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Bringing Credibility Back to Macroeconomic Policy Frameworks

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For most of the past decade, unconventional monetary policies (UMPs) have affected the wealth of savers, renters and younger generations. These policies, which enlarge central bank balance sheets – supporting credit expansion in the economy – but have no reliable mechanism for reversal, raise the simultaneous risk of higher inflation and deflation. In this paper, we critique UMPs by drawing on extant literature and empirical data that elucidate the undesired economic effects they cultivate. In particular, we focus on the implications of UMPs on efficient portfolio holdings by proposing an intuitive ex-ante measure of dynamic efficiency loss that has applications for future research.

Keywords: financial markets, macroeconomic policy, quantitative easing, unconventional monetary policy.

1. Introduction

We begin by posing the question: *What is Money?* Paul Volcker, Chairman of the Federal Reserve (1979–1987), would categorise it as a reliable store of value that is exchangeable for goods and services. This statement of fundamental principle, however, belies the critical and ongoing duty owed by policy-makers to protect the integrity of the money supply. Instead, central bankers can be anaesthetised by governing authorities intent on promoting flows of money under the guise of full employment or fiscal plans. Volker's standard (Volcker & Harper, 2018), however, remains clear:

> "It is a governmental responsibility to maintain the value of the currency they issue. And when they fail to do that, it is something that undermines an essential trust in government."

Volker's urging was that governments need to maintain the robustness of their policy frameworks by enacting policies that are subject to consistent and sustainable benchmarks. Translating this into guidance for policy-makers suggests, above all, that policy decisions must engender allocative efficiency and avoid distorting portfolio allocation decisions.

In this paper, we argue that the recent onslaught of sizeable monetary stimuli has implications for multiple facets of the financial ecosystem that can be counterproductive to allocative efficiency. By

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drawing on relevant literature and empirical data, we critique unconventional monetary policies (UMPs) to bring attention to their undesired effects, especially in the context of financial markets. In particular, we expand on the seminal work of Gibbons *et al.* (1989) and propose a dynamic ex-ante measure of the efficiency loss caused by these policies, constituting this paper's theoretical contribution. The proposed framework shows that UMPs can truncate the efficient frontier through a reduction in risk-free rates, resulting in lower excess returns expressible as a smaller Sharpe ratio. We suggest the framework can be applied to future research that seeks to quantify the effects of UMPs on allocative efficiency.

The critiques we make against UMPs focus on debt levels and asset prices, two timely indicators that provide informative insight on the effects of sizeable monetary stimulus. We find that while Volcker's time as Federal Reserve Chairman did promote the framing of macroeconomic policies around medium-term targets, namely the introduction of inflation targeting to guide monetary policy (Svensson, 2000) and balanced budgets for fiscal policy (Kopits, 2001), the more recent experience suggests a deviation from this practice. Concretely, since the late 1990s, the stance of monetary policy has been excessively expansionary. The onset of the GFC and the more recent COVID-19 pandemic has seen global macroeconomic policy settings become unhinged from sustainable foundations, promoting a transition away from the price-setting objectives of traditional monetary policy to a regime of actively managing the balance sheet to expand the money supply[1].

The fundamental UMP that we critique is quantitative easing (QE), a policy that seeks to promote declines in interest rates beyond the limitations of the zero lower bound through the purchase of financial securities (Bernanke *et al.*, 2004). While there is some evidence that QE promotes real economic growth (Gagnon, 2016), its effects are found to be modest in magnitude when compared to the scale of intervention (Kandrac, 2018; Ferreira-Lopes *et al.*, 2022). Furthermore, it is important to note that the adoption of unconventional measures as permanent components of the central bank toolkit contradicts the original emergency status of these policies (see for instance Bernanke, 2020) and, in effect, renders a sustained impact on allocative efficiency for as long as they are utilised.

In contrast, the effects of QE on financial markets are more transparent given the copious amount of research that has identified its possible channels of transmission. The channels through which QE affects financial markets have enabled the identification of signalling, liquidity and portfolio rebalancing effects as key transmission mechanisms that permit an easing of financial conditions (Krishnamurthy & Vissing-Jorgensen, 2011; Janus, 2016). It is through these channels, however, that we argue QE can inflict a negative effect on allocative efficiency.

Specifically, while easing financial conditions in the face of an adverse exogenous shock is indeed important, our position is that the benefits of QE must be weighed against its less-desirable effects. For instance, Gagnon *et al.* (2018) find that QE can promote increased volatility spillovers across multiple asset classes, promoting "yield-seeking" behaviour that can undermine financial stability. This notion of yield-seeking behaviour is particularly problematic, as it implies investors seek out riskier securities to sustain their required rates of return, distorting risk–return dynamics. Huston and Spencer (2018) provide further evidence to this effect, revealing that QE has promoted significant asset price growth that can add to the risk of future economic shocks.

In all, this paper contributes to the debate on QE by discussing the potentially negative effects that can result from sizeable monetary stimulus without sustainable benchmarks. The theoretical framework we propose is intuitive and provides a way forward for future studies to quantify the allocative efficiency loss due to macroeconomic policies. The paper proceeds as follows: Section 2 composes a series of critiques against UMPs. Section 3 focuses on the implications of UMPs on debt levels and asset prices. Section 4 briefly discusses the notion of optimality for monetary and fiscal policy. Section 5 introduces the theoretical framework that we suggest can assist in quantifying the impacts of UMPs on efficient portfolio holdings. Section 6 concludes.

[1] Historically, many central banks have manipulated the money supply. However, UMPs are unmatched in terms of the scale of intervention in financial markets.

2. Critique of Unconventional Monetary Policy

To begin our critique, we propose a simple initial test to examine macroeconomic policy settings since the GFC in the spirit of Mundell (2000). The "stable anchor test" examines the relative stability of major international currencies against the price of real resources.

2.1. Stable Anchor Test

We consider the United States Dollar (USD) for this exercise. Under a fiat currency system, the value of the USD should equate to unity and maintain parity with real resources throughout time, subject to the soundness of government policies. Indeed, the stability of the USD is evident during most of the Volcker era and well into the early 2000s. Since then, it has consistently depreciated relative to the price of gold. A similar trend is noticeable in other reserve currencies, suggesting a simultaneous erosion in the credibility of macro-policy settings since the onset of the GFC (Figure 1).

The depreciation in reserve currencies against gold has occurred in congruence with the significant growth in central bank balance sheets, which can potentially distort asset prices and portfolio allocation decisions. Researchers have long studied these potential effects. For instance, Chen *et al.* (2016) find that financially vulnerable economies, primarily those reliant on USD funding, may experience disproportionate impacts stemming from UMPs carried out by central banks. In this sense, changes in the stance of monetary policy can promote capital flows that can pose a risk to the financial stability of emerging markets (Hutchison & Noy, 2006). In a similar vein, Morgan (2011) finds evidence of

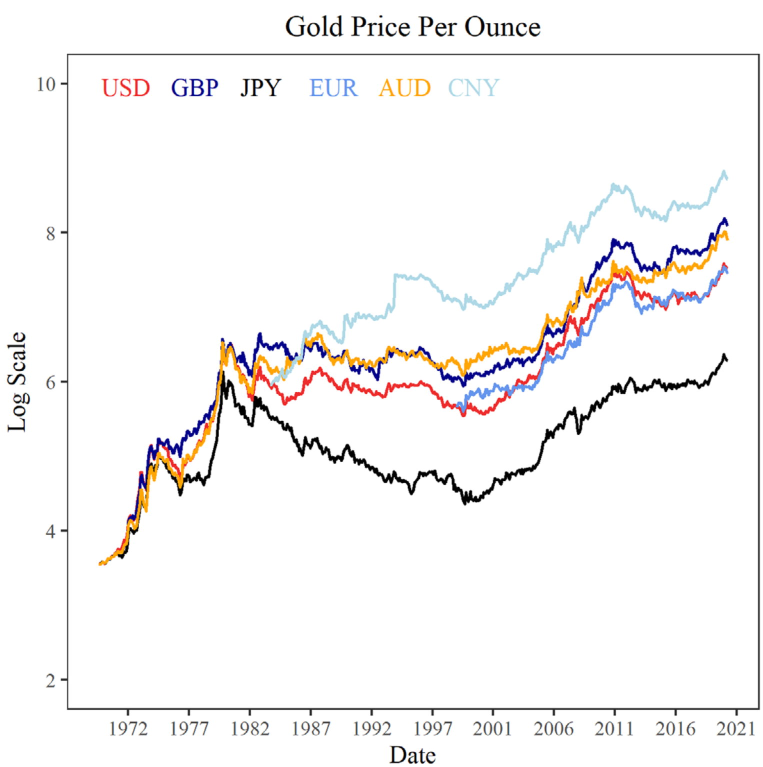

Figure 1. *Note. Gold Prices Are Expressed in Natural Logarithms and Are Rescaled for Comparison with the USD as the Base Currency. The Data Are Sourced from the Reserve Bank of Australia (2021b).*

significant capital flows from the United States into emerging Asian economies, suggesting that UMPs can contribute to the financial stability risks faced by developing economies.

2.2. Macro-Policy Conducted by Unconventional Means

The decline in credibility for macroeconomic policy frameworks traces back to the mid-2000s, aligning with the end of the Great Moderation. This period, characterised by robust growth and stability in the business cycles of developed nations, ended with the collapse of Lehmann Brothers in October 2007. To offset the effects of this immense economic disturbance, central banks made significant use of their policy headroom, quickly hitting the limits of conventional monetary policy.

In the face of a constraining zero lower bound, central banks implemented a series of unconventional measures. In 2008, the Federal Reserve (drawing on experiences by the Bank of Japan) committed to large-scale liquidity operations to support the U.S. banking system (Bernanke *et al.*, 2004). These liquidity operations, which initially had a net-zero effect on the supply of money, evolved into QE, promoting prodigious money supply growth. Defined as the large-scale purchase of assets funded by the creation of risk-free bank reserves, QE allowed the Federal Reserve to further ease funding costs and enhance the availability of credit (Joyce *et al.*, 2012). Initially, purchases were concentrated in housing credit markets to address elevated risk premia. Soon, however, purchases expanded into U.S. Treasuries, and since the initial implementation of QE, the Federal Reserve has increasingly amplified both the size and the depth of the assets purchased under the programme (Gagnon *et al.*, 2018).

Despite significant stimulus, most economies continued to experience lacklustre economic growth following the GFC. More recently, owing to the COVID-19 pandemic, the degree of stimulus has yet again expanded, increasing major central bank balance sheets to record-breaking levels (Figure 2). Likewise, the People's Bank of China (PBOC), which traditionally operates monetary policy differently from its peers, has also experienced modest balance sheet growth (Figure 3). When viewed in totality, central banks have expanded their balance sheets to levels that warrant caution in the case of a future normalisation, much like the "Taper Tantrum" of May 2013 that saw significant financial market volatility (Kawai, 2015).

In the context of Keynes[2], greater fiscal stimulus in the face of a liquidity trap may have been a more appropriate economic decision. Indeed, the body of literature is abundant with empirical studies that find fiscal policies may act as an effective tool to overcome liquidity traps (Cook & Devereux, 2011; Werning, 2011). While many federal treasuries followed this advice during the GFC, fiscal policies may have tightened prematurely. In contrast, central banks have continued utilising significant monetary stimulus throughout the past decade. As such, central bankers have been kept well at the forefront of macroeconomic management. Further, central banks have also been keen to foster the impression that they have economic conditions well under control as if they are still overseeing the same successful inflation targeting regime they operated during the Great Moderation. This continued and elevated position of power over policy decisions may have prevented more fundamental reforms and potentially acted as a detriment to global policy coordination.

2.3. Has Unconventional Monetary Policy Been Effective?

So why has not QE elevated economies into a position of strong and stable growth? To answer this question, it is worth discussing how these policies work and what they are intended to achieve. Firstly, these policies work through multiple transmission channels to enhance the availability of credit and promote lower interest rates beyond their natural bounds (Bernanke *et al.*, 2004; Gagnon, 2016). These transmission channels can be generalised into three categories: signalling, liquidity and portfolio rebalancing channels (Janus, 2016). While these channels are not the only mechanisms

[2]In Chapter 25 of the General Theory, Keynes criticised economists that believed interest rates would always equate to the flow of savings to investments. Keynes maintained that economic agents do not have to invest and can instead store their wealth.

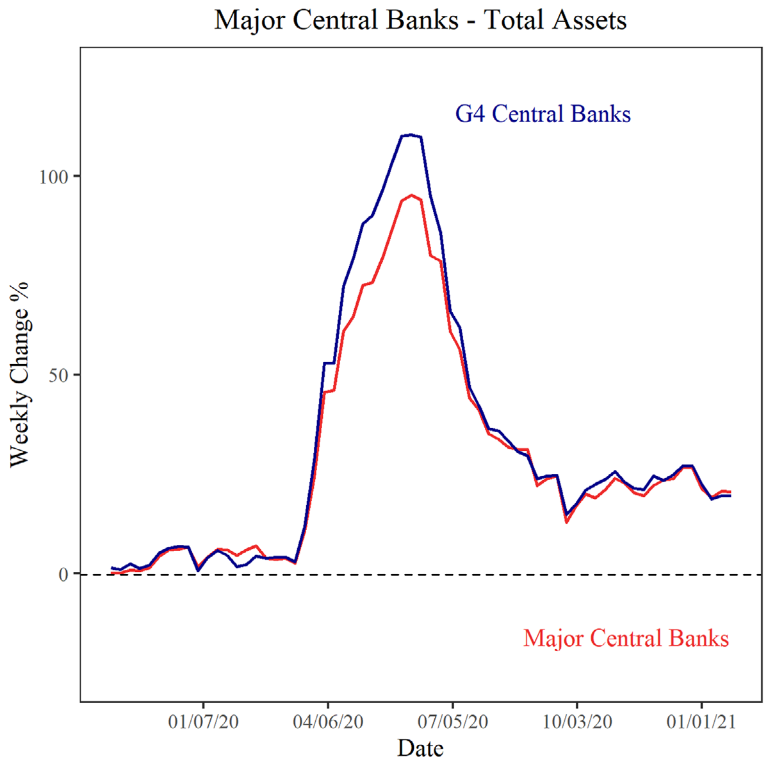

Figure 2. *Notes. These Charts Depict the Weekly Change in the Sum of Total Assets of Central Bank Balance Sheets Calculated in USD from November 2019 to January 2021. The G4 Central Banks Include the U.S. Federal Reserve, European Central Bank, Bank of England and Bank of Japan. The Majors Expand on the G4 and Include the People's Bank of China and the Swiss National Bank. The Data Are Sourced from each Respective Central bank's Official Website.*

that permit QE to affect financial markets given evidence of asset-specific channels (see Lucca & Wright, 2022), they do represent the majority of empirical findings.

Signalling refers to the guidance revealed to market participants by policy-makers that can promote changes in financial conditions *before* any policy has been officially enacted. For instance, QE announcements can be made before a central bank actively purchases assets, forcing market participants to make preliminary investment decisions that are akin to managing the fallout of an unexpected shock (Bomfim, 2003). Likewise, the liquidity channel is defined as a mechanism through which pricing frictions such as wide bid–ask spreads are alleviated temporarily, enhancing market liquidity (Iwatsubo & Taishi, 2018; Christensen & Gillan, 2022). Finally, the portfolio rebalancing channel is defined as the influence of QE on changes in the holdings of assets by market participants, promoting a reallocation of capital to riskier securities to seek higher rates of return as interest rates decline (Fratzscher *et al.*, 2018). This portfolio rebalancing channel is of particular interest in this study as our proposed framework will attempt to elucidate the effects of this channel on efficient portfolio holdings.

While it is difficult to disentangle the channels of QE due to their correlated impact on financial markets, in aggregate they entice economic agents to consume and invest sooner. We identify this effect as a potentially counterproductive consequence of QE. While this effect certainly worked

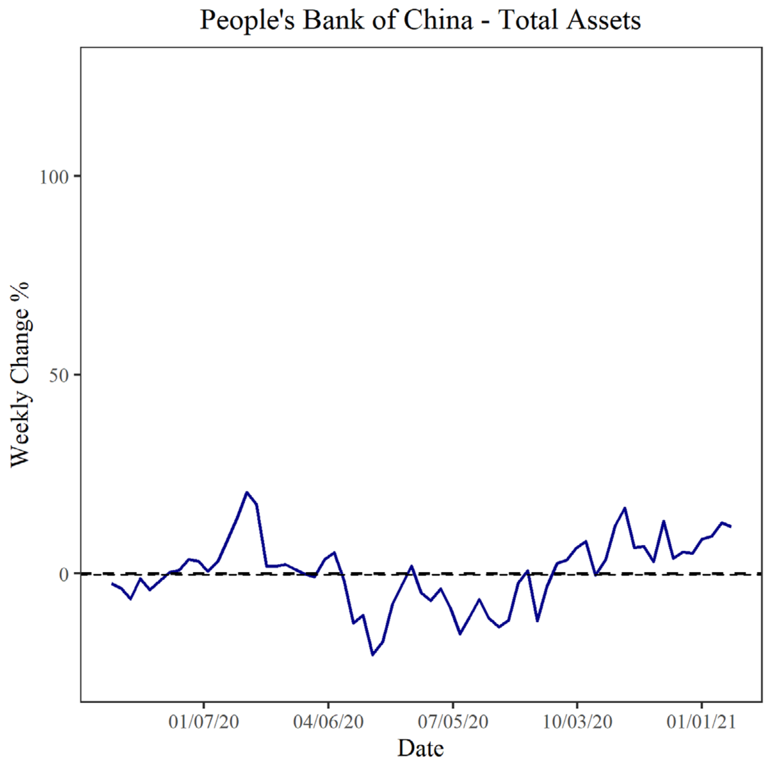

Figure 3. *Notes. These Charts Depict the Weekly Change in the Sum of Total Assets of Central Bank Balance Sheets Calculated in USD from November 2019 to January 2021. The G4 Central Banks Include the U.S. Federal Reserve, European Central Bank, Bank of England and Bank of Japan. The Majors Expand on the G4 and Include the People's Bank of China and the Swiss National Bank. The Data Are Sourced from each Respective Central bank's Official Website.*

positively during the GFC in terms of steadying advanced economies, the bringing forward of consumption may place a handbrake on future growth prospects and so undermine the likelihood of a sustainable recovery. This can be seen by examining capital expenditure growth since the GFC, which has been the weakest since the post-WWII period. As such, the prelude to the COVID-19 crisis was a decade of weak business investment in OECD economies, seemingly driven by expectations of lower future income growth, set against a backdrop of increasing asset returns.

This expectation of lower-income growth appears to have stemmed, in part, from the "secular stagnation" identified by Summers (2013). Here, the combined effect of an ageing population promoted an excess of global savings and lacklustre business investment. Together, these effects led to a decline in neutral interest rates and lower trend productivity growth, accounting for around half of the measured slowing of advanced economies over the 2010s, totalling around 1.5 per cent of GDP. QE policies may account for much of the remainder in the reduction of GDP (Blundell-Wignall & Roulet, 2013).

An additional reason why QE policies may struggle to foster real economic growth is that they tend to inflate the demand for existing assets, which does little to drive current consumption. In contrast, average, but not marginal, returns to existing capital have risen, owing to lower funding costs that may contribute to a loss in productivity. Meanwhile, private non-financial corporations have vigorously committed to equity market buybacks, the payment of large-scale dividends, and have scaled back capital expenditures, all of which together further reduce trend productivity growth (Acharya & Plantin, 2019). When viewed in sum, lower capital expenditures can foster a decline in trend growth rates, further decreasing private investment (Figure 4).

3. The Implications of UMPs on Debt and Asset Prices

Several implications arise from UMPs on the level of public and private debt. Globally, government debt and measures of liquidity as a proportion of GDP have nearly doubled since 2009 (Figure 5), with Japan standing out as a key example. Japan's ultra-loose policy settings have contributed to a vast increase in the level of general government net debt to GDP, which expanded from 154 per cent in late 2007 to 224 per cent just before the onset of the COVID-19 outbreak. In Australia, the figures are correspondingly significant, with a net asset position of 13 per cent to GDP converting into a net debt position of 60 per cent to GDP. For a relatively smaller open economy like Australia, such an accumulation of debt may pose serious risks in an environment of normalising interest rates. This trend is consistent across the globe, and the outbreak of COVID-19 has seen both public indebtedness and private indebtedness continue to rise (Figure 6).

Corporate debt is also increasing in many economies. In the United States, corporate indebtedness has reached around 53 per cent of GDP, with nearly half of the issuance rated speculative by credit rating agencies. Much of this debt has also had the distortionary effect of sustaining companies with

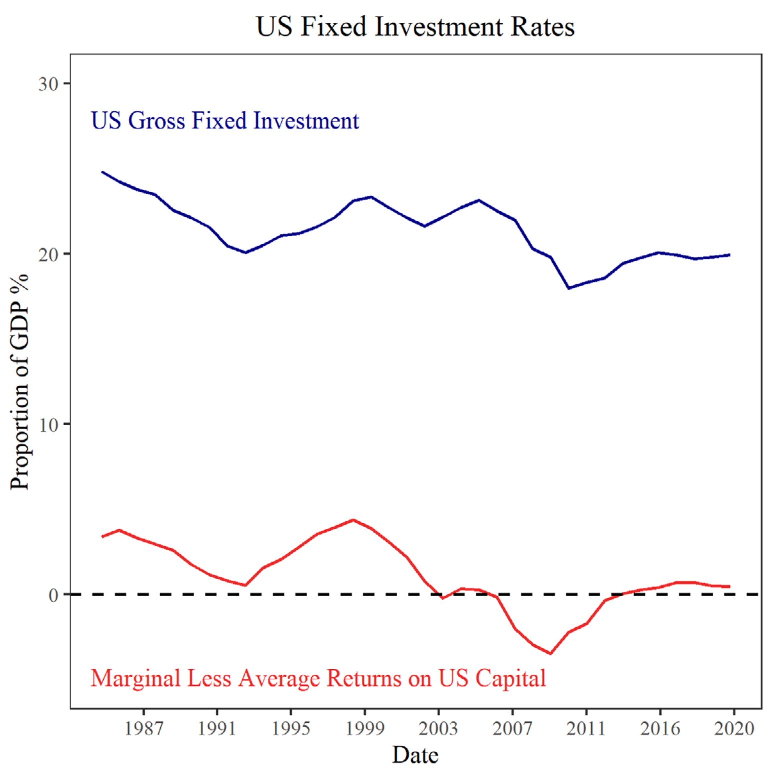

Figure 4. *Note. US Gross Fixed Investment Spending Is Measured as a Proportion of GDP. The Data Are Sourced from the International Monetary Fund (2020a).*

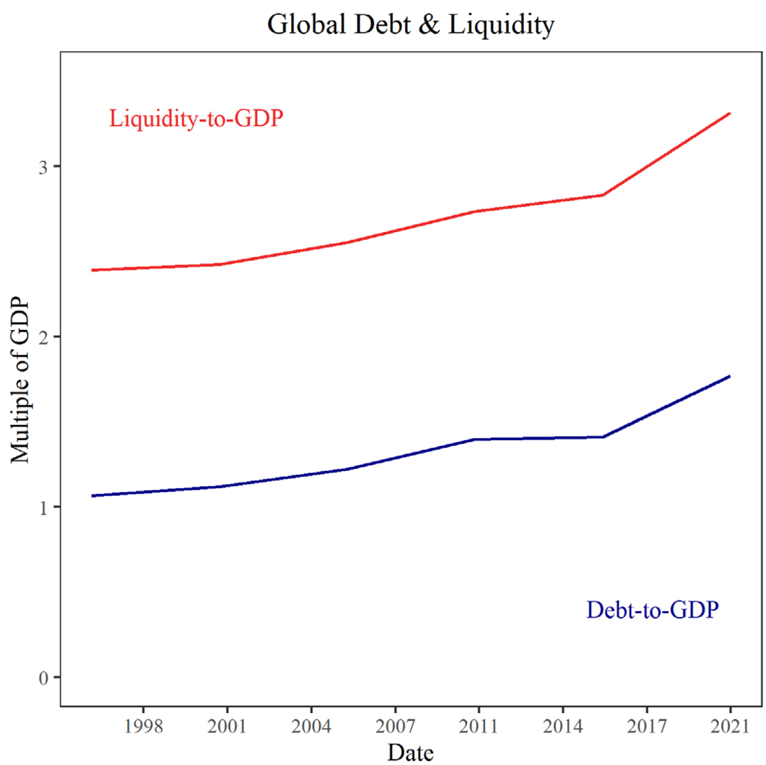

Figure 5. *Notes. Liquidity Is Measured as the Sum of Total Cash Savings and Credit in the Private Sector across 85 Countries, Expressed in USD. Household, Corporate, Finance and Government Debts Reflect the Sum of the Values for each Classification across 85 Countries, Expressed in USD. The Data Are Sourced from National Monetary Authorities in each Respective Country.*

earnings less than their interest bill, commonly referred to as "Zombie" companies (Banerjee & Hofmann, 2018; Urionabarrenetxea *et al.*, 2018; Favara *et al.*, 2021). Perhaps most striking is the increase in household debt, particularly among advanced economies that have seen exponential increases in residential property prices. Australia leads the way in this sense, with household debt exceeding 100 per cent of GDP (Figure 7).

This rapid increase in gross debt issuance also raises the question of whether a smooth reversal in QE can occur without significant market volatility. If central banks are no longer key market participants, asset prices may decline and liquidity conditions may deteriorate without their intervention. More insidiously, a higher level of private-sector debt issuance induces a more substantial refinancing burden in the future, and without sizeable central bank support, many corporates may face elevated refinancing risk (Bordo & McCauley, 2017).

Finally, it is worth noting that concerns about smooth reversibility in unconventional policy settings are justified as they stem from historical difficulties. The Taper Tantrum of May 2013 is one such example, whereby signalling by the Federal Reserve of a potential future tapering in asset purchases induced significant market volatility (Kawai, 2015). Similarly, when the Federal Reserve tried to reverse out of QE from 2017 onwards (by scheduled and limited selling down of its asset holdings known as quantitative tightening), their actions culminated in a significant market drawdown in

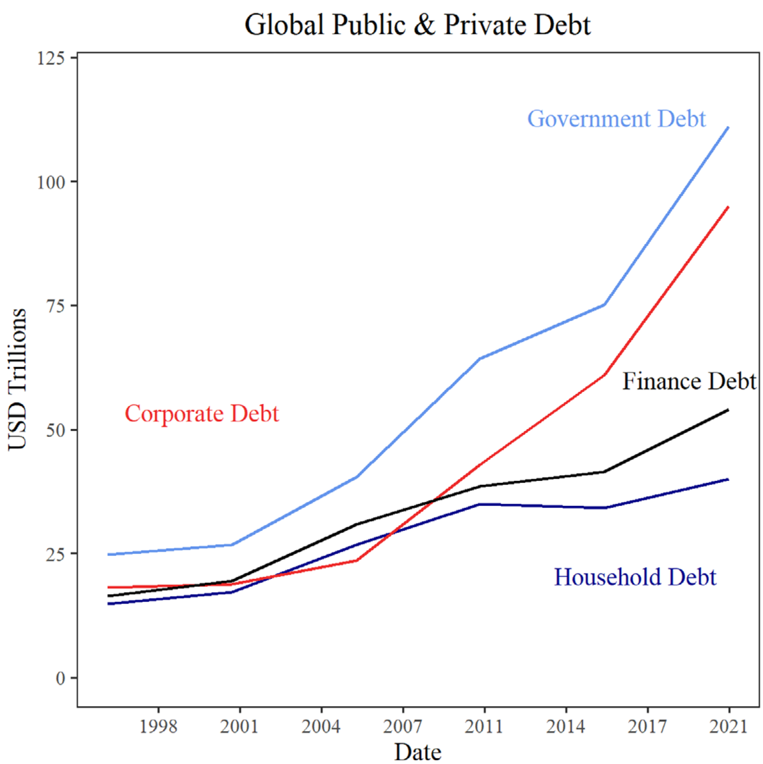

Figure 6. *Notes. Liquidity Is Measured as the Sum of Total Cash Savings and Credit in the Private Sector across 85 Countries, Expressed in USD. Household, Corporate, Finance and Government Debts Reflect the Sum of the Values for each Classification across 85 Countries, Expressed in USD. The Data Are Sourced from National Monetary Authorities in each Respective Country.*

November 2018. This saw the Federal Reserve change back to an expansionary policy footing in January 2019. Liquidity pressures also became evident in repurchase agreement (repo) markets in October 2019, which justified further policy easing. Ultimately, an accelerated expansion in debt levels driven by extremely loose policy settings may stymie a smooth reversal, limiting the capacity for policy-makers to respond to future shocks.

3.1. The Counteraction of QE Policies by Investment Firms

If QE can induce a host of undesired implications, one must question why this is the case? The consensus among central bankers, however, is that their actions do not cause market prices to increase above and beyond economic fundamentals, nor that they have maintained stability at a cost of market efficiency. In contrast to this view, we argue that QE policies are inequitable in their application by favouring existing asset holders, a view that aligns with the findings of academic research as opposed to central bank publications (Bagchi *et al.*, 2019). Importantly, Fabo *et al.* (2020) provide evidence of the dispersion in the reported effects of QE by central bankers in contrast to academics. The authors find that central bankers are more likely to report significant and positive effects stemming from QE, boding well for the careers of the researcher, and suggesting potentially biased research publications.

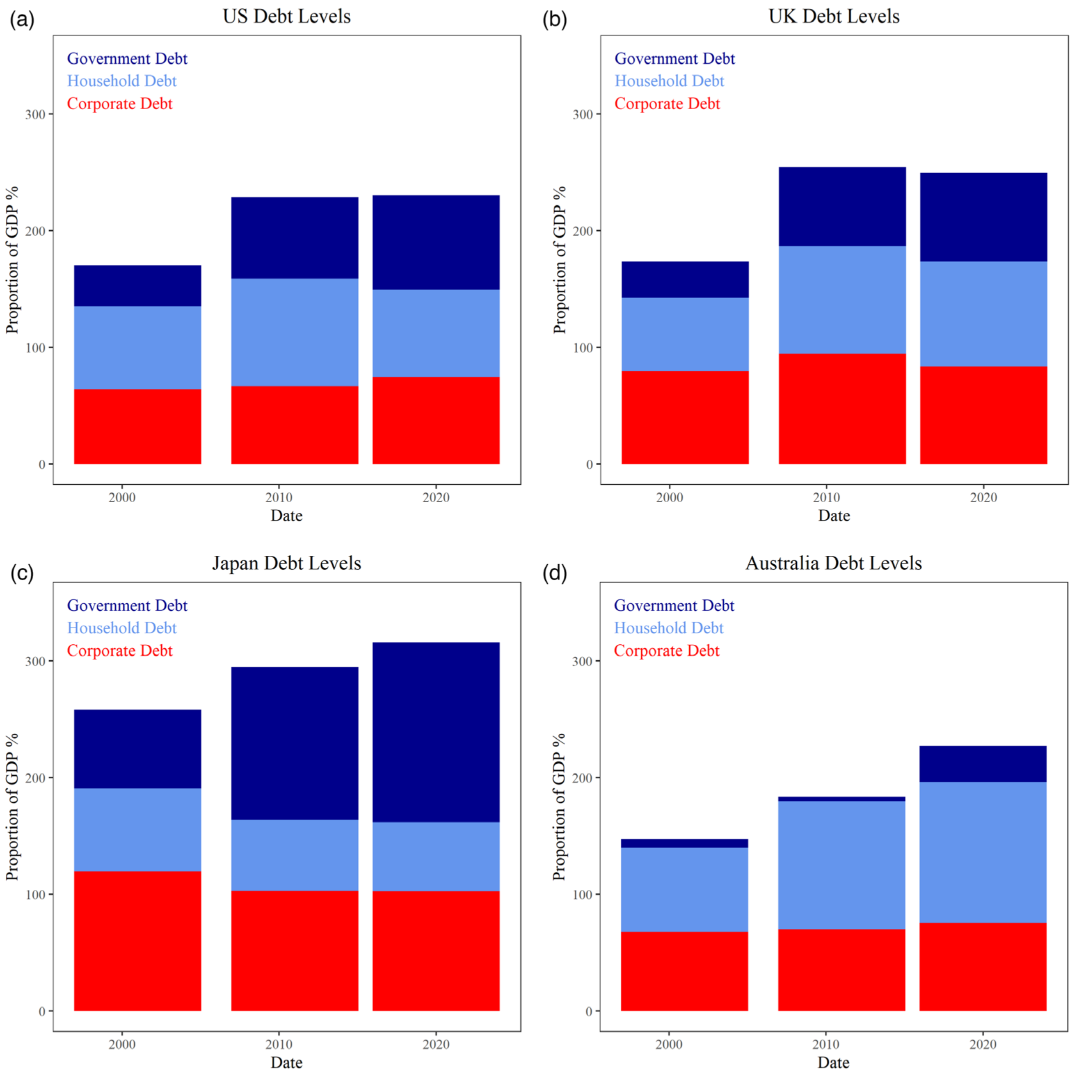

Figure 7. *Notes. General Government Net Debt Represents Gross Debt minus Financial Assets for all Levels of Government. Household Debt Includes Household Debt, Loans and Debt Securities. Finally, Corporate Debt Includes Non-financial Corporate Debt, Loans and Debt Securities. The Data Sources Include the Following: Australian Bureau of Statistics (2020); International Monetary Fund (2020); International Monetary Fund (2020a, 2020b).*

To support our argument, it is first important to understand the process through which risk-free reserves are created. As a central bank purchases assets, its injection of risk-free reserves is placed onto the balance sheets of banks, investment funds and broker-dealers (Adrian & Shin, 2009). As these risk-free reserves surpass the levels needed to meet regulatory and liquidity purposes, excess reserves are expected to circulate into the broader economy, supporting the cost of borrowing and the availability of credit. The injection of reserves, however, is concentrated on the balance sheets of large investment banks and investment funds that may act as a barrier to the flow of credit into the wider economy. These agents may be likely to use the low-cost funding to serve their objectives of generating higher-yielding returns. One such example of this process includes the use of low-cost funding to purchase government securities that serve as collateral in repo transactions (Fuhrer *et al.*, 2016). The cash obtained as part of the transaction can then be used to purchase higher-yielding financial securities such as corporate debt, potentially distorting credit risk premiums (Figure 8). The increased trading volume in repo markets may also help explain the elevated sensitivity of these markets to liquidity conditions in cash and credit markets. In essence, the use of low-cost funding to seek out higher-yielding trades can foster greater linkages among financial markets, magnifying risk spillovers (Haldane *et al.*, 2016; Yang & Zhou, 2017).

3.2. Monetary Easing and Inflationary Pressures

To further investigate whether QE has undermined the credibility of macro-policy settings, an examination of financial asset prices is essential. Fundamentally, QE can influence the real economy by impacting the wealth of asset holders. Supporting economies through asset purchases *en masse*, however, may undermine the rational pricing of securities. Throughout the 2010s, QE policies gave rise to rapid inflation across a wide range of assets. By 2015, asset prices had hit 200-year highs across 15 major Western economies (Deutsche Bank Research, 2019). The link between growth rates in global liquidity and financial asset prices reveals the pass-through of the asset price channel (Figure 9).

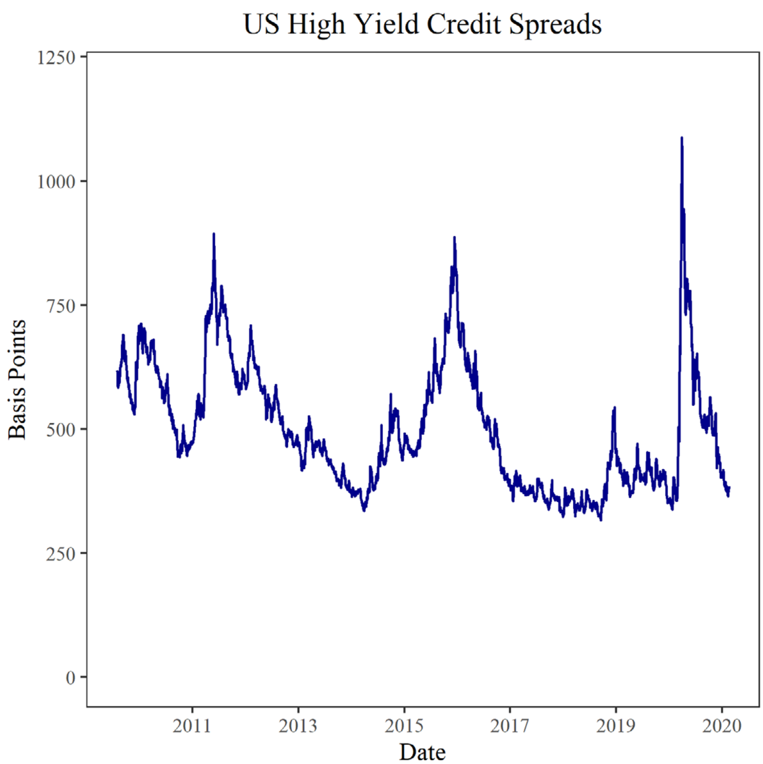

Figure 8. *Note. Credit Spreads Are Calculated as Option-Adjusted Spreads (OAS) Relative to the Spot Treasury Curve. The Data Are Sourced from the Federal Reserve Bank of St. Louis (2021c).*

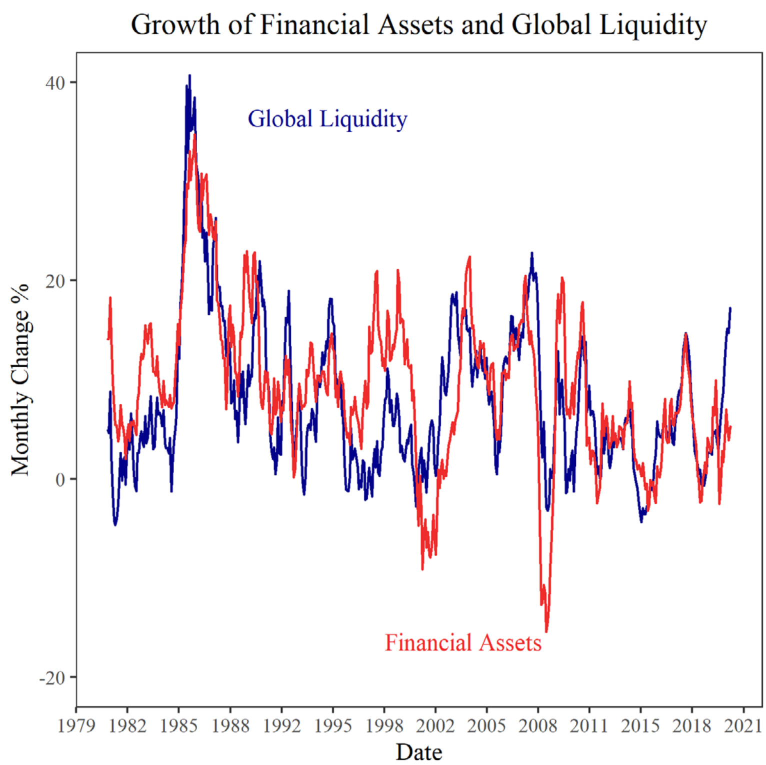

Figure 9. *Notes. These Charts Depict the Monthly Change in Global Liquidity and Financial Assets. Liquidity Is Measured as the Sum of Total Cash Savings and Credit in the Private Sector across 85 Countries, Expressed in USD. Financial Assets Measure the Sum of the Market Value of Equity, Bond, Gold and Cryptocurrency Markets across 85 Countries, Expressed in USD. The Data Are Sourced from National Monetary Authorities in each Respective Country. Cryptocurrency Markets Include Bitcoin (BTC), Ethereum (ETH) and Several Other Coins.*

Friedman (1963) warned that "…inflation is always, and everywhere, a monetary phenomenon." This remains true even when central banks only managed to generate anaemic consumer price inflation for over a decade. This begs the question as to where inflationary pressures were generated, given the extent of the stimulus. What Friedman understood was that inflation can rise within national economies through consumer prices, wages, asset prices or some combinations of each element. It is thus evident that most of the inflationary pressure generated by QE can be found among asset prices. Japan provides a good example of this effect. The Japanese economy has long suffered deflationary pressures in terms of consumer prices since the mid-1990s, an aftermath of the asset bubble perpetuated by the Bank of Japan up to the late 1980s. In response, the Bank of Japan has vigorously implemented QE policies. The asset purchases implemented by the Bank of Japan span the most diverse purchases comparable to most advanced economy central banks, including purchases of private debt and exchange-traded funds (ETFs). Consequentially, these policies have seen the yen depreciate against the price of gold by around 80 per cent since the mid-2000s. In essence, while promoting significant growth in asset prices through QE, the Bank of Japan failed to address depressed consumer price growth (Ferreira-Lopes *et al.*, 2022).

4. Potential Errors in Central Bank Policy Decisions

Perhaps the critical error that central bankers have made is their belief that they have full authority over the supply of financial flows. Confidence in the ability to fine-tune these flows stems from standard macroeconomic models. In these models, money is mainly exogenous and neutral in terms of its impact on output over time, and liquidity is a frictionless, free good. This may have been an accurate depiction of the world with fixed exchange rates under the Bretton Woods system before the 1980s, but not thereafter. Thus, a brief discussion of optimal monetary and fiscal policy helps reveal the potentially erroneous policy decisions made by central banks in the last decade.

4.1. Optimal Sizing for Central Bank and Government Balance Sheets

Before the adoption of unconventional methods, central bank policy from the mid-1980s was centred on the regulation and pricing of the money supply. This critical lever of pricing, the main function of conventional monetary policy, was the key tool. While balance sheet growth was important and did occur, it was utilised generally to assist and enhance the objectives pursued by pricing the money supply. By employing quantitative tools, however, central banks became key market participants by purchasing assets.

An obvious result of increased central bank intervention is the distortion of financial market participants' roles and responsibilities, which was largely the intermediation of credit and the making of investments based on risk–return dynamics. Instead, QE policies have left monetary authorities managing massive balance sheets in marketplaces dominated by a handful of major financial intermediaries.

Certainly, the balance sheets of the four major central banks including the Federal Reserve, European Central Bank (ECB), Bank of Japan (BoJ) and the People's Bank of China (PBoC) are now worth \$30 trillion, or some \$24 trillion more than that at the end of 2008 and are far larger in GDP terms (Figure 10). Simultaneously, the public indebtedness in these economies has also greatly expanded (Figure 11). For instance, the Federal Reserve's balance sheet has reached \$8 trillion, or 37 per cent of GDP, and is expected to rise rapidly, with the Congressional Budget Office estimating the U.S. federal budget deficit will reach \$3 trillion in 2021, or around 13 per cent of GDP. If part of this projected deficit is funded through QE, it may see the Federal Reserve's balance increase further. Similarly, the BoJ's balance sheet already exceeds 130 per cent of GDP, while the ECB's is around 60 per cent of GDP and the PBOC's is just below 40 per cent of GDP. The expansive growth in central bank balance sheets is not limited to only the major players. Even the Reserve Bank of Australia (RBA), a smaller but by no means insignificant central bank, has implemented a series of unconventional tools, including a variant of QE based on yield-curve control (Lucca & Wright, 2022). This has seen total assets rise from 8 to 25 per cent of GDP between February 2020 and July 2021.

Given this exuberant growth in asset holdings, it is worth considering what the optimal size for central bank balance sheets could be and its interconnection with the government. For central banks, monetary policy should be a long-term objective that evolves throughout the business cycle, ensuring the stabilisation of the output gap (Chari & Kehoe, 1999; Corsetti & Pesenti, 2005). Problems, however, begin to emerge when central banks dominate the financial system or certain markets in a manner that cannot be easily unwound. In its current state, monetary policy does not reflect a sensible and measured approach to a long-term objective.

For governing authorities, optimality is a stable level of GDP growth through time, providing adequate fiscal space to deal with unexpected shocks. Stability in economic growth also alleviates the future tax burden for households and minimises the potential crowding out of private investment. This is not to say that circumstances will not require governments to accept deviations in balance sheets to accommodate external shocks such as the current COVID-19 within reasonable bounds. In this sense, optimal fiscal policy should be countercyclical, making use of fiscal headspace to deal with exogenous shocks that pose risks to economic growth (Chari *et al.*, 1994).

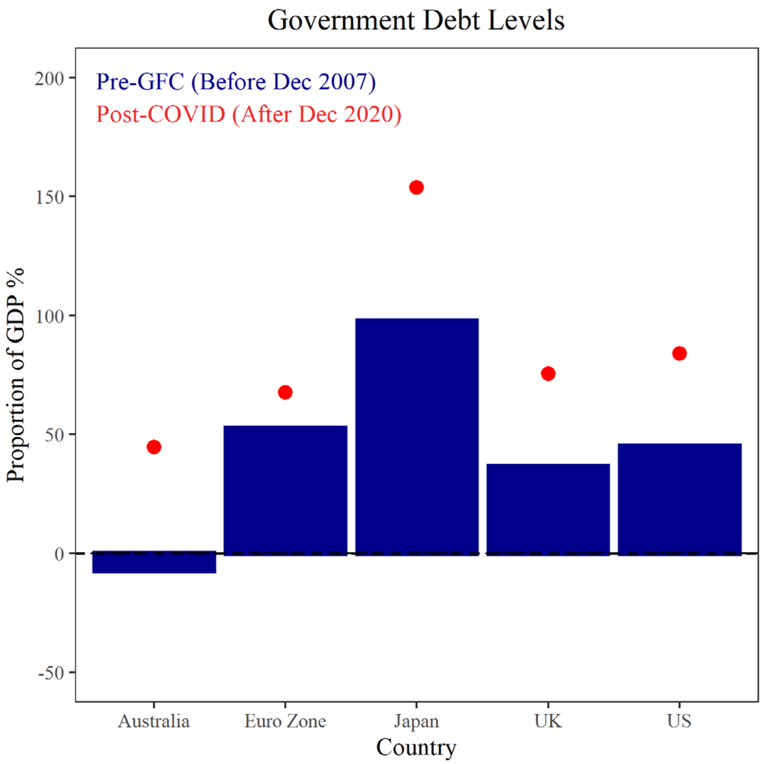

Figure 10. *Notes. General Government Net Debt Represents Gross Debt minus Financial Assets for all Levels of Government. The Post-COVID Figure for Australia Is Calculated from ABS Category: 5519.0.55.001 Including a Prospective Fiscal Stimulus of $184.5 Billion. Central Bank Total Assets Refer to the Assets Recorded on their Balance Sheets, Sourced from each Respective Central Bank's Official Website. The Data Sources Include the Following: Federal Reserve Bank of St. Louis (2021a, 2021b, 2021d); International Monetary Fund (2020a, 2020b); Australian Bureau of Statistics (2020); and Reserve Bank of Australia (2021a).*

5. Measuring the Impact of QE on Efficient Portfolio Holdings

Suboptimal monetary policy decisions by central banks, such as enacting QE with no sustainable benchmarks, may lead to significant difficulties in constructing mean–variance efficient portfolios. The distortion of mean–variance efficiency can be viewed in the same light as the broader notion of allocative efficiency, whereby sizeable monetary stimulus can engender yield-seeking behaviour that affects the risk–return dynamics of multiple asset classes.

To explore this dilemma, we propose a two-period model whereby a reduction in the risk-free rate in the second period affects the ex-post efficient frontier and results in lower risk-adjusted returns following the UMP decision. To conduct this analysis, we draw on the seminal work of Gibbons *et al.* (1989) (GRS) who construct a robust multivariate F test of ex-ante portfolio efficiency. Within their framework, the authors propose an intuitive test of the capital asset pricing model (CAPM) pioneered by Sharpe (1964) and Lintner (1965). In the context of this study, the framework provides a simple and visually intuitive explanation of the suboptimal portfolio rebalancing that takes place as QE policies are enacted, capturing the potential efficiency loss. To begin, we state the mathematical tautology of Markowitz (1959), whereby the efficient frontier can be spanned by any two portfolios

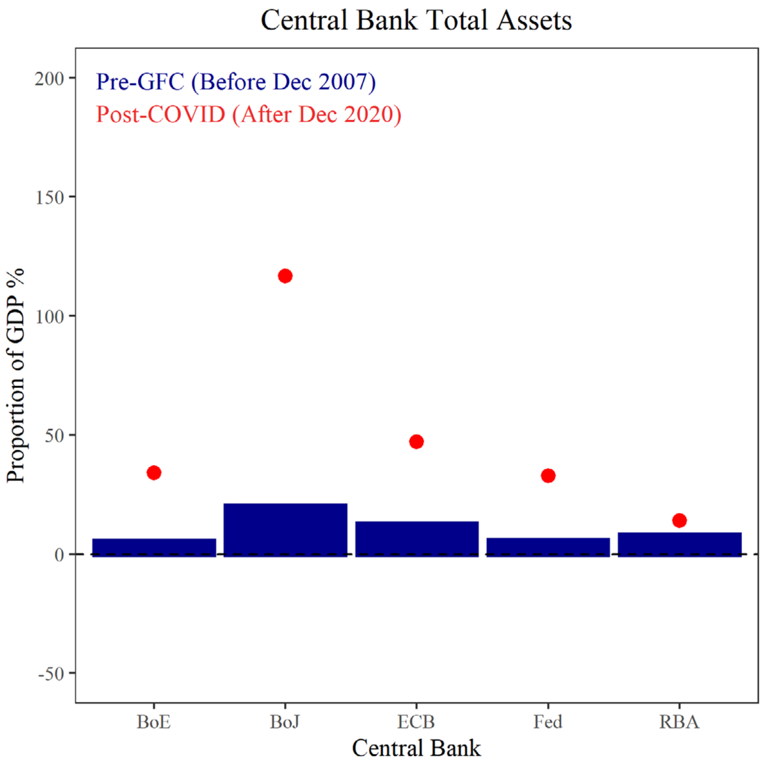

Figure 11. *Notes. General Government Net Debt Represents Gross Debt minus Financial Assets for all Levels of Government. The Post-COVID Figure for Australia Is Calculated from ABS Category: 5519.0.55.001 Including a Prospective Fiscal Stimulus of $184.5 Billion. Central Bank Total Assets Refer to the Assets Recorded on their Balance Sheets, Sourced from each Respective Central Bank's Official Website. The Data Sources Include the Following: Federal Reserve Bank of St. Louis (2021a, 2021b, 2021d); International Monetary Fund (2020a, 2020b); Australian Bureau of Statistics (2020); and Reserve Bank of Australia (2021a).*

that fall upon it:

$$E[R_i] = E[R_{z,p}] + \beta_{i,p} E[R_p - R_{z,p}] \quad \forall i \tag{1}$$

Equation (1) illustrates that the expected return on any portfolio i is a function of an efficient portfolio, R_p, and a portfolio with zero covariance known as the zero-beta portfolio, $R_{z,p}$, multiplied by the beta coefficient. Similarly, the CAPM is expressed as:

$$E[R_i] = R_f + \beta_{i,m} E[R_m - R_f] \quad \forall i \tag{2}$$

where R_f is the risk-free instrument, and R_m is the market portfolio. As can be inferred from Equation (2), the CAPM is virtually identical to Equation (1), albeit, with R_p set equal to the market portfolio. Thus, to satisfy the mathematical tautology of the mean–variance efficient frontier, the market portfolio must also be efficient (Smith & Walsh, 2013). That is, the market portfolio must minimise risk at a given level of return to be able to span the frontier and serve as one of the infinite ex-post portfolios that satisfy Equation (1). To test this theory, GRS proposes a testable null hypothesis by commencing with an assumption about the existence of a risk-free rate of return, $R_{f,t}$, that is used to calculate the excess returns on asset i:

$$r_{i,t} = \left(R_{i,t} - R_{f,t}\right) \quad \forall i = 1, \ldots, N \tag{3}$$

GRS considers the following multivariate regression of the excess return on asset i projected onto the excess return of a portfolio, $\tilde{r}_{p,t}$, that serves as the portfolio that will have its efficiency tested. It is assumed that the disturbance term, $\tilde{\epsilon}_{i,t}$, is distributed as a multivariate normal distribution. This assumption implies that the excess return of asset i is distributed as, $\tilde{r}_{i,t}\text{M}\tilde{\text{V}}\text{N}$, and holds for all N assets:

$$\tilde{r}_{i,t} = \alpha_{i,p} + \beta_{i,p}\tilde{r}_{p,t} + \tilde{\epsilon}_{i,t} \quad \forall i = 1, \ldots, N \tag{4}$$

The variance–covariance matrix of the disturbance term is expressed as $E\left[\tilde{\epsilon}_{i,t}, \tilde{\epsilon}'_{i,t}\right] = \Sigma \otimes I$, where Σ represents the matrix of contemporaneous covariances of the disturbances across each N asset:

$$\Sigma = \begin{bmatrix} \theta_{11} & \cdots & \theta_{1N} \\ \vdots & \ddots & \vdots \\ \theta_{N1} & \cdots & \theta_{NN} \end{bmatrix} \tag{5}$$

Taking the expectation of Equation (4) gives the following relation:

$$E[\tilde{r}_{i,t}] = \alpha_{i,p} + \beta_{i,p}E\left[\tilde{r}_{p,t}\right] \quad \forall i = 1, \ldots, N \tag{6}$$

If the portfolio, $\tilde{r}_{p,t}$, is indeed mean–variance efficient, then the following necessary first-order condition of the Sharpe (1964)–Lintner (1965) CAPM must hold:

$$E[\tilde{r}_{i,t}] = \alpha_{i,p} + \beta_{i,p}E\left[\tilde{r}_{p,t}\right] \tag{7}$$

By equating Equations (6) and (7), it is shown that for the equality to hold, the intercept term, $\alpha_{i,p}$, must be equal to zero for all N assets:

$$\begin{aligned} &\alpha_{i,p} + \beta_{i,p}E\left[\tilde{r}_{p,t}\right] = \beta_{i,p}E\left[\tilde{r}_{p,t}\right] \\ &\Rightarrow \alpha_{i,p} = 0 \quad \forall i = 1, \ldots, N \end{aligned} \tag{8}$$

From Equation (8), GRS shows that the parameter restriction on $\alpha_{i,p}$ can be represented as the null hypothesis that allows for a test of the ex-ante efficiency of the portfolio:

$$\mathrm{H_0 : \alpha_{i,p} = 0 \quad \forall i = 1, \ldots, N} \tag{9}$$

The distributional assumption of multivariate normality in Equation (4) permits the null hypothesis to be tested using an intuitive multivariate F test[3]. GRS estimates the multivariate regression and shows that the estimated intercepts have a multivariate normal distribution that is conditional on $\tilde{r}_{p,t}$:

$$\sqrt{\frac{T}{1+\hat{\theta}_p^2}}\,\hat{\alpha}_p\tilde{N}\left\{\sqrt{\frac{T}{1+\hat{\theta}_p^2}}\,\hat{\alpha}_p, \Sigma\right\}, \tag{10}$$

where T equals the number of observations, $\hat{\alpha}_p$ is a vector of the intercept terms for each N equation, and $\hat{\theta}_p = \bar{r}_p/\hat{s}_p$, where $\bar{r}_p$ is the sample mean of the portfolio's excess return, and $\hat{s}_p$ is the sample variance. Borrowing from the work of Anderson (1962) and Morrison (1976), GRS derives the F test statistic:

[3]While the multivariate normality assumption is problematic, there are variants of the GRS framework that permit testing under more robust conditions. For instance, MacKinlay and Richardson (1991) & Harvey and Zhou (1993) propose estimating the test statistic through the use of alternative distributional settings. They find the applicability of the GRS model still holds under more relaxed assumptions.

$$F=\frac{T}{T-2}\left(\frac{T-N-1}{N}\right)\left(\frac{1}{1+\hat{\theta}_p^2}\right)\hat{\alpha}_p'\hat{\Sigma}^{-1}\hat{\alpha}_p\tilde{F}_\lambda(N,T-N-1)$$
$$\Rightarrow F=\frac{T}{T-2}\left(\frac{T-N-1}{N}\right)\underbrace{W}_{\frac{\hat{\alpha}_p'\hat{\Sigma}^{-1}\hat{\alpha}_p}{1+\hat{\theta}_p^2}}\tilde{F}_\lambda(N,T-N-1) \tag{11}$$

Equation (11) shows that the test statistic is distributed as a non-central F distribution with a non-centrality parameter λ, and degrees of freedom N and $(T-N-1)$. The non-centrality parameter is given by:

$$\lambda=\left(\frac{T}{1+\hat{\theta}_p^2}\right)\hat{\alpha}_\text{p}'\hat{\Sigma}^{-1}\hat{\alpha}_p \tag{12}$$

The intuition of the non-centrality parameter stems from the fact that under null, $\hat{\alpha}_p=0$, which implies that $\lambda=0$, and thus, the test statistic is distributed as a central F distribution. Departures from centrality thus imply an invalidation of the null hypothesis and potentially mean–variance inefficiency of the given portfolio. GRS shows that the W parameter in Equation (11) can be rearranged as follows:

$$\text{W}=\left[\frac{\sqrt{1+\hat{\theta}^{2*}}}{\sqrt{1+\hat{\theta}_\text{p}^2}}\right]^2-1\equiv\varphi^2-1, \tag{13}$$

where $\hat{\theta}^*$ is the maximum excess sample mean return per unit of sample standard deviation, and $\hat{\theta}_p=\overline{r}_p/\hat{s}_p$. Under the null hypothesis, φ^2 should be in proximity to unity (and thus W should be close to zero), which implies the portfolio is mean–variance-efficient. From this representation of the W parameter, GRS illustrates a graphical depiction of efficiency that we reconstruct in Figure 12:

In the first period, the curve represents the ex-post mean–variance efficient frontier of risky assets. A combination of risky securities and the risk-free instrument transforms the frontier into a straight line commencing from the origin at [0, 0] and eventually falling tangent with the frontier at point m_1. In the second period, as the risk-free rate is suppressed by an easing of policy settings, the expected return of the frontier portfolio is truncated and results in a new tangency point at m_2. This is because $R_{f,t}$ is implicit in the calculation of the excess return of the portfolio, and thus, a lower $R_{f,t}$ results in a decline in the future return. Correspondingly, the zero-beta portfolio is shown at point b and is defined as the portfolio that is orthogonal to the original optimal portfolio at point m_1. Finally, points c and d correspond to the slopes of $\hat{\theta}^*$ and $\hat{\theta}_p$ at a standard deviation of excess return equal to one.

The economic intuition of this result is best encapsulated in the context of Sharpe (1994). Specifically, as m_1 and m_2 represent excess returns per unit of standard deviation, $\hat{S}$, the linear distance between the two tangency points captures the shrinkage in the Sharpe ratio (SR) as a result of the truncation of the efficient frontier following the UMP decision:

$$\text{SR}=\frac{\text{m}_1-\text{m}_2}{\hat{\text{S}}} \tag{14}$$

This shrinkage in the SR is defined as the efficiency loss following the imposition of QE. The implication of this model aligns with empirical studies that find evidence of reduced expected future asset returns due to QE (see Shah *et al.*, 2018; Joyce *et al.*, 2020) and suggests that risk–return dynamics can indeed be affected by UMPs. In this sense, UMPs that suppress $R_{f,t}$ beyond the zero lower bound can augment the efficient frontier in a meaningful manner.

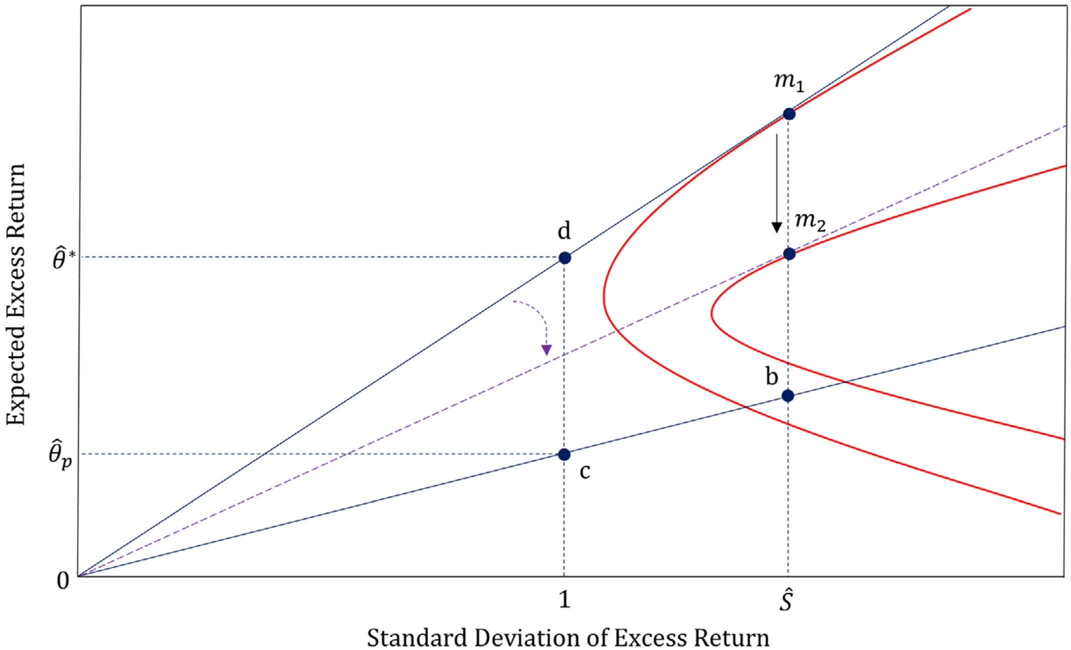

Figure 12. *Notes. This Chart Expands on the Work of Gibbons et al. (1989). The Curves Represent the Mean–Variance Efficient Frontiers of Risky Assets. The Lines Commencing from the Origin Reflect the Combination of the Risk-Free and Risky Assets that Eventually Fall Tangent at Points m_1 and m_2. The Linear Distance between the Two Tangency Portfolios Represents the Efficiency Loss that Occurs Following the Imposition of QE. $\hat{S}$ Is the Standard Deviation of the Tangency Portfolios, while b Is an Inefficient Portfolio that Is Orthogonal to the Tangency Portfolios. $\hat{\theta}^*$ is the Maximum Excess Sample Mean Return per Unit of Sample Standard Deviation, and $\hat{\theta}_p = \bar{r}_p/\hat{s}_p$, where $\bar{r}_p$ Is the Sample Mean Of the portfolio's Excess Return, and $\hat{s}_p$ Is the Sample Variance.*

6. Concluding Thoughts

Policies that enlarge central bank balance sheets, without a reliable mechanism for smooth reversal, can raise the simultaneous risk of higher inflation and deflation. As part of this paper, we have argued that UMPs such as QE can inflict several potentially negative effects on the financial ecosystem, rendering a suboptimal outcome for allocative efficiency. We have argued that quantifiable benchmarks for macroeconomic policy are necessary to safeguard financial stability and avoid distorting portfolio allocation decisions.

The key contribution of this paper is the proposal of a theoretical framework that examines the ex-ante efficiency loss for a given portfolio. We argue that UMPs can inflict declines in risk-free rates that truncate the efficient frontier of risky assets, resulting in a lower return for a given portfolio. We invite researchers to adopt our framework to examine the interconnection between UMPs and allocative efficiency.

Conflict of Interest

The authors have no conflicts of interest to declare.

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