been proposed that incorporate some of the factors that are also associated with the secular stagnation phenomenon, demographic factors, the hypothesized decline in the natural real interest rate and now the global and economy-specific impact of the ongoing pandemic (e.g., Brunnermeier et. al., 2020; Guerrieri et. al., 2020; Mian et. al., 2020; Eggertsson et. al., 2019; Fiorentini et. al., 2018; Berg et. al., 2018), and the impact of fiscal policy. We are also seeing a shift away from thinking that Japanification is exclusively a Japanese phenomenon (e.g., El-Arian, 2019).

Nevertheless, standard macro models applied to observed data continue to be strongly wedded to some variant of the new Keynesian (NK) synthesis (Romer, 1993). The GFC has led to taking more seriously agent heterogeneity (Kaplan et. al., 2018) which has also permitted the impact of fiscal policy to be taken more seriously. A parallel development is found in the so-called fiscal theory of the price level (FTPL) which, as the name implies, shifts attention to the inter-temporal government budget constraint. Japan might well be seen as contradicting the FTPL since inflation has not soared despite ultra-loose monetary and fiscal policies, but this ignores, among other considerations, the relationship between growth and interest rates which weakens the link between deficit, or debt, and inflation (Cochrane, 2021).¹³ This partly explains the surge in studies that, theoretically and empirically, examine the r versus g inequality (inter alia, Reis, 2021; Blanchard, 2019) where r represents the nominal interest rate on government debt while g is the nominal GDP growth rate.¹⁴ Conventional monetarist models (i.e., ones built on the quantity theory) also fall short since extraordinarily accommodative monetary policies have also failed to generate much inflation. Arguably, however, the principal theoretical and empirical lesson that can be drawn is an old one, namely that monetary and fiscal policies cannot work at cross-purposes for very long without inflationary consequences (e.g., see Bordo and Levy, 2021). However, with a few exceptions (e.g., armed conflicts, political instability), it is difficult to know the timing between the onset of a breakdown, political or otherwise, and poor inflationary or economic performance.

¹³ “That inflation has been quiet despite long periods of constant near-zero interest rates in the U.S., Europe and Japan is a feather in the fiscal cap...” (Cochrane, 2021; p. 326) “The fiscal theory ties the price level to the present value of future surpluses, not to current surpluses.” (Cochrane, 2021; p. 506).

¹⁴ There are, of course, many r 's and, as a result, this will impact how often the $r < g$ conditions will hold. However, this topic is outside the scope of the paper. That said, if we use long-term government bond yields then there was less fiscal space for Japan during the 1990s but, other than around the GFC, the $r < g$ condition holds persistently since 2013 and on and off previously, at least since the early 1990s. The appendix provides a plot for all three economies.

Demographic forces, as mentioned previously, are also beginning to play a more serious role in theoretical macro models and, while NK models have recognized this element, others have proposed overlapping generations models since these explicitly allow a focus on the implications for the ‘young’ and ‘old’ generations. Eggertsson et. al. (2019) is an example where the authors take the position that ultra-low interest rates are likely to remain a permanent feature of monetary policy. The neutral real rate is impacted by demographic factors (e.g., low population growth, increase in life expectancy). This kind of model suggests that fiscal policy can be a way out from the secular stagnation equilibrium while raising the inflation target (e.g., Blanchard et. al., 2010), as the Bank of Japan did in 2013, may not be enough to get rid of the secular stagnation problem.¹⁵ As such, their approach yields conclusions that differ markedly from the NK approach where monetary policy actions have pride of place.

Much earlier, search and labor market frictions were used to motivate a demographic element to explain macroeconomic performance. Early on, however, Bean (2004) remarked that, while demographic factors represent a macroeconomic shock, the “...glacial nature of demographic change ...” would limit its impact on monetary policy. Of course, this does not take away from the potential for demographic changes to reverse many trends including the persistently low inflation rates in the advanced world since the late 1990s (Goodhart and Pradhan, 2020). Demographic changes can influence the transmission of monetary policy shocks because consumption spending patterns are heterogeneous, that is, they differ as between younger and older population groups (e.g., Berg et. al., 2018). It is not possible, of course, to divorce demographic elements and, therefore, labor productivity, from the behavior of the neutral or equilibrium interest rate, often called r^* , a concept¹⁶ that dates back more than a century and was relegated to the background during the years of the Great Moderation when it could reliably be assumed to remain constant. Despite the high degree of uncertainty around point estimates of r^* there is a fair amount of consensus that it has been in decline for several years (e.g., see Holston et. al., 2017; Mian et. al., 2021; Sudo et. al., 2018).¹⁷ Demographic factors are likely to have been at play here and,

¹⁵ Eggertsson et.al’s (2019) model can also be used to study the implications arising from income inequality which is outside the scope of this paper.

¹⁶ Wicksell (1898).

¹⁷ Since r^* is unobserved there are, unsurprisingly, differences in the way it is estimated. Interestingly, some point estimates (see the appendix) suggest that while r^* for the Euro Area and the USA have been in decline since the early 1990s the same is not true for Japan where it has been volatile but reasonably constant on average. Whether this reflects the demographic and productivity factors is unclear since time series models used to generate the estimates do not directly capture these effects.

according to Fujita and Fujiwara (2021), accounts for over 40% of the decline in Japan while the impact of an aging population also reflected in the decline of productivity (also see Feyrer, 2007).

3. Data and Econometric Specifications

3.1 Some Preliminaries

Table 1 lists the main variables that are included in the vectors used to generate the factor model estimates to be used below.

Consider first the case of an individual economy j . We assume that economic shocks can be decomposed into factors i we describe below. If \mathbf{X} denotes the vector of series used in estimating factors i over time (t), we can, dropping j to economize on notation, write

$$\mathbf{X}_{it} = \boldsymbol{\alpha}_{it} \mathbf{F}_{it} + \boldsymbol{\varepsilon}_{it} \quad (1)$$

where \mathbf{X} is a vector of time series from which common factors are estimated, \mathbf{F} are the factors, that is the common component, and $\boldsymbol{\alpha}$ are the factor loadings.

Six separate factors i are estimated. They are: real, monetary, financial, fiscal, demographic, and a global factor. More details about the data sources and the specific series included in each grouping, including links to the raw data sources, are relegated to the e-component (i.e., appendix) of the study. However, as a sensitivity test, all estimation is also repeated using observable time series and these are also listed at the bottom of Table 1. Raw data were obtained at the monthly, quarterly, semi-annual, and annual sampling frequencies. All data and econometric tests are performed at the quarterly frequency.¹⁸

A recurring issue in empirical studies of this kind is the form in which the data enter any econometric relationship which ordinarily requires the series to be stationary. Five different sets of filters were estimated. They are (not in any order of importance): log first differences or simple first differences depending on the series in question,¹⁹ a (one-sided) Hodrick-Prescott filter, a band pass filter (Christiano-Fitzgerald asymmetric), Hamilton's filter, and the average of all filters. There is, of course, a huge and long-standing literature that deals with the choice of filters. Space

¹⁸ Monthly data are converted to the quarterly frequency arithmetic averaging. Any interpolation was carried out via the Chow-Lin method. Demographic data and comparable fiscal data are most likely to be available at the annual frequency.

¹⁹ For example, interest rates and unemployment rates are in percent so the first difference filter is employed while for asset prices and the price level, the first log difference is applied.

limitations prevent further discussion, except to remark that differencing, followed by an average of all filters produced similar findings. Since differencing generates series that are more easily interpreted, we discuss only these results below.²⁰

Table 2 provides some summary statistics for the select the time series for the available samples shown. Focusing on mean values only we observe that real GDP growth is lowest for Japan and highest for the US. Differences in term spreads are, on the other hand, small.²¹ Unsurprisingly, the demographic factor suggests that Japan's population is the oldest, followed not far behind by the EA and a much 'younger' US population. These comparisons are based on age dependency ratios. Similar differences are observed for the fiscal factor such that the fiscal burden is roughly twice as high for Japan than the EA and lowest for the US, based on an indicator of (gross) debt. Looking at the average relative monetary policy stances (i.e., the policy rate) the US is tightest, followed by the EA and Japan is last. Although data availability varies slightly across the G3 (see Table 1) note that all econometric tests rely on a balanced sample (1999Q1-2019Q4, before any lags or other data transformations). As discussed below, I also exploit the potential cross-sectional interactions between the G3 economies that form the dataset.

Figure 1 plots the time series for the six factors previously defined. Estimation details are relegated to the notes to the Figure.²² The estimation method generally returned one factor. In the case of the real factor, there were some instances where two factors were obtained. These could be interpreted as aggregate demand and supply factors, respectively. As will be discussed below, the estimation technique can quickly exhaust degrees of freedom. Although I experimented with the inclusion of two real factors the conclusions of interest were unaffected when only the aggregate demand factor is retained.

The top left plot shows the estimates of the real factor for the G3 together with the NBER recession chronology-based dates.²³ It is immediately seen that a reduction in the real factor is an

²⁰ Unit root test of the cross-section dependent variety were also performed to ensure that the unit root null could be rejected for the transformed time series. Test results are relegated to a separate appendix available from the author.

²¹ Data limitations, however, imply that the term spreads are not, strictly speaking, comparable across the G3.

²² Not shown are time-varying versions of the estimated factor scores. Generally, these produced similar plots (not shown) and were estimated by rolling five-year samples (i.e., 20 quarters) that were re-estimated by shifting the samples eight quarters at a time. Time series of the kind shown in Figure 1 were then obtained by splicing together the rolling sample scores and averaging the scores when samples overlapped. In addition, I also experimented by varying the number of series considered in each factor and the conclusions are unaffected. The note to Figure 1 provides additional details.

²³ Chronologies exist for the other economies and were also used but are not show to avoid clutter especially since recession periods often, though not always, overlap. See the e-component for details.

indication of a downturn in economic activity. At least for the US, the factor model estimated downturns overlap nicely with the NBER chronology. We also observe that while changes in economic activity in the G3 move in a similar manner until the GFC, there is considerably more heterogeneity post financial crisis. Almost the reverse phenomenon is observed for the financial factor (top right in Figure 1). A rise in the series is indicative of a tightening of financial conditions while a fall signals, of course, looser financial conditions. We observe considerable heterogeneity in financial conditions pre-GFC, but the differences appear much more muted after the financial crisis until the end of the sample.

Next, I turn to a comparison of monetary conditions in the G3 (middle left of Figure 1). Cross-country heterogeneity is fairly evident throughout the entire sample. Fed tightening often occurs pre-recession but there is sometime evidence that monetary policy is loosened just before a recession is thought to have taken place as seems to the case for the GFC. EA loosening is observed when the sovereign debt crisis reaches its peak in 2013. In contrast, fluctuations in the stance of BoJ monetary policy do not appear to be as large as in the EA and the US but it must be recalled that, other than at the beginning of the sample when BoJ policy is far tighter than in the US, UMP together with ultra-low interest rates became the norm in Japan. Nevertheless, there are clearly periods when monetary policy becomes tighter for prolonged periods of time followed by persistently looser policy thereafter. Clearly visible examples include the early 1990s and the period between 2006 to 2010 when the BoJ is seen as tightening policy. The year 2013 marks a reversal but it is not nearly as dramatic as claimed when one of the three arrows of Abenomics are announced, culminating with QQE and yield curve control.

Next, Figure 1 displays the evolution of expansionary and contractionary fiscal policy (middle right plot). One can observe considerable volatility and fairly large swings in fiscal policy in every G3 economy shown. The sharp expansion of fiscal policy in all three economies is particularly noticeable around the time of the GFC. Moreover, as with the real factor, there is apparently more homogeneity in fiscal policy since the GFC than before this crisis.

The demographic factor (bottom left plot in Figure 1) is somewhat more difficult to interpret.²⁴ The interpretation adopted here owes much to Goodhart and Pradhan (2020) who link demographics to inflation. On this score we clearly observe how the ageing of the populations in the EA and Japan signal lower scores for the demographic factor over the full sample although

²⁴ Savings, life expectancy, age dependence, and crude birth rates drive the scores for this factor.

there are occasional reversals. For the US the trend is more inflationary, that is, until shortly after the GFC when the factor levels off and begins to show a few signs of declining.²⁵ Here, the population is not seen to be ageing in the same manner as in Japan and the EA. Finally, the global factor, largely driven by oil prices, displays sharper movements than the other sources of economic fluctuations considered but appears well synchronized with NBER recession dates with some additional downturns around the time of the downturn in stock markets in 1997 and the EA debt crisis of 2013.

3.2 Panel VARs, VARs, and Local Projections

To exploit the cross-sectional dimension that links the economic fortunes of the three economies in our study, we estimate the dynamic relationship between the factors in a panel setting. This gives rise to the following panel factor (or factor-augmented) vector autoregression model (Panel VAR) written as

$$\mathbf{P}_{ijt} = \mathbf{\Omega}_{ijt}(L)\mathbf{P}_{ij(t-1)} + \mathbf{\Psi}_{ijt}(L)\mathbf{\Gamma}_{ijt} + \varepsilon_{ijt} \quad (2)$$

where \mathbf{P}_{ijt} represents the estimated factors (i.e., real, monetary, financial, demographic, fiscal, and global). ε is residual process and the lag length is selected according to Schwarz's information criterion which always selects one lag for all the specifications considered. We also allow for the possibility that there are exogenous variables defined by the vector $\mathbf{\Gamma}$. This is done to investigate the sensitivity according to whether or not the demographic and global factors are treated endogenously. The details are left to the appendix but the dynamic responses of the remaining factors do not appear to be greatly impacted by these model variants. Also, given the existing theoretical literature, it would appear more desirable to treat these two factors as endogenous. The panel VARs are estimated via GMM instrumented using one or two lags of the endogenous variables chosen by applying the Schwartz Information Criterion (also see Holz-Eakin, et. al., 1988; Abrigo and Love, 2005). Panel-specific fixed effects are removed via a Helmert transformation to reduce dimensionality.²⁶

²⁵ Readers will have noticed that the US data reveal a trend during parts of the sample considered (viz., late 1990s to shortly before 2010). I re-estimated the models using the first difference in the US demographic factor with no impact on the conclusions. Hence, the factor enters the estimated models as shown in Figure 1.

²⁶ It is a transformation used in instrumental variable estimation even if the label itself is not always used. See, for example, Arellano and Bover (1995).

An issue that arises from specification (3) is the ordering of the variables. While ordering the real factor first is unlikely to be controversial, as almost all empirical work of this variety suggest that the real economic factor (R) should enter first in a recursive or Cholesky decomposition, the rest of the ordering is not always as clear cut with the possible exception of the monetary (M) factor which is traditionally seen as the among the ‘least’ endogenous factors since it is affected by all the other shocks while these same shocks only impact by M with a lag. This is also standard in almost all estimated macro-econometric models. The results that seem most intuitive and consistent with a priori theory are ones where the financial factor follows the real scores, followed by the monetary factor. Since the demographic factor is believed to influence economies slowly over time and the global factor is clearly outside the immediate influence of policy makers these two factors enter last.

Arguably, one might consider identifying more precisely the structural shocks either by imposing long-run or short-run restrictions, or even sign restrictions. Such extensions are feasible (e.g., see Canova and Ciccarelli (2013), and references therein) but create additional demands on the data with the net benefits unclear. For example, it is doubtful that the same sign or long-run restriction is valid for all four economies. Finally, estimated factors are time-varying which, in effect, implies that $\mathbf{\Omega}$ is also time-varying.²⁷ The same is true for the vector of exogenous variables, $\mathbf{\Gamma}$.

Specifications such as equation (3) are non-standard. Accordingly, I also consider a version of (3) where \mathbf{P} consists of observed data as detailed in Table 1.²⁸ Hence, a more conventional alternative specification, is written

$$\mathbf{P}_{jt}^* = \mathbf{\Omega}_j(L)\mathbf{P}_{jt-1}^* + \mathbf{\Psi}_j(L)\mathbf{\Gamma}_{jt} + \boldsymbol{\xi}_{jt} \quad (3)$$

All terms were defined previously. Note that $\mathbf{\Omega}$ and $\mathbf{\Psi}$ are time invariant. I did not estimate a time-varying version of equation (3).

²⁷ See n. 22 for the details. For completeness, we also estimate versions of (3) that are time-invariant. We also could have explored the impact of selected shocks at time t but this is even more demanding of the data.

²⁸ A consequence of the GFC is the limited usefulness of an observed policy rate as an indicator of the stance of monetary policy. Indeed, this is an additional motivation for estimating monetary policy using the factor model approach (also see Lombardi and Zhu, 2018) to estimate the stance of monetary policy. Nevertheless, following the practice adopted by many in the literature, published shadow policy rates are used for the US, the Eurozone and Japan, once the zero lower bound is reached. See the notes to Table 1 and the e-component of this study.

I now turn to the data and estimation results. The balanced sample is 1999Q1-2019Q4 before lags or data transformations. The estimates are based on 3 cross-sections yielding 246 observations. The main panel VAR results are shown in Figures 2 and 3 and Table 3. Figure 2 presents IRFs for the case based on time-varying factor model estimates (see equation (2) and n. 22). The impulse response functions (IRF) should be interpreted as follows. The first variable listed in the impulse response (IRF) figures represents the impulse (i.e., the source of the shock) while the second variable name indicates which factor or variable responds. For example, in Figure 2, the real: financial case (last row, next to last column) shows the response of the financial factor to a one standard deviation shock in the real factor. Point estimates are shown as the black line while 68% (standard in Panel VAR estimation) appear as shaded areas.

Figure 2 displays 36 pairs of IRF and it is impractical to discuss all of them. Since the aim of the paper is to discuss the role that fiscal and demographic factors might play the discussion focuses primarily on rows two and four. Ageing (i.e., a rise the demographic factor) generates more global inflation, tighter monetary policy, a loosening of fiscal policy, looser financial conditions, and economic contraction. If Goodhart and Pradhan's (2020) view that the ongoing demographic reversal will lead to a return to inflation then the signs for the global and monetary factors support their hypothesis. The reduction in economic activity may be partly explained by a reduction in productivity among the other constituents of the real factor which also effectively proxies aggregate demand also seen as falling due to the fallout of an older population. The looser fiscal and financial positions may perhaps be due to the added burdens on the state to support an ageing population while the rising wealth associated with an ageing population may go hand in hand with the impact of the continued savings glut on financial conditions.

Turning to the impact of a fiscal shock I find that a fiscal expansion (a rise in the fiscal factor; see Figure 1) is inflationary in the sense that it positively impacts the global factor. This then translates into a tighter monetary policy while the demographic factor declines which is associated with greater inflationary pressure. However, neither the financial not the real factors are significantly affected by a fiscal shock. A few additional results are worth highlighting. A positive real shock (viz., a rise in aggregate demand) tightens monetary policy, fiscal policy and financial conditions. These results appear consistent with most priors that try to explain links between these variables.

In Figure 3, I repeat the Panel VAR exercise shown in Figure 2. However, the variables are observed magnitudes. The VAR consists of the G3 cross-section based on the following vector of variables (also see Table 1), namely, real GDP growth, CPI inflation, the long-short government bond yield spread, the age dependency ratio²⁹, fiscal policy as proxied by the (gross) debt to GDP ratio, and a series that splices observed and, as UMP are introduced, shadow central bank policy rates (*monpol*). Although broadly similar in spirit to the Panel VAR using factors, resorting to observables leads to a substantively different model. Hence, the results in Figure 3 can be interpreted as a kind of robustness test. As with Figure 2, I focus on the fiscal (second row) and demographic variable (dependency; row three).

An expansionary fiscal policy is found to tighten monetary policy, is inflationary (5th column), as well as being expansionary. The latter result contradicts the one in Figure 2 though it is worth noting that the significant impact disappears after just five quarters. A positive fiscal shock (i.e., a stimulus) raises the age dependency ratio although the size the response is economically very small. Finally, a shock to the debt to GDP ratio leads to a narrowing the term spread (anywhere from 2 or 5 to years). Perhaps such a shock raises short-term rates more than long-term rates but the model cannot provide any clues. Turning to the demographic factor I find that greater age dependency loosens monetary policy though only for one quarter. The same shock is also found to loosen fiscal policy while, other than for the own shock, the remaining variables, that is, inflation, real GDP growth and the term spread, are not significantly different from zero. Finally, a few other results that are mostly intuitive are worth reporting. For example, a shock to age dependency reduces inflation, contrary to the Goodhart and Pradhan (2020) prediction though the IRFs are economically very small. A positive growth shock tightens monetary policy, as well as fiscal policy, reduces the age dependence ratio, and is inflationary. With only a few exceptions then, the Panel VARs based on observables broadly parallel the results based on the factor model equivalent.

A few additional insights about the Panel VARs can be obtained from the results shown in Table 3 where, to conserve space, select forecast error variance decompositions (FEVD) are shown.³⁰ Selected results are shown for both the time-varying factor model case (top portion) as

²⁹ A reminder that the raw data for this series is non-stationary. Hence, the series enter the model in first difference form.

³⁰ Only selected results are shown though these provide the principal details one would want to obtain from the variance decompositions. Detailed estimates are in a separate appendix.

well as the case where observables are used (bottom portion). The peak percent of variation explained for each factor or variable is displayed, as well as the lag where the peak occurs. Clearly, FEVD are lower on either side of the peak.³¹

Table 3 reveals that the fiscal factor explains almost 20% of the variation in the real factor after 10 quarters. This is considerably greater than the FEVD for the monetary factor while both the financial and global factors can also, at times, explain around 20% of variation in the real factor. The fiscal factor also explains almost 10% of the variation of the financial factor after ten quarters but otherwise contributes little explanatory power to the remaining factors. Interestingly, the demographic factor can explain 17.2% of the monetary factor after ten quarters. Otherwise, the contribution of the demographic factor is small.

The FEVD reveal at least two other interesting insights for a model that incorporates both demographic and fiscal factors when these are estimated using observable magnitudes. Turning first to the demographic factor this explains almost half of the variation in real GDP growth after eight quarters and a non-trivial fraction, close to 8%, of the variation in the global factor. In the case of the fiscal proxy, the debt to GDP ratio, this can explain over 80% of the variation in real GDP growth after 3 quarters as well as a significant proportion of the variation in the demographic factor after one quarter (35.7%). Monetary policy explains one quarter of the variation in economic growth after two quarters but otherwise contributes relatively little explanatory power to the remaining variables. The same story applies to inflation, especially the relatively small contribution to real GDP growth. Of course, it should be noted that inflation (also see Table 2) is relatively low in all three economies during the sample considered.

Given the challenges associated with estimating Panel VARs another approach is to estimate VARs for the individual economies and treat, as exogenous, the potential impact of the same sources of shocks from the remaining two economies. I retain the same recursive ordering (see the note to Figure 4 for the details) but provide alongside estimates of the relevant IRFs for standard VARs focusing, as before, mainly on demographic and fiscal determinants, estimates using local projections (LP; Jordà, 2005).³² The confidence intervals shown are, as in the case of the Panel VARs, 68% around the estimates via LP. I discuss only the case where observables are

³¹ A maximum of 10 lags are estimated and while there are several instances where the peak is reached at lag 10 the relevant FEVD decline thereafter (not shown).

³² Omitted details, estimates, and IRFs are available on request. With over 100 separate IRFs it is impractical to display and discuss all of them. Some are available in a separate appendix.

used not only to conserve space but also because most of the literature relies on this format. IRFs for Japan are in Figure 4, while EA estimates are displayed in Figure 5. Finally, US estimates are provided in Figure 6.

Beginning with the response to an ageing shock (AGEDEPRAT) the responses across the three economies are often comparable though not always exactly the same. For example, a rise in age dependency is generally not inflationary although there is some evidence of a disinflationary impact for the EA (CPIALLG). Similarly, ageing reduces the debt to GDP ratio (GROSSDEBTGDP) while the impact for the US is positive.³³ The term spread (SPREAD) falls in response to this shock in Japan and the EA whereas the accumulated impact on the US is more neutral. Ageing depresses economic activity (RGDPG) in Japan, appears to be expansionary for the EA with the US somewhere in the middle. Interestingly, ageing generates a reduction in global inflation (GLOBAL_INFLATIONG), and a loosening of monetary policy (SHADOWRATEG) in all three economies, although the total impact is smallest for the US.

Next, I turn to the impact from a debt shock which proxies fiscal policy. Japan stands out with an expansion in GDP growth while a debt shock depresses economic activity in the other two economies. Notice that the term spread rises with an expansion of debt and so the combination of an ageing population and expansionary fiscal policy may have little overall impact on the term spread. Global inflation stands to decline even further if both ageing and debt shocks operate simultaneously. Global inflation declines when there is a positive debt shocks though the accumulated impact appears smallest for the EA. The impact on inflation is mixed but is generally negative, on balance, except for the EA. Arguably more important, debt loosens monetary policy in all three economies. Hence, at least two sources of pressure that lead to more accommodative monetary policy have been identified.

Finally, it is worth briefly commenting on the impact of a domestic inflation shock on a few key variables. Inflation depresses economic activity in all three economies, although the accumulated impact appears small for the EA and the US. Hence, if there is a trade-off between these two, it is somewhat weak over the three decades covered by the data. That said, a global inflation shock negatively impacts real GDP growth in all three economies. There is some support

³³ Data limitations mean that the US time series proxying fiscal effects is slightly different than for Japan and the EA and so it is possible that this is a source for the differences in the results. The same applies to the term spread (see below).

then for those who support the view about the importance of global inflation pressures on domestic economies. Finally, consistent with standard thinking on the subject, a positive monetary policy shock, that is, a tightening of monetary policy, depresses real GDP growth in all three economies.

Overall, the individual country results parallel ones obtained from the panel VARs estimated using observable data. Nevertheless, it can also be said that the results shown in Figures 4 through 6 provide some insights into idiosyncratic elements in the response to demographic and debt shocks. Equally important, the results so far should dispel the view that Japan's macroeconomic experience differs fundamentally from the one in the EA and the US. While there are certainly some differences, there are also several results that are similar across the three economies.

3.3 A Glimpse Into the COVID-19 Era

It goes without saying that the economic shock from the pandemic that began in 2020 is raising many questions about the usefulness of models estimated with pre-COVID era data. In statistical terms, one would not be entirely incorrect to ask whether additional data would require some allowance for a structural break due to the large economic disruption due to the fallout from the COVID-19 crisis. Nevertheless, policy makers and other observers will require some idea about what might have been predicted by models used in this study. Given that the impact of the pandemic is likely heterogeneous, given the known economic impact to date, a simple experiment is conducted based on the models reported in Figures 4 through 6. The VARs are used to generate forecasts for inflation and real GDP growth in 2020. The results are displayed in Figure 7. Inflation forecasts for the three economies are shown in the left-hand column while real GDP growth forecasts are plotted in the right-hand side column. Also shown are 95% confidence intervals around the forecasts as well as outturns in inflation and real GDP growth in all three economies.

The precipitous drop in inflation during 2020 is clearly observed though it appears most visible for the EA. Forecasts based on history before COVID clearly over-estimate inflation in 2020. Forecasts are fairly modest for the US. Nevertheless, actual inflation performance is within the confidence intervals shown for all three economies. This outcome may perhaps be explained by the addition of demographic and fiscal elements to an otherwise fairly standard macro model.³⁴

³⁴ Some experimentation with simpler models that omit fiscal and demographic variables (not shown) appear consistent with such an interpretation.

The story for real GDP growth is entirely different. Observed growth rates easily exceed the confidence intervals in all three economies for most of 2020. While forecasts suggest a downturn was in the offing as seen from the dip in growth forecasts or at least constant growth for the US, the models are clearly unable to forecast outturns like the one shown in Figure 7.

Conclusions

Even before the events of the last two years questions were being asked about macroeconomic models that ignored or downplayed the importance of demographic and fiscal factors. Moreover, narratives that continued to treat Japan's experience as akin to one that had little resemblance to outcomes in other large economies persisted. This paper revisits these issues by examining how demographic and fiscal shocks play out in Japan, the Euro Area and the US over the past three decades. A series of models are estimated which utilize three different methodologies to investigate the interaction of standard macroeconomic and financial factors with the addition of demographic and fiscal variables. Both panel and economy-specific econometric techniques are applied. Moreover, estimates are generated that utilize observed time series as well as variables generated by combining many time series via factor models.

Although a large number of results are generated a few salient ones emerge. For example, despite the longheld view of some observers that Japan is different many of the shocks examined have comparable impact across all three economies considered. This is especially the case for monetary policy and the response of global inflation to ageing and demographic shocks. Similarly, the response of real economic activity to several of the shocks considered is also comparable. Finally, and perhaps most notably, demographic and fiscal factors have significant real economic impact although the size of the response does differ across the three economies examined.

One concern with empirical evidence of the kind shown here is that the models are quite demanding of the available data and it is difficult to build a comparable data set that goes back much before 1990. In addition, the interactions between a large number of variables are potentially more complex than is allowed for by the methodologies employed. Macroeconomists have a better understanding of how to measure the stance of monetary policy than, for example, how demographic forces should be quantified. Clearly, there are several avenues available to pursue research using models of the kind specified in this study once we have longer time series to work with. Finally, the larger unknown is how estimates presented here will fare once the pandemic has

passed and we begin to observe how economies adjust to changed circumstances. Of course, ongoing global geopolitical events may also pose new modelling challenges. As shown in this study, the models used here did not do a bad job forecasting inflation in 2020 but were far less successful in forecasting real GDP growth. All of these questions and extensions are left for future research.

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Tables and Figures

Table 1 – Defining the Factor Groupings and Observables

REAL	MONETARY	FINANCIAL	FISCAL	DEMOGRAPHIC	GLOBAL
Inflation	Policy rates	Spreads	Borrowing	Crude birth rate	Inflation
Output	UMP indicator	Bond yields	Debt (Gross/Net)	Life expectancy	Output
Forecasts	Money growth	Asset prices	Deficit (Structural)	Age dependency ratio	Transport costs
Labor market	Forex reserves	CAPE	Government expenditures	Personal savings rate	Commodity prices
External indicators	CB Balance sheet	Credit indicators			China
Savings	Regime indicators	Debt service costs			VIX
Productivity	<i>Idiosyncratic</i>	Loan officer surveys			
Sentiment		<i>Idiosyncratic</i>			
Neutral real interest rate					
<i>Idiosyncratic</i>					
	Observables				
Real GDP growth	Policy rates	Spread	Gross Debt/GDP	Age Dependency ratio	Crude Oil inflation

Note: Details of the time series used to proxy the contents of the factors are relegated to a separately available appendix. *Idiosyncratic* refers to times series available specific to the economy in question. Examples are provided in the text.

Table 2 – Summary Statistics: Observables

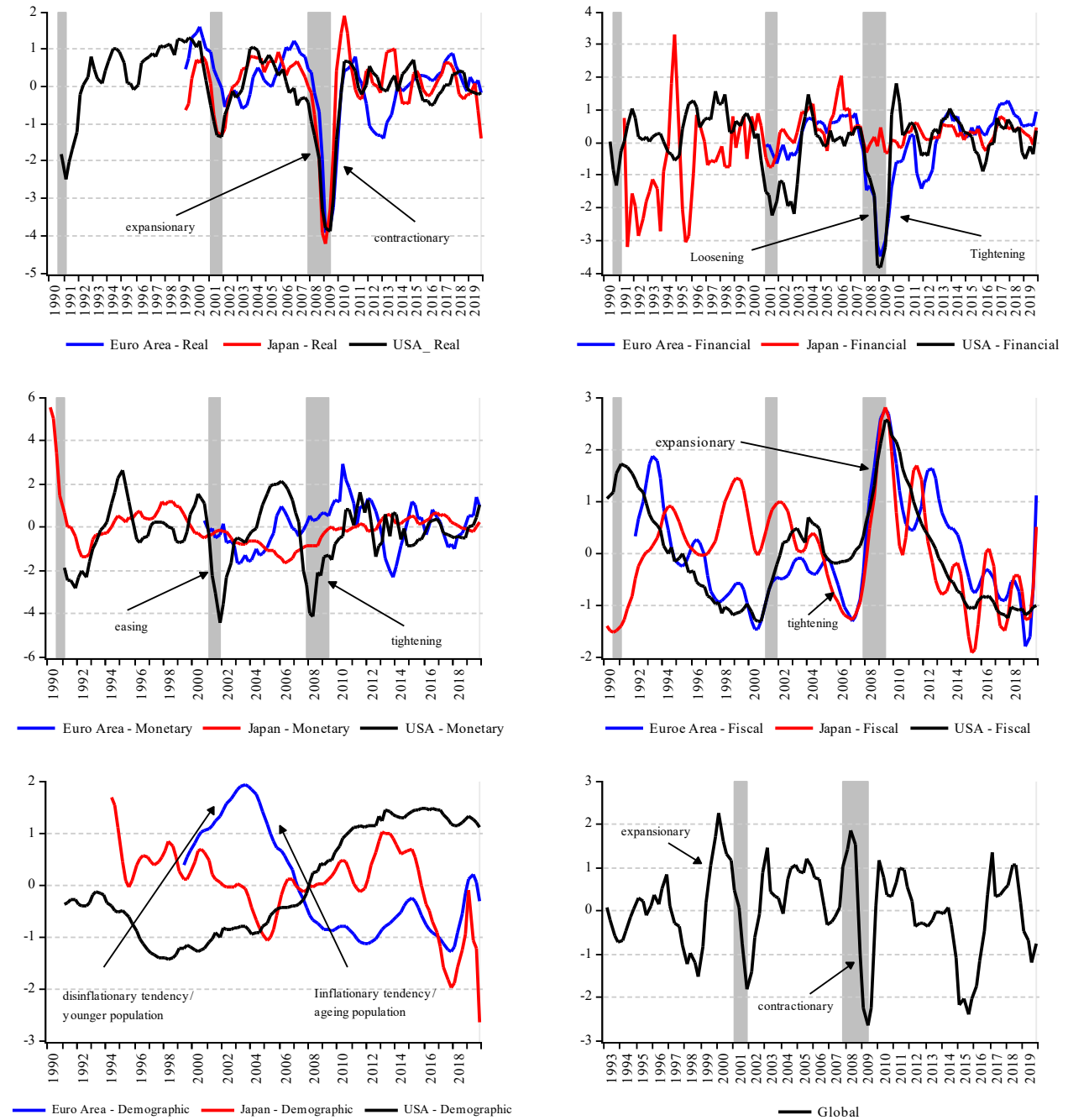
Economy	Statistic	GDP Growth	Inflation	Spread	Demographic	Fiscal Policy	Monetary Policy
		1999Q1-2019Q4					
Euro Area	Mean	1.44	1.69	0.84	30.47	81.74	0.62
	S.D.	1.85	0.90	0.87	2.87	10.51	2.41
	Max	4.41	3.87	2.34	34.88	97.14	4.85
	Min	-5.82	-0.33	-1.30	24.96	65.86	-4.32
		1994Q4-2019Q4					
Japan	Mean	0.83	0.17	1.05	32.72	179.19	-0.82
	S.D.	2.15	0.99	0.65	8.28	47.03	1.10
	Max	5.26	3.54	2.87	47.50	241.46	2.14
	Min	-9.27	-2.24	0.04	20.28	90.12	-3.56
		1992Q1-2019Q4					
United States	Mean	2.43	2.18	1.04	20.06	18.76	1.23
	S.D.	1.64	1.14	0.76	1.93	1.08	2.12
	Max	5.11	4.83	2.71	25.15	21.42	4.70
	Min	-4.08	-1.39	-0.64	18.42	17.42	-2.18
		1992Q1-2019Q4					
Global	Mean		4.41				
	S.D.		2.41				
	Max		10.70				
	Min		1.28				
Global	Mean		109.77				
	S.D.		64.73				
	Max		241.36				
	Min		27.32				

Table 3 – Select Forecast Error Variance Decompositions: Selected Estimates

<i>Time-Varying Factors PVAR</i>						
Variable	Real	Financial	Fiscal	Monetary	Demographic	Global
Real	99.1 (1)	12.8 (10)	.20 (10)	1.7 (10)	6.9(10)	.8(10)
Financial	18.3(1)	84.9(2)	.1(6)	6.7(10)	8.7(10)	3.8(10)
Fiscal	18.0(10)	9.4(10)	85.6(1)	.3(5)	3.4(10)	5.4(10)
Monetary	1.5(1)	14.9(10)	11.1(10)	93.2(1)	2.0(9)	.3(10)
Demographic	1.4(10)	.4(1)	6.0(1)	17.2(10)	90.1(1)	.9(8)
Global	22.9(5)	9.8(9)	6.0(8)	1.5(10)	37.9(10)	77.8(1)
<i>Observables PVAR</i>						
GDP Growth	92.3(1)	1.4(8)	10.1(5)	.2(7)	25.9(5)	9.9(7)
Inflation	15.2(4)	94.4(1)	2.2(9)	.2(10)	9.8(9)	1.5(10)
Spread	9.6(6)	.2(1)	98.5(1)	.02(10)	2.5(10)	2.4(10)
Age Dependency	45.4(8)	4.4(6)	12.1(4)	78.7(1)	11.7(4)	7.6(6)
Gross Debt/GDP	82.7(3)	1.2(9)	17.4(8)	.4(1)	35.7(1)	7.2(1)
Monetary Policy	25.2(2)	8.0(10)	4.3(10)	.5(1)	7.8(7)	72.0(1)

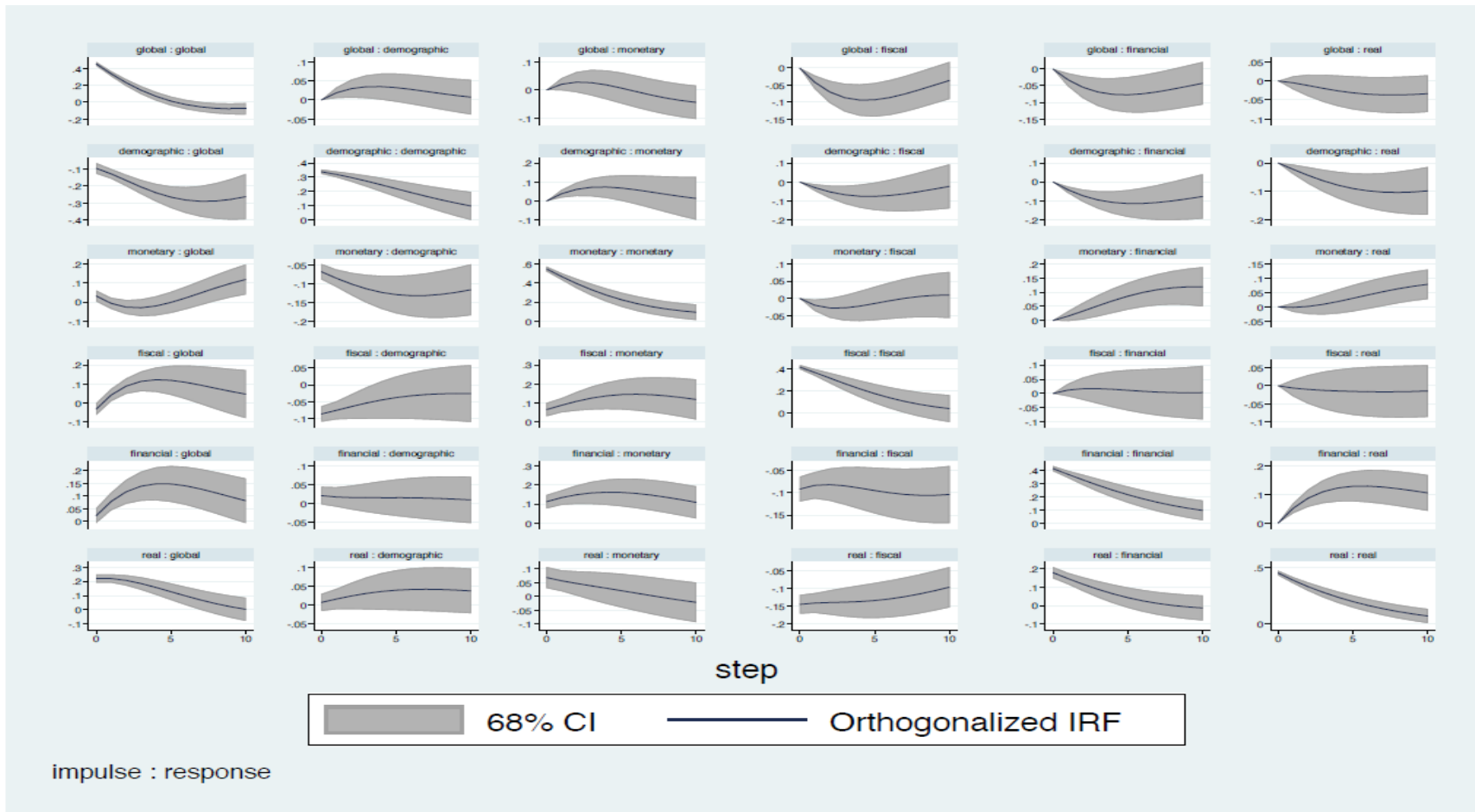
Note: Forecast error decompositions are shown in percent. The lag at which the FEVD peak (up to a maximum of 10 lags) is given in parenthesis. See Table 1 for the series used and the text for additional details. Own variable FEVD in bold.

Figure 1 – Factor Model Estimates of Economic Conditions



Note: Shown are normalized factor scores based on the underlying observables. Estimates are based on the variable classifications shown in Table 1. Estimates are obtained using the Bai-Ng methodology (average of test criteria) via maximum likelihood with the series time demeaned. For each economy a balanced sample is used. The number of factors are obtained using the Ahn-Horenstein method.

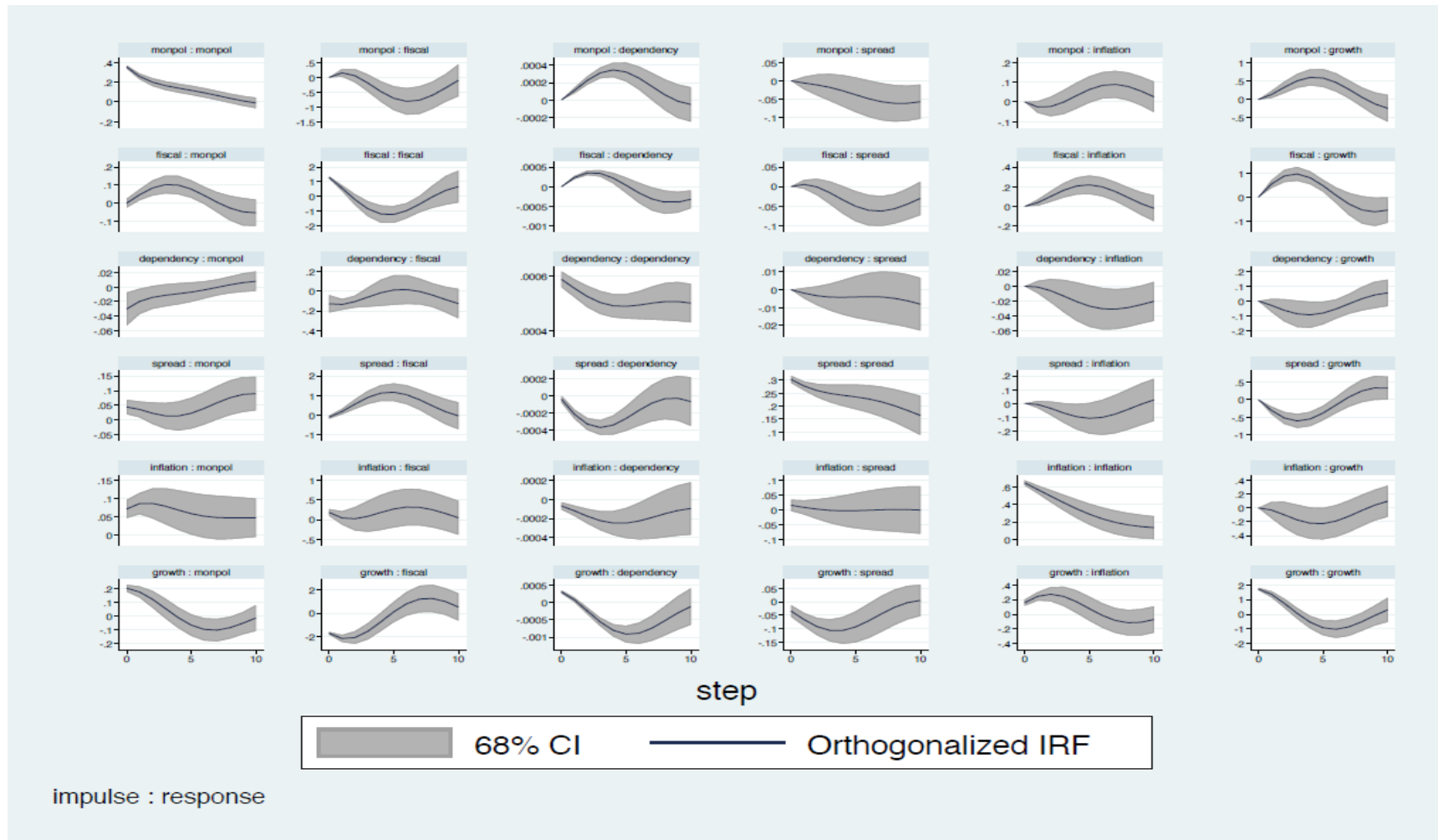
Figure 2 – Impulse Responses from a Panel Vector Autoregression Using Time-Varying Factor Scores



Note: The time-varying factor scores are estimated using the method described in Figure 1 for rolling overlapping samples as described in the main body of the text. The ordering of the panel VAR is given by the first set of factors in the IRF while the source of the shock is given by the second. For example, **real:global** shows the IRF for the response of the global factor to a 1% shock in the real factor. The Cholesky decomposition is ordered as: real, financial, fiscal, monetary, demographic, and global. Additional estimation details can

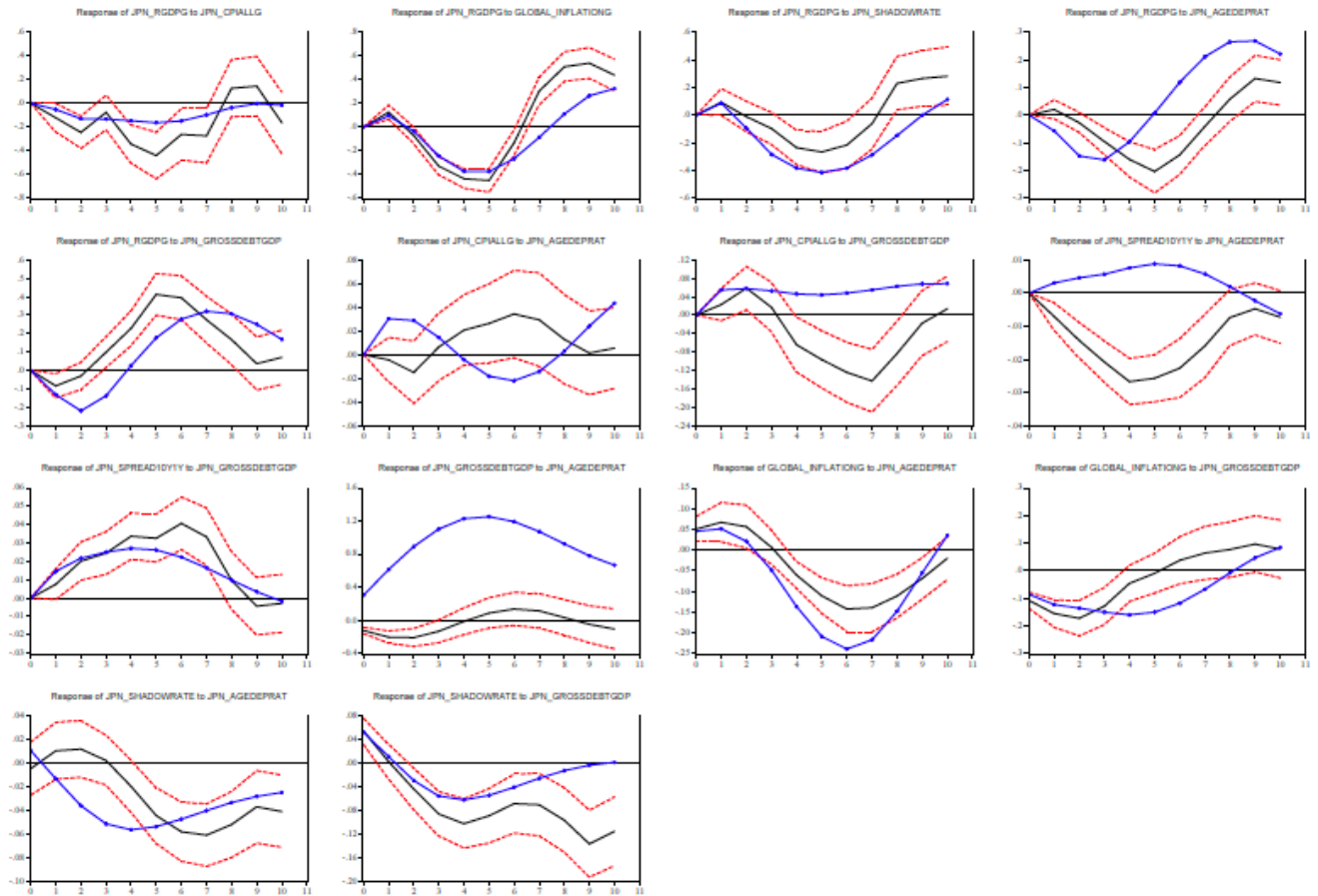
be found in the main body of the text. A balanced sample of 1999Q3-2019Q4 (after differencing and lags). Lags selected according to the SIC criterion yielding 1 lag. CI are the confidence intervals (68%).

Figure 3 – Impulse Responses from a Panel Vector Autoregression Using Observable Time Series



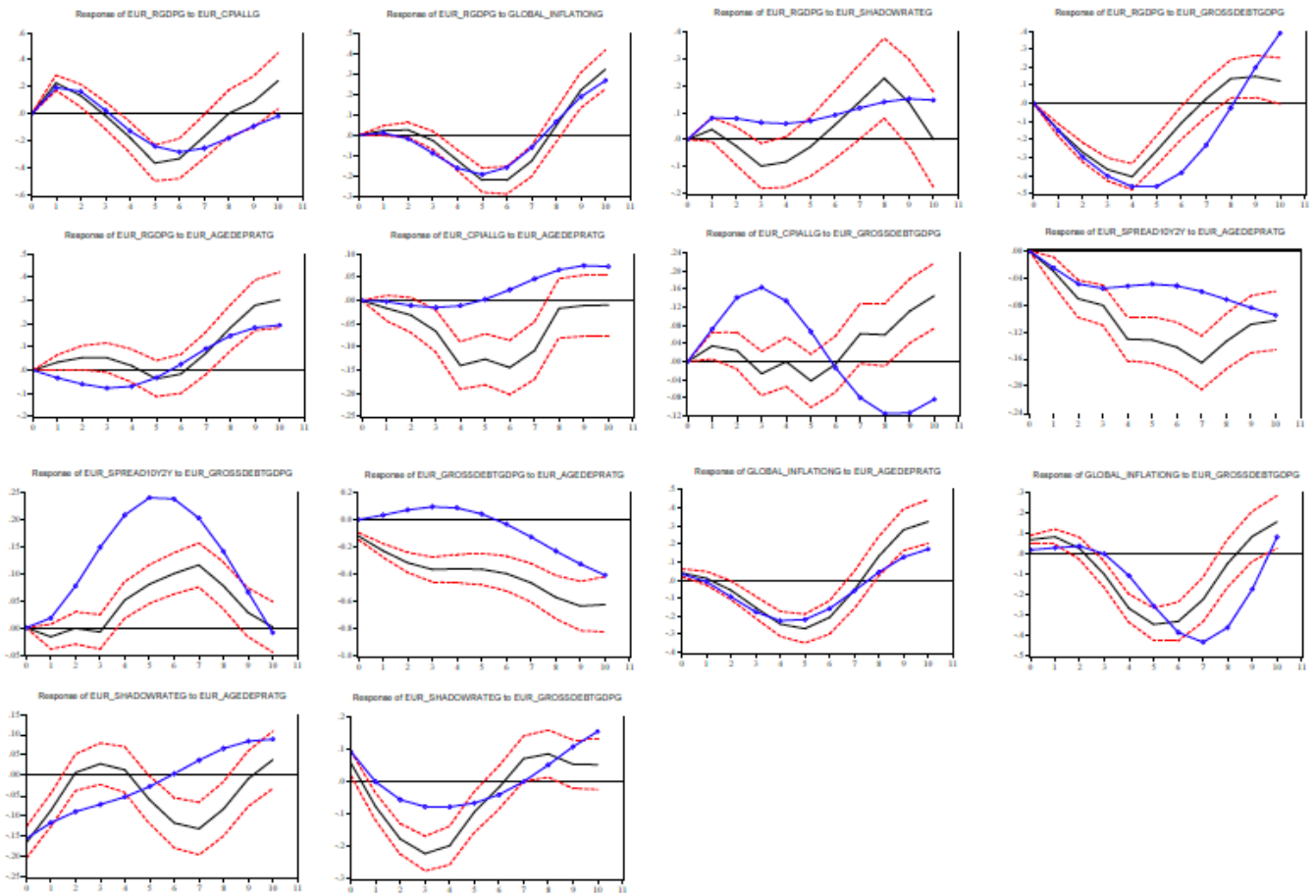
Note: See Table 1 for the list of observables and Figure 2 for the interpretation and ordering of the panel VAR.

Figure 4 – JAPAN: Selected Local Projections



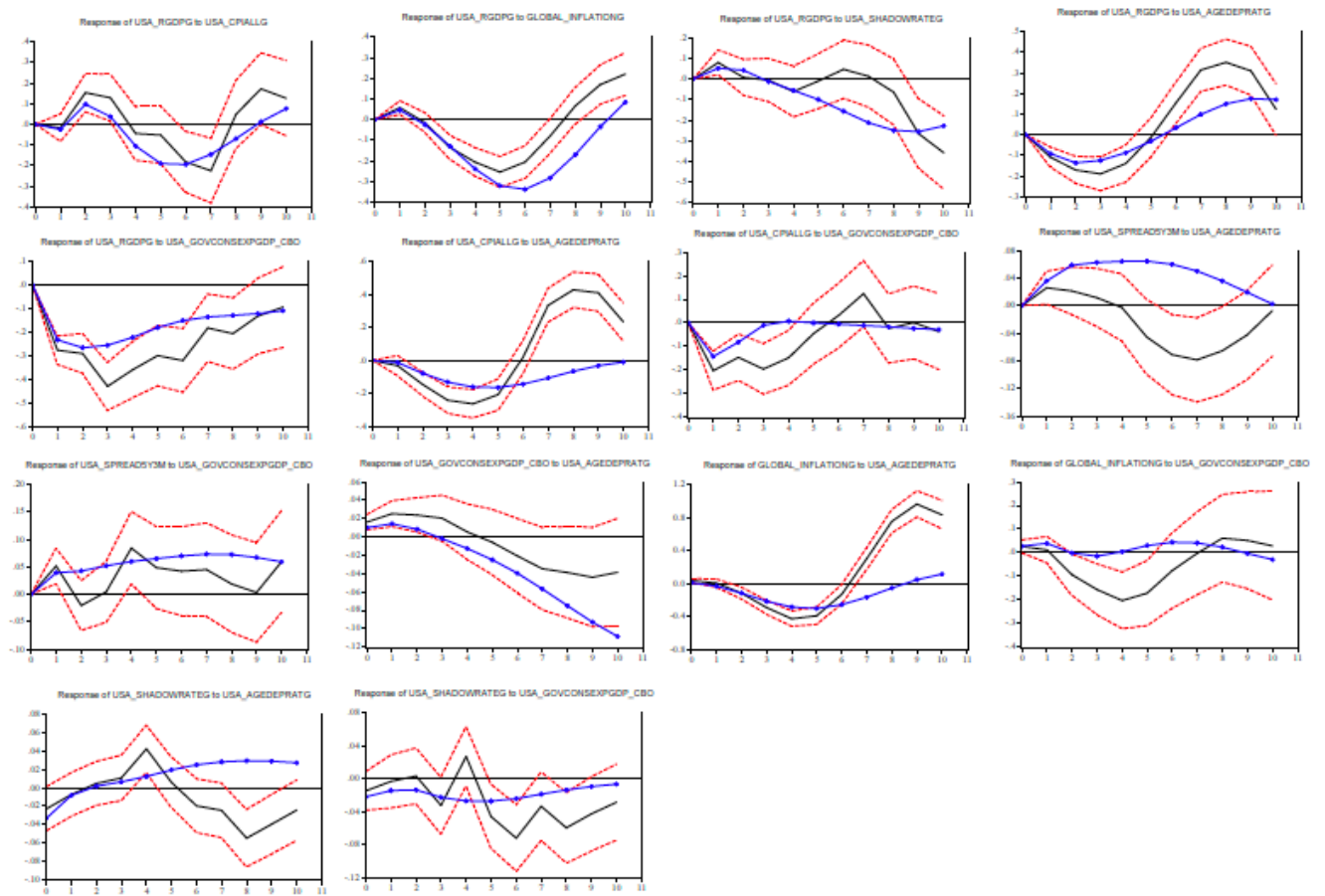
Note: 68% confidence intervals for the LP shown in red. The black line represent LP IRF estimates while the blue dotted line represents estimates from a conventional VAR. Data used are observables (see Table 1). JPN mean Japanese data; EUR represents Euro Area Data and USA are data for the United States. RGDPDG (real GDP growth), GROSSDEBTGDPG (gross debt to GDP ratio), AGEDEPRAT (age dependency ratio), CRUDEOILG (crude oil price inflation), SPREAD (long versus short government bond term spread), GLOBAL_INFLATIONG (world-wide inflation), and SHADOWRATEG (observed and shadow policy rate). The main body of the text explains how the variables enter the VAR. the sample is the same as for the panel VAR (see Figure 2). However, these VARs utilize only data for the individual economies.

Figure 5 – EURO AREA: Selected Local Projections



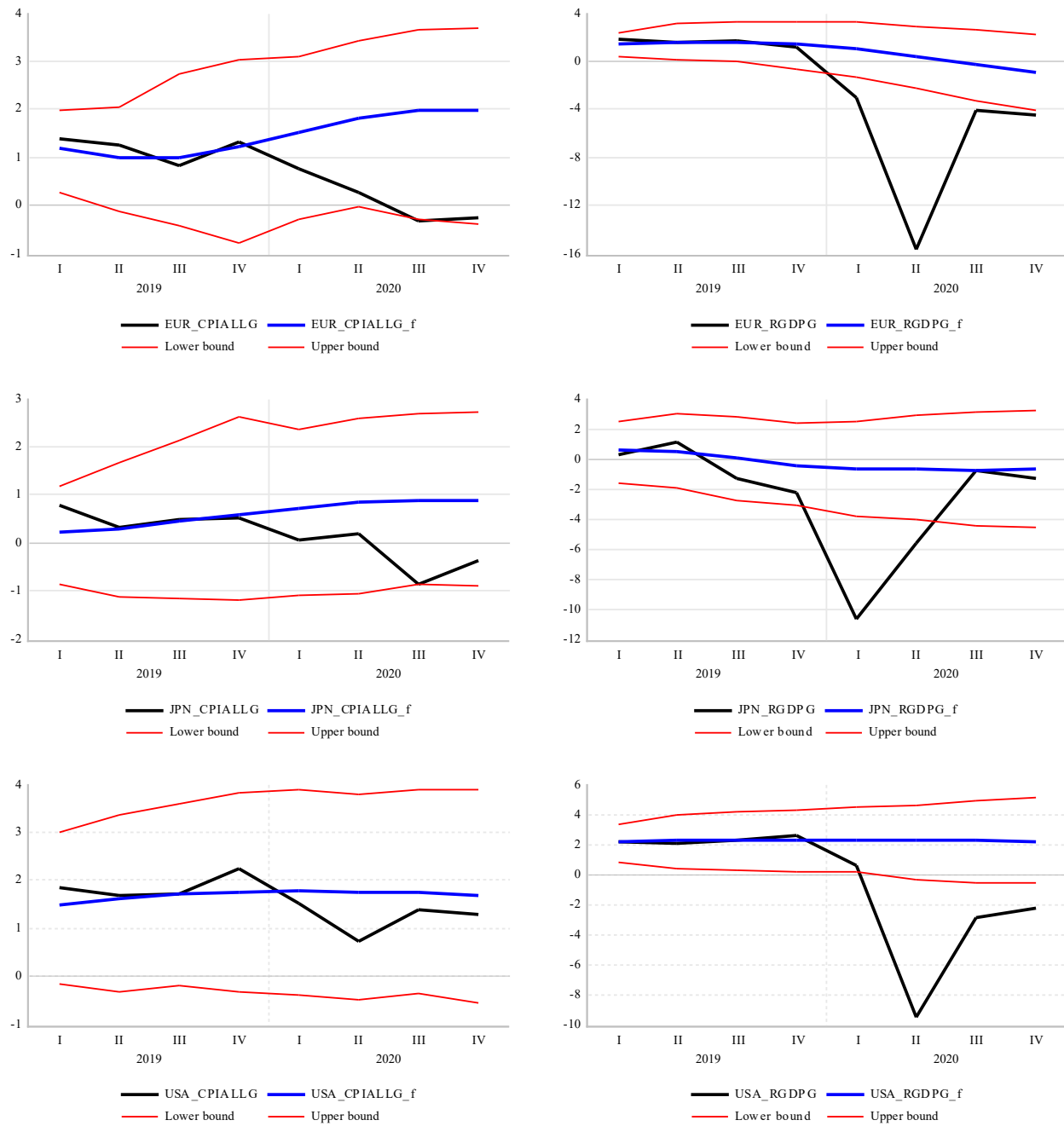
Note: See note to Figure 4.

Figure 6 – USA: Selected Local Projections



Note: See note to Figure 4A.

Figure 7 – Out of Sample Forecasts: The First Year of the COVID-19 Pandemic



Note: dynamic forecasts (i.e., one period ahead using previously forecasted values for lagged dependent variables). Observed inflation and real GDP growth (also see Figure 4 for mnemonics) in black, forecasts in blue (with _f extension), and 95% confidence intervals shown. Samples are the same as in Figure 4 (1999-2019) but forecasts for 2019 and 2020 only are shown.

Appendix

Data Sources

<i>Name</i>	<i>Main Link</i>
Bank for International Settlements (BIS)	https://www.bis.org/statistics/index.htm
Bank of Canada	https://www.bankofcanada.ca/publications/mpr/
International Monetary Fund	https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b (international financial statistics) https://www.imf.org/en/Publications/SPROLLs/world-economic-outlook-databases#sort=%40imfdate%20descending (World Economic Outlook) https://data.imf.org/?sk=471DDDF8-D8A7-499A-81BA-5B332C01F8B9 (Primary Commodity Price System)
World Bank Development Indicators	https://databank.worldbank.org/source/world-development-indicators
International Disasters Data Base	https://www.emdat.be/
Bank of Japan	https://www.boj.or.jp/en/statistics/boj/index.htm/
Federal Reserve Bank of St. Louis (FRED2)	https://fred.stlouisfed.org/
European Central Bank	https://sdw.ecb.europa.eu/
OECD	https://www.oecd-ilibrary.org/economics/data/main-economic-indicators_mei-data-en (Main Economic Indicators) https://stats.oecd.org/Index.aspx?DataSetCode=MEI_ARCHIVE (Revisions Analysis Dataset)
Siklos (2021)	Data on inflation expectations and real GDP growth have been compiled and updated from Siklos (2013, <i>Journal of International Economics</i> ; 2019, <i>Oxford Handbook on the Economics of Central Banking</i>)
Economic Policy Uncertainty	https://www.policyuncertainty.com/
Geopolitical Risk	https://www.matteoiacoviello.com/gpr.htm
Exchange Rate Regime Indicator	https://www.ilzetzki.com/irr-data
Wu-Xia shadow rate	https://www.atlantafed.org/cqer/research/wu-xia-shadow-federal-funds-rate
Krippner shadow rate	https://www.ljkmfa.com/
New York Federal Reserve (R*)	https://www.newyorkfed.org/research/policy/rstar
United Nations	https://unstats.un.org/unsd/demographic-social/
Robert Shiller's data base	http://www.econ.yale.edu/~shiller/data.htm
Structure of Economic News	http://www.structureofnews.com/
Refinitiv	https://www.refinitiv.com/en

Note: Most of the above links will allow access and free downloads (subject perhaps to registration). Refinitiv is one exception (used to obtain Baltic Dry Index data and update some Consensus forecast data).

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