Better Risk Sharing through Monetary Policy?
The Financial Stability Case for a Nominal GDP Target

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Abstract: A series of papers have shown that a monetary regime targeting nominal GDP (NGDP) can reproduce the distribution of risk that would exist if there were widespread use of state-contingent debt securities (Koenig, 2013; Sheedy, 2014; Azariadis et al., 2016, Bullard and DiCecia, 2018). This paper empirically evaluates this view by exploiting an implication of the theory: those countries whose NGDP stayed closest to its expected pre-crisis growth path during the crisis should have experienced the least financial instability. This paper constructs an NGDP gap measure for 21 advanced economies that is used to test this implication. The results strongly suggest that there is a meaningful role for NGDP in promoting financial and economic stability.

I. Introduction

Ten years after the financial crisis there is a new appreciation for the role household debt and financial fragility play in the business cycle. Though some economists recognized their importance going into the crisis, many observers did not and were blindsided by the severity of the Great Recession. Motivated by this experience, a spate of research over the past decade has refocused attention on the relationship household balance sheets and the financial system have on the economy.

One line of this research has focused on household finance and how it contributed to the economic downturn in the United States (Mian and Sufi, 2010, 2013, 2014). It documents how the buildup of household debt, especially mortgage debt, during the housing boom made households susceptible to the decline in housing prices starting in 2006. This decline precipitated deleveraging by households and, in turn, curtailed consumer spending and economic growth.[1] Another vein of this research has looked at the role the financial crisis played in the U.S. economic slowdown (Brunnermeier, 2009; Gorton, 2012; Ricks, 2016; Bernanke, 2018). It shows how a systemic run on institutional money assets caused a collapse in wholesale funding and triggered a severe credit crunch. In turn, this breakdown in financial intermediation caused economic activity to contract.[2]

While the household balance sheet and financial panic views are distinct, they are also interrelated: household deleveraging affected the health of financial firms during the crisis while the reduction in credit supply exacerbated household financial problems. Along these lines, Gertler and Gilchrist (2018) and Aikman et al. (2018) show both factors were jointly important to the emergence of the Great Recession.[3] Jorda et al. (2013, 2015, and 2016), relatedly, in their cross-country studies find countries with high household debt levels tend to have a higher incidence of financial crises. Highly leverage household sectors and financial crises, in other words, are often a jointly determined process.

This new appreciation for household debt and financial fragility can be seen from a broader perspective as the long-time coming consequence of the advanced economies credit regime that emerged in the 1980s. Jorda et al. (2017) show that private sector credit growth relative to GDP accelerated during that decade creating a "financial hockey stick" pattern of leverage for advanced economies. They show this development has dampened business cycle volatility overall while making advanced economies more susceptible to spectacular financial crashes.

This renewed interest in household balance sheets and financial system stability has led to several different policy recommendations. First, the IMF, BIS, and policymakers in many advanced economies have called for *macroprudential regulation*. This approach focuses on the stability of the entire financial system and works by adjusting buffers—such as countercyclical capital requirements and caps on loan to value ratios—to respond to aggregate financial shocks.

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[1] Cross-country studies similarly find that those countries with rising household debt to GDP ratios generally experience slower economic growth over the medium to long-term horizons (Mian et al., 2016, Lombardi et al. (2013).

[2] Cross-country analysis similarly finds that those countries with greater financial vulnerabilities leading up to the crisis experienced larger economic losses after the crisis (IMF, 2018).

[3] Bernanke (2018) makes the case that the severity of the Great Recession was mostly due to the financial panic.

This approach, however, is not without its challenges. It is hard to know what is a true financial vulnerability, what are the appropriate indicators to follow, and how to define financial stability.[4] In addition to these knowledge problems, macroprudential goals may conflict with other policy goals and be subject to rent seeking by affected parties.[5] For these reasons, macroprudential regulations, which have been implemented to varying degrees in different countries, are not yet fulfilling all of their desired goals (IMF, 2018; BIS, 2018)

A second policy recommendation put forth by some observers is the need for *state-contingent debt contracts* (Shiller, 2008; Mian and Sufi, 2014; Elberly and Krishnamurthy, 2014; Piskorski and Seru, 2018). These are financial contracts whose payouts are contingent on certain economic outcomes. In this context, the push has been for mortgages whose principal and payments are indexed to local economic conditions. A weakening local economy would lower the real mortgage burden on households while a booming one would raise it. Such mortgages would resemble equity more than debt and lead to better risk sharing between debtors and creditors. In turn, this improved distribution of risk should improve the stability of the financial system. Shiller (2004), more generally, shows how these and other state-contingent contracts could radically transform our world into a more equitable and flourishing place.

Some progress has been made on this front with income-contingent student loans, contingent convertible corporate bonds, and a few state-contingent mortgages.[6] Most debt, however, remains written in fixed nominal terms. The dearth of contingent debt contracts suggests that the cost of writing and enforcing them is prohibitively expensive. For now, then, state-contingent contracts do not provide a practical solution to the household debt and financial stability concerns of advanced economies.

A third policy recommendation that addresses these concerns is to use *monetary policy to create better risk sharing between debtors and creditors*. Specifically, a monetary regime that targets the growth path of nominal GDP (NGDP) can be shown to reproduce the distribution of risk that would exist if there were widespread use of state-contingent debt securities (Koenig, 2013; Sheedy, 2014; Azariadis et al., 2016, Bullard and DiCecia, 2018). The basic idea is that the countercyclical inflation created by an NGDP target will cause real debt burdens to change in a procyclical manner. As a result, debtors will benefit during recessions and creditors will benefit during booms. Fixed nominal-priced loans will act more like equity than debt and therefore promote financial stability.

This policy recommendation has the potential to be the most tractable of the above three proposals since all it requires is a credible commitment to a new monetary regime. While switching to a new monetary regime is a nontrivial task, it would accomplish the same goals of state-contingent debt contracts and complement the efforts of macroprudential regulations. However, of the three proposals this one has received the least attention. This may be due to the fact that the recent work on this proposal been largely theoretical since no country explicitly targets NGDP. This policy proposal, consequently, is ripe for further attention and development.

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[4] For more on the knowledge problem inherent to macroprudential regulations see Salter (2014).

[5] The recent delisting of Prudential as a significantly important financial institution (SIFI) by the U.S. Financial Stability Oversight Council is seen by some as example of rent seeking.

[6] Companies like Unison, Patch, and Point have begun offering state contingent-like mortgages. However, they remain a small part of the mortgage market due in part to GSE subsidizing traditional mortgages.

This paper attempts so shed more light on this proposal by providing the first empirical assessment of it. It does so by exploiting an implication of the theory: those countries whose NGDP stayed closest to its expected pre-crisis growth path should have experienced the least financial instability. Put differently, some countries experienced more stability in aggregate nominal spending than others during the crisis and these differences should be systematically related to financial stability if the theory is true. So even though no countries were targeting NGDP during the crisis, there is still a way to test the theory.

This paper uses this understanding to provide an empirical test of the third policy proposal. It does so by outlining a method for estimating the expected growth path of NGDP for advanced economies and then seeing whether the gap between it and actual NGDP is systematically related to various measures of financial stability. This exercise is only a first look and is not the final word, but the results indicate more attention should be given to this third proposal. The findings strongly suggest that a stable NGDP growth path supports financial stability. These findings, therefore, lend support to the existing arguments for why advanced economies should consider adopting an NGDP level target.

In the sections that follow, the paper further outlines the arguments of Koenig (2013), Sheedy (2014), Azariadis et al. (2016), and Bullard and DiCecia (2018). It then derives the expected growth path of NGDP for 21 advanced economies using IMF data and the 'sticky forecast' approach of Beckworth (2018). Next, the paper uses this measure to create an NGDP gap that is used in some scatterplots, a panel vector autoregression, and a panel local projection model to determine the relationship between the NGDP gap and various economic variables. The paper then concludes with some policy considerations.

II. Better Risk Sharing through NGDP Targeting

The key insight of Koenig (2013), Sheedy (2014), Azariadis et al. (2016), and Bullard and DiCecia (2018) is that in a world of incomplete markets where there is non-state contingent nominal contracting, an NGDP target can reproduce the risk distribution that would occur if there were complete markets and state contingent nominal debt contracting.[7] An NGDP target, in other words, can make up for the lack of insurance against future risks that could affect debtors' ability to repay their debt. Conversely, an NGDP target can also make up for the lack of insurance against potential returns a creditor might miss out on because their funds are locked up in a fixed-price nominal loan. Bullard and Dicecia (2018) show that this result holds even when the heterogeneity among debtors and creditors modeled approximates that of the actual income, financial wealth, and consumption inequality in the United States. They note this makes NGDP targeting "monetary policy for the masses."

The intuition behind these formal findings is that debtors and creditor who have committed to fix-nominal debt contracts and therefore to fixed money payments can be subject to both price level and real income shocks. The former shocks have long been understood and generally seen as bolstering the case for a price-level or inflation target. Most famously, Irving Fisher (1933) made

[7] The ideas in these formal papers date back to Bailey (1837, pp. 111-133) as shown by Selgin (2018, pp. 57-70).

Table 1: Risk Bearing by Household Type

Household Type	Bears More Risk If:		
Debtor	(1) $\Delta p_t < \Delta p_t^{E_{t-1}}$ or (2) $\Delta y_t < \Delta y_t^{E_{t-1}}$	$\Rightarrow$	$\Delta(py)_t < \Delta(py)_t^{E_{t-1}}$
Creditor	(3) $\Delta p_t > \Delta p_t^{E_{t-1}}$ or (4) $\Delta y_t > \Delta y_t^{E_{t-1}}$	$\Rightarrow$	$\Delta(py)_t > \Delta(py)_t^{E_{t-1}}$

the case for price level stability as a way to avoid unexpected deflation and a rise in real debt burdens that could trigger a cascade of loan defaults. As Koenig (2013) notes, however, Fisher's "debt deflation" scenario is incomplete because it only looks at price level shocks. Debtors may also face financial stress from negative real income shocks. Both types of shocks make it harder for debtors to service fixed money payments since both shocks lower nominal income flows relative to expectations. In both cases, the debtor is bearing the additional risk of these negative shocks relative to the creditor.

These two scenarios are illustrated in Table 1 as (1) and (2), where Δp_t, Δy_t, and $\Delta(py)_t$ represent changes in the log of the price level, real income, and nominal income. Note, that in general, any combination of these shocks that *lowers* nominal income relative to expectations puts a strain on debtors. It follows, then, that stabilizing $\Delta(py)_t$ via an NGDP target serves a useful insurance function for debtors. For a central bank, that means allowing changes in price level to offset real income shocks so that actual nominal income equals expected nominal income. That is, in order for the following nominal income equality to hold

$$\Delta(py)_t = \Delta(py)_t^{E_{t-1}}, \tag{1}$$

it must be the case that innovations to real income be offset by innovations to the price level:

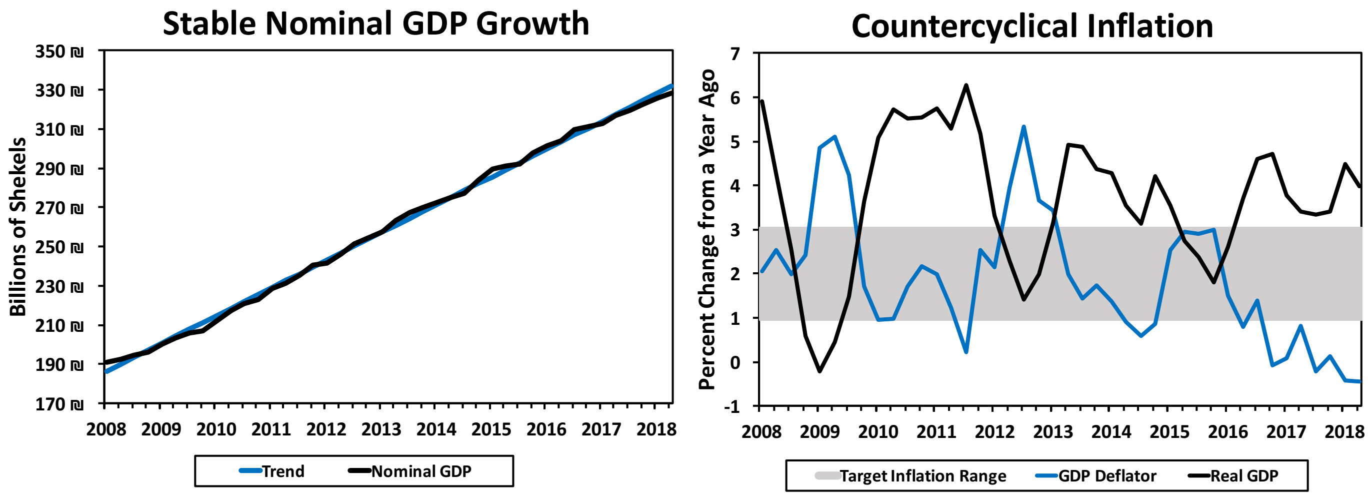
$$\left(\Delta y_t - \Delta y_t^{E_{t-1}}\right) = -\left(\Delta p_t - \Delta p_t^{E_{t-1}}\right) \tag{2}$$

or, equivalently:

$$\Delta p_t = \Delta p_t^{E_{t-1}} - \left(\Delta y_t - \Delta y_t^{E_{t-1}}\right). \tag{3}$$

Another way to understand equation (3) is that under an NGDP target a negative real income shock leads to an unexpectedly higher price level and, for a given stock of fixed-price nominal debt, an unanticipated lower real debt burden for the debtor. The creditor, consequently, receives a lower real debt payment than expected and shares in the real income loss. In short, the risk of a real income loss is shared more evenly between the debtor and creditor under an NGDP target than under a price stability target.

Figure 1: Stable NGDP Growth and Countercyclical Inflation in Israel



Equation (3) also implies that under an NGDP target a positive real income shock will lead to an unexpectedly lower price level and, for a given stock of fixed-price nominal debt, an unanticipated higher real debt payment from the debtor to the creditor. This feature can be seen as providing insurance to a creditor against having their funds locked up in a fixed nominal loan with a constant yield while real earnings in the rest of the economy rise due to the positive real income shock. For example, imagine there is a positive total factor productivity (TFP) shock that raises real returns in the economy. If a creditor knew this productivity innovation was going to occur ex-ante, he would have required an equivalent risk-adjusted return on a loan to a debtor. But the creditor cannot know this outcome ex-ante since it is a shock. Under a price stability target, the creditor bears this risk and would miss out on the gain from the TFP shock. An NGDP target, on the other hand, forces the debtor to share some of the "windfall gain" with the creditor through a higher real debt payment. Again, risk is shared more evenly between the debtor and creditor under the NGDP target and therefore mimics a world of state-contingent debt contracts.

Finally, if there are no real income shocks then an NGDP target effectively defaults to a price stability target so that $\Delta p_t = \Delta p_t^{E_{t-1}}$.[8] An NGDP target, consequently, also avoids the "bad" price level surprises depicted in scenarios (1) and (3) in Table 1.[9]

In practice, a central bank targeting NGDP does not need to manually adjust the price level to offset real income shocks. Instead, the central bank simply aims to keep aggregate nominal spending on its targeted growth path and the price level will by default adjust to the real income shocks. The insurance benefits from the countercyclical inflation are therefore produced automatically (Beckworth, 2017). No central bank has ever attempted this, but the Bank of Israel (BoI) has unintentionally provided an example of what such a monetary regime might look like.

[8] This can be seen in equation (3) by noting that if there are no real income shocks then $\Delta y_t = \Delta y_t^{E_{t-1}}$ and $\Delta p_t = \Delta p_t^{E_{t-1}}$.

[9] The "bad" price level surprises should be distinguished from the "good" price level surprise that an NGDP target creates when there are real income shocks. As noted above, in the latter case these price level surprises act as a form of insurance.

The BoI officially targets an inflation range of 1-3 percent, but as Figure 1 shows NGDP in Israel has been growing on a fairly stable trend since 2008. As a consequence, real income shocks have led to almost mirror opposite movements in the inflation rate as measured by the GDP deflator. This inverse relationship is not perfect, but it is strong enough that the GDP deflator inflation has been allowed to temporarily move outside the inflation target range when there have been large real income shocks. For example, in 2009 during the Great Recession the inflation rate just topped 5 percent. Despite this inflation flexibility, inflation on average over the entire period in Figure 1 has been near the center of its targeted range at a rate of 1.9 percent. An explicit NGDP target would arguably result in a similar outcome.

III. Measuring NGDP Expectations

The main objective of this paper is to empirically assess the policy proposal that NGDP targeting will result in better risk sharing between debtors and creditors. An obvious challenge to doing so is that no country has targeted NGDP so there is no track record to evaluate.

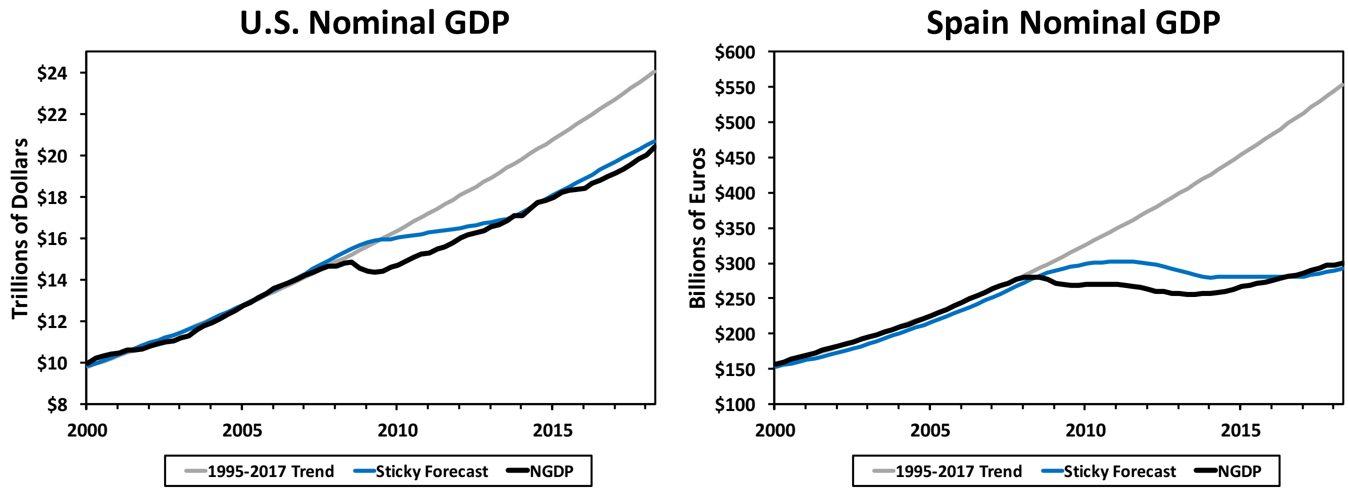
There is, however, an indirect way to test this proposal by exploiting an implication of the theory. It predicts that those countries whose NGDP stayed closest to its expected pre-crisis growth path should have experienced the least financial instability during the crisis. Put differently, some countries experienced more stability in aggregate nominal spending than others during the crisis and these differences should be systematically related to financial stability if the theory is true. A cross-country sample over this period of NGDP deviations from expected growth paths should reveal whether this prediction is borne out in the data.

This possibility raises another challenge: how best to measure the expected growth path of NGDP? One wants to avoid using simple, naïve pre-crisis trends since expectations and nominal contracting do eventually adjust. Figure 2 illustrates the problem with such trends for the United States and Spain. If they were taken seriously, then there would be a 15 percent shortfall of aggregate nominal expenditures in the United States and a 45 percent shortfall in Spain as of 2018:Q2. Figure 2 reports another measure, the "sticky forecast" path of NGDP outlined in Beckworth (2018) and it shows a gradual adjustment so that expected path of NGDP and actual NGDP eventually converge. This measure is more consistent with the notion of expectations and nominal contracting eventually adjusting to sustained changes in NGDP. This sticky forecast is used in this paper as the expected growth path of NGDP for 21 advanced economies and its motivation and construction is outlined below.

Sticky Forecast Path for NGDP

The idea behind the sticky forecast path for NGDP is twofold. First, the public makes many economic decisions based on a forecast of their nominal incomes. For example, households may take out a 30-year mortgage based on an implicit forecast of their nominal income over this horizon. The actual realization of nominal income may turn out to be very different than expected, but the households may not be able to quickly adjust their plans given sticky debt contracts and other commitments that constrain them. Therefore, the consequences of previous forecasts are often binding on them and slow to change even if their nominal income forecasts have been updated. Second, in addition to these old forecasts and decisions whose influence lingers, new

Figure 2: Simple NGDP Trends versus Sticky Forecast NGDP Paths



forecasts and new decisions are being made each quarter for subsequent periods that will also have lingering effects. Together, this means future periods have many overlapping and different forecast applied to them that only gradually adjust.

To capture this sticky forecast idea, a five-year forecast is created that gradually updates over time. Five years are chosen since it assumed that all constraints created by decisions based on the forecast can be reconfigured within five years. The data for this exercise come from the IMF's World Economic Outlook (WEO) forecast database. Every spring and fall there are WEO forecasts published for member countries that extend six years out. These biannual forecasts are interpolated to a quarterly frequency and used here to construct a sequence of five-year overlapping forecasts for every period between 2000:Q1 to 2018:Q2. This process is done for 21 advanced economies: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Israel, Italy, Japan, Netherlands, New Zealand, Portugal, South, Korea, Spain, Sweden, Switzerland, United Kingdom, and the United States.[10]

The exact steps are as follows. First, for every quarter beginning in 1995 a five-year forecast (20 quarters) is created using the IMF's forecasts of NGDP growth.[11] Second, for a given starting period, these NGDP growth forecasts are then used to create a 20-quarter forecast path of the NGDP level in national currency form. These forecasts are created for every period up to 2018:Q2. Third, the next step is to recognize that starting with 2000:Q1 there are 20 overlapping NGDP level forecasts in national currency for every quarter. All of these 20 forecasts are averaged into one NGDP level value for each period as follows:

$$NGDP_t^{sticky\ forecast} = \frac{\sum_{i=1}^{20} NGDP_{t-i}^{IMF\ forecast\ (t)}}{20}. \qquad (4)$$

This process is repeated for every forecasted period so that a new NGDP level forecast time series

[10] For Korea and Japan, the forecast is set at 2.5 years since these two countries' forecast were found to converge much faster.

[11] The IMF provides forecasts for real GDP growth and inflation. These are combined to create an NGDP growth forecast.

Figure 3: Actual and Sticky Forecast Paths for NGDP

In National Currency

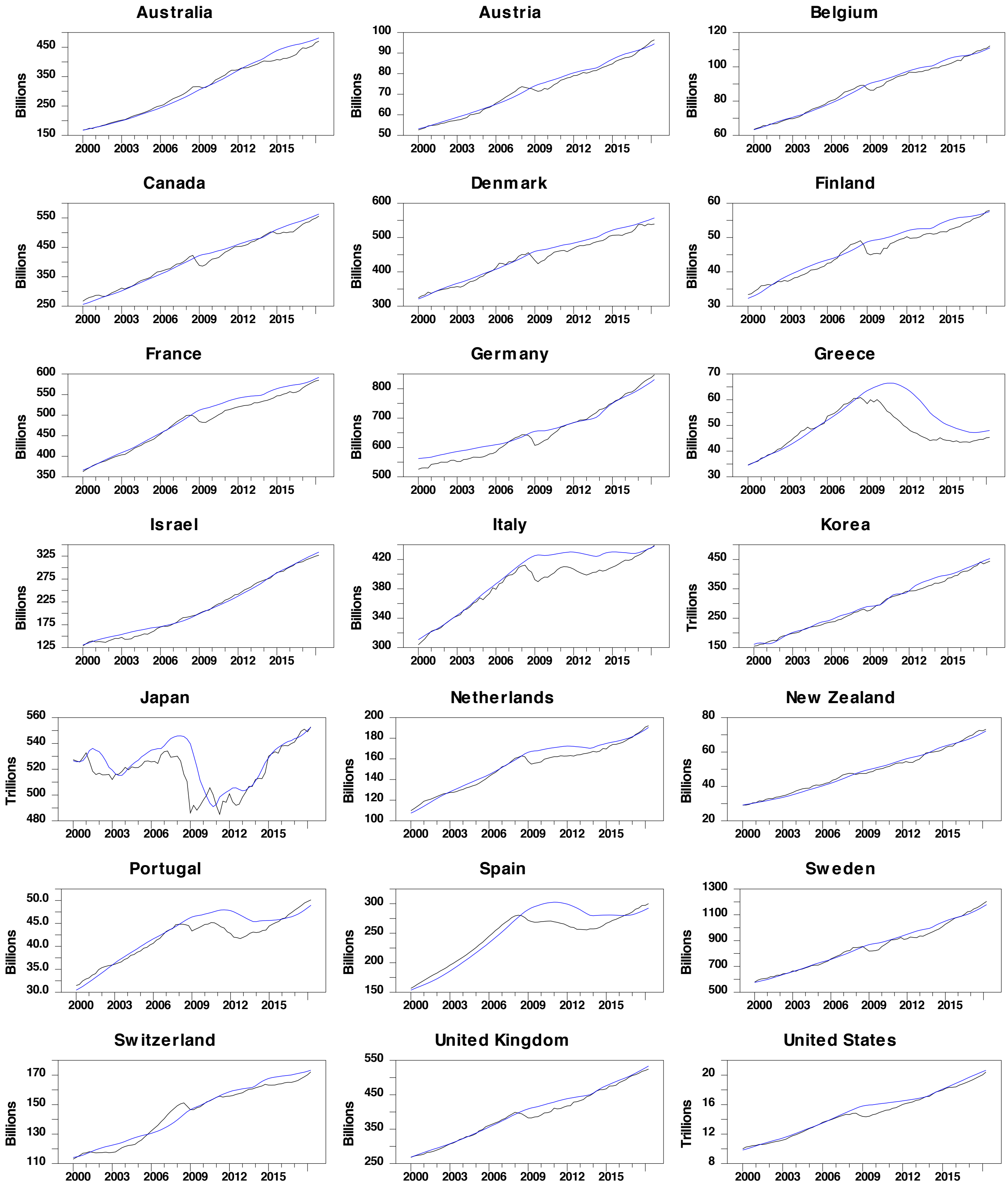
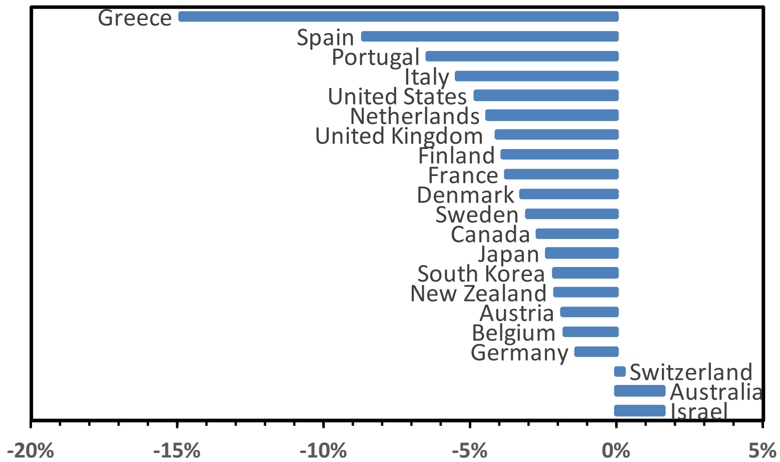


Figure 4: The Average NGDP Gap

2008:Q1 – 2013:Q4



is created. This new time series is used as the sticky forecast NGDP growth path. Figure 3 shows the actual and sticky forecast paths for NGDP in the 21 advanced economies in their national currency. There is a diverse set of NGDP experiences in Figure 3, but it is misleading to compare across countries the actual and sticky forecast NGDP levels since absolute size matters. This paper, consequently, looks at the percent difference between the actual and sticky forecast NGDP levels, called hereafter the "NGDP Gap".

Figure 4 reports the average NGDP gap for the crisis years of 2008:Q1-2013:Q4 ranked by size. Most countries had a negative NGDP gap during this time, indicating NGDP was on average below expected values in most advanced economies. Greece had the largest average NGDP gap at -14.9 percent, followed by Spain at -8.7 percent and Portugal at -6.5 percent. The best performers turned out to be Israel and Australia both with an NGDP gap of 1.6 percent followed by Switzerland at 0.2 percent. The risk sharing theory of NGDP outlined by Koenig (2013), Sheedy (2014), Azariadis et al. (2016), and Bullard and DiCecia (2018) implies these NGDP Gap differences among the 21 countries should be systematically related to financial stability. This claim is tested in the next section.

IV. Empirical Evidence for NGDP and Financial Stability

This section gets to the main objective of this paper: to empirically assess the policy proposal to use NGDP as a way to improve financial stability. As noted earlier, it does so by exploiting an implication of the theory: those countries whose NGDP stayed closest to its expected pre-crisis growth path—and therefore kept risk more evenly spread between debtors and creditors—should have experienced the least financial instability. The section of the paper tests this claim in two parts. First, it looks at series of scatterplots to see if there is any systematic relationship between the NGDP gap and measures of financial stability. Second, it then uses the same variables in a panel vector autoregression (VAR) and panel local projection model to better test for causality.

Scatterplot Analysis

As a first look at the potential relationship between NGDP and financial stability, this section plots in Figure 5 the average NGDP gap over the crisis period of 2008:Q1-2013:Q4 against six financial measures over the same period: private credit growth, M3 money supply growth, stock price growth, home price growth, the nonperforming loan rate, and the equity risk premiums. Details on the sources of these measures are found in the data appendix. To be clear, these scatterplots are not intended to establish causality. Instead, they are provided to establish whether there is any systematic relationship between NGDP forecasting errors and the financial variables.

One issue is whether to treat Greece as a legitimate observation or an outlier given the severity of its experience during this time. On one hand, Greece can be viewed as part of the same data-generating process as other countries but just happened to receive the largest 'treatment' of NGDP forecasting errors. In this case, including Greece is important since its absence could result in biased estimates. On the other hand, maybe Greece does come from a different data-generating process and should be considered an outlier. To account for this possibility, the scatterplots are shown with fitted lines and R^2 for the full sample and for the sample excluding Greece.

The first scatterplot in the figure shows the change in the average year-over-year growth rate of credit to the private non-financial sector (PNFS) against the NGDP gap. The change is the difference between the average PNFS credit growth rate in 2003:Q1-2007:Q4 and in 2008:1-2013:Q4. That is, the change in the average credit growth rate between the boom and crisis years. The first scatterplot shows there is fairly strong and positive relationship with an R^2 of 48 percent when all countries are included. Without Greece, the R^2 is still a robust 38 percent. These results mean the larger the decline in the NGDP gap, the greater the decline in the average growth rate of PNFS credit during the crisis years.

The second scatterplot reveals a similar positive relationship for the year-over-year M3 money supply growth rate. Here the R^2 is 58 percent for the full sample and 57 percent without Greece. Here too, then, the figure indicates a strong positive relationship between the NGDP gap and the growth in the M3 money supply.

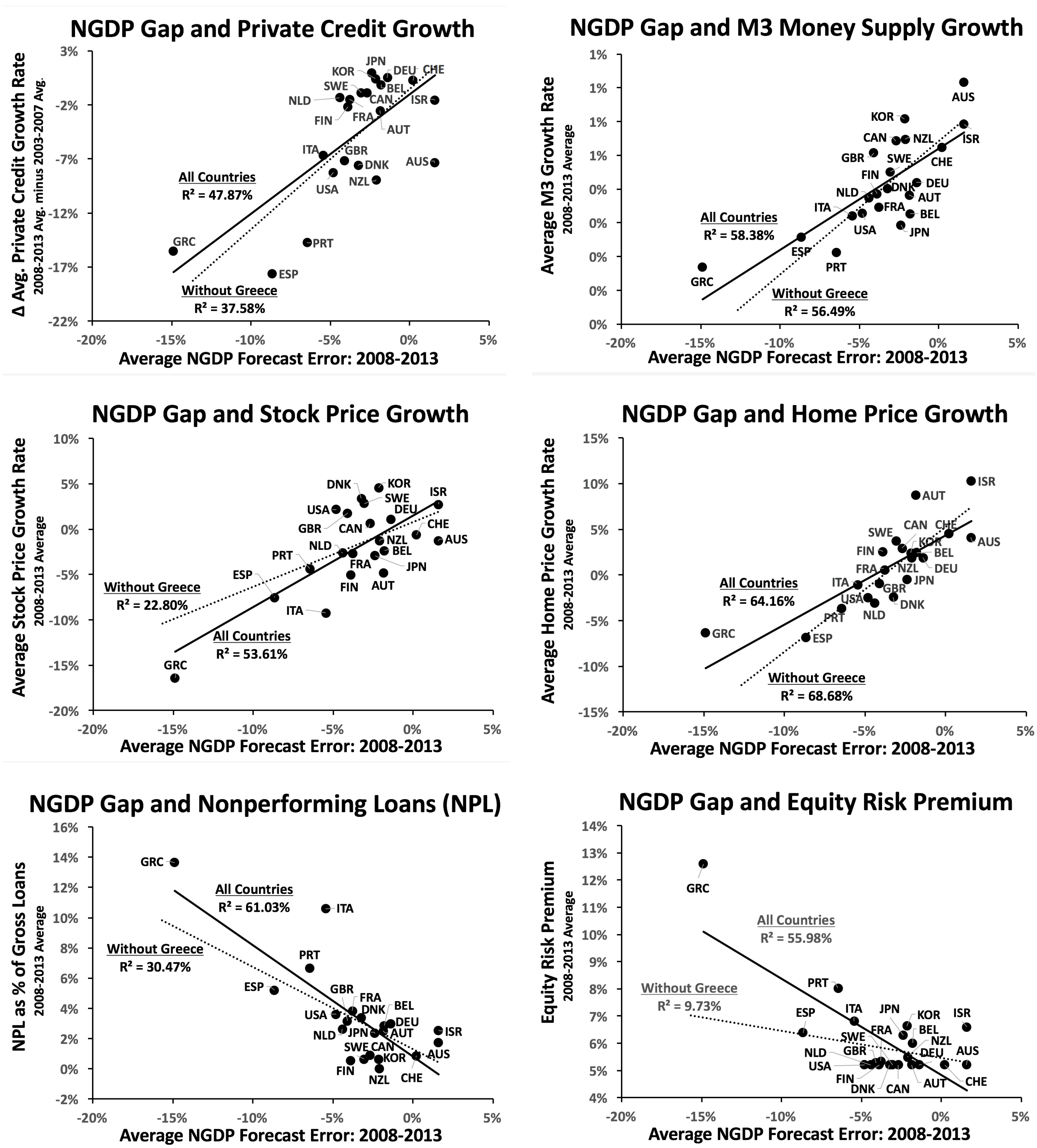
The third scatterplot displays the relationship between the year-over-year growth rate in stock prices and the NGDP gap. Here again, there is a strong positive relationship between the size of the NGDP gap and the growth in stock prices in the full sample with a R^2 of 53 percent. The relationship weakens a bit, but remains non-trivial in size with a R^2 of 23 percent in the absence of Greece. In general, the larger the decline in the NGPD gap the greater the decline in this asset price.

The fourth scatterplot shows the relationship between the year-over-year growth in home prices and the NGDP gap. This relationship is also a strong positive one with a R^2 of 64 percent for the full sample. Excluding Greece actually leads to a stronger fit with a R^2 of 69 percent . This is another asset price that is strongly related to the NGDP gap during the crisis.

The fifth scatterplot reveals the relationship between nonperforming loans as a percent of gross loans against the NGDP gap. Now there is a strong negative relationship, indicating that as the

Figure 5: The NGDP Gap and Financial Conditions

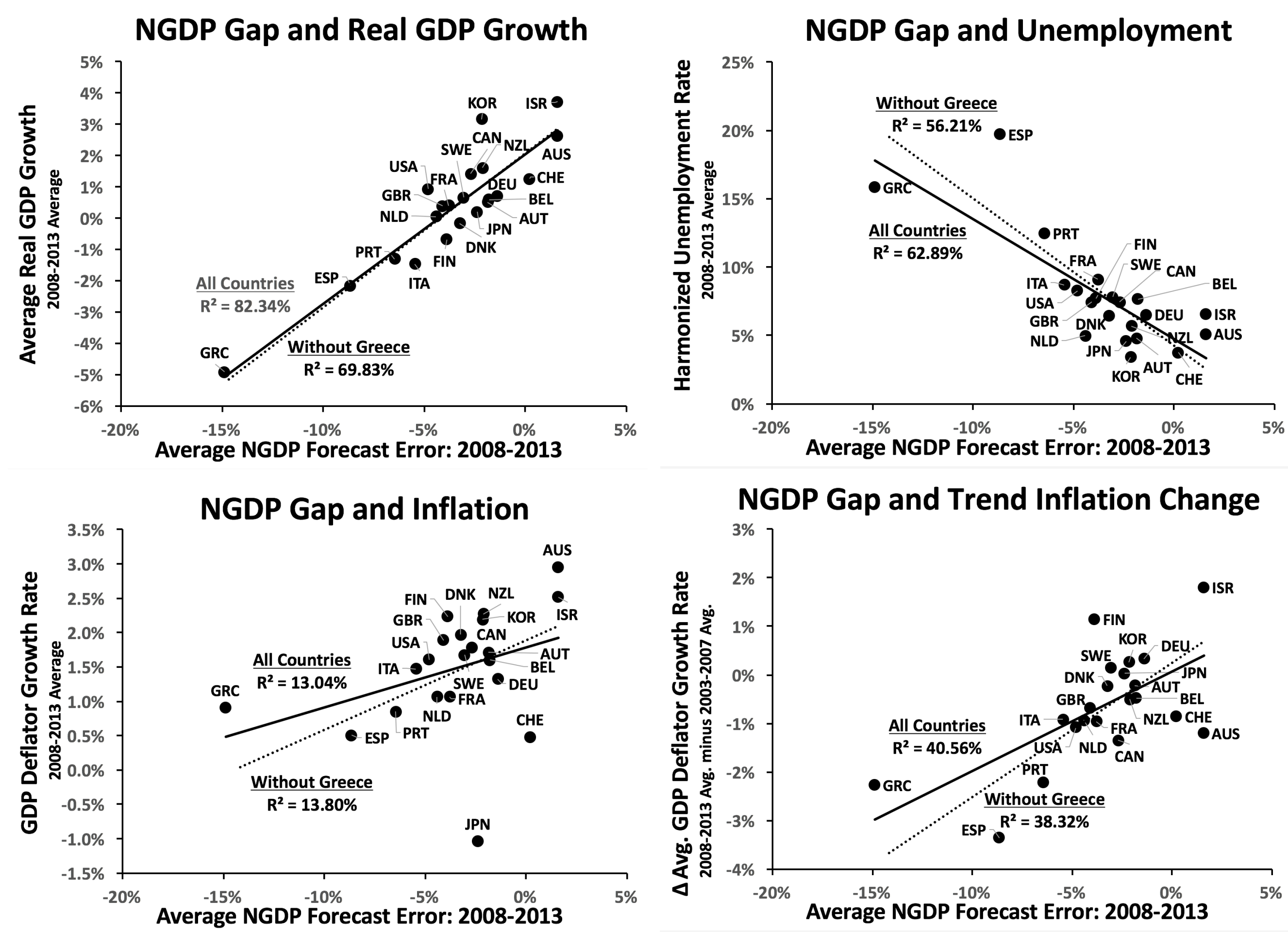
2008:Q1-2013:Q4



Note: data sources listed in the data appendix.

Figure 6: The NGDP Gap and Macroeconomic Indicators

2008:Q1-2013:Q4



Note: data sources listed in the data appendix.

NGDP gap gets larger the rate of non-performing loans increases. The R^2 here is 61 percent for the full sample and 31 percent excluding Greece. Non-performing loans also appear to be robustly related to the NGDP gap.

Finally, the sixth scatterplot displays the relationship between the equity risk premium and the NGDP gap. Here, there is a strong negative relationship for the full sample a R^2 of 56 percent, indicating that as the NGDP gap gets larger the equity risk premium rises. The R^2, however, shrinks to 10 percent when Greece is excluded. This may be the one case where Greece is an outlier.

Figure 5, in short, shows that in almost all cases there was a systematic relationship between the NGDP gap and financial measures, with or without Greece, in the direction predicted by the risk-sharing theory of NGDP during the crisis years. Figure 6 shows the NGDP gap was also systematically related to year-over-year real GDP growth and the unemployment rate during this time. It was less related, however, to the year-on-year inflation rate. There is a stronger fit, though, between the NGDP gap and the change in trend inflation between the 2008-2013 and 2003-2007 periods.

These scatterplots, therefore, strongly suggest that NGDP stability is closely tied to financial and economic stability. Moreover, since most countries experienced persistent NGDP forecast errors over several years during this sample, one can view macroeconomic policy as failing to provide stable nominal demand growth and therefore was an exogenous contributor to this relationship. Put differently, it seems plausible that a meaningful portion of causality flowed from NGDP forecast errors to financial variables in these scatterplots. Still, the scatterplots only establish a robust relationship. The next section attempts to establish causality.

Panel VAR

To better tease out causality, this section estimates a panel vector autoregression (VAR). A VAR is an estimated system of endogenous variable that provides a dynamic forecast. The forecast can be used to identify non-forecasted movements or innovations to variables in the system. These innovations coupled with identification restrictions on the data create exogenously identified shocks to variables of interest. Here, that variable of interest is the NGDP gap.

The VAR is estimated on the data for all 21 countries using quarterly data over the entire sample of 2000:Q1 to 2018:Q2. This larger sample is used avoid degrees of freedom problems that arise using the shorter sample period of the crisis. Moreover, the theory applies to boom periods as much as it does to bust periods since any deviation of NGDP from its expected growth path should affect the distribution of risk between debtors and creditors.

Since this is panel data, a panel VAR is estimated that controls for individual country fixed-effects. This feature means unobserved country-specific heterogeneity that is fixed over the sample will not affect the estimates. Greece, therefore, should not be problem for these estimates.

A parsimonious panel VAR is estimated that has three core macroeconomic variables—the NGDP gap, real GDP growth, and the unemployment rate—and a financial variable as its endogenous variables:

$$z_{i,t} = \left((py)_{i,t}^{gap}, \Delta y_{i,t}, u_{i,t}, f_{i,t}\right)'. \tag{5}$$

Here, $z_{i,t}$ is the vector of endogenous variables, $(py)_{i,t}^{gap}$ is the NGDP gap, $\Delta y_{i,t}$ is the year-over-year growth rate in real GDP, $u_{i,t}$ is the unemployment rate, and $f_{i,t}$ is one of the six financial variables. The subscripts *i* and *t* and represent country *i* and time period *t*. This model is estimated six times with a separate financial variable filling the $f_{i,t}$ slot each time. The model is also estimated an additional time with inflation filling the $f_{i,t}$ slot.[12] Four lags are used in the estimated model and a Choleski identification scheme is imposed on the data.

[12] The IRFs of the core macroeconomic variables do not materially change with the change in the financial variables.

Given the ordering of the variables, the Choleski identification means the $(py)_{i,t}^{gap}$ shock is exogenous to all other variables in the short-run. This allows for impulse response functions (IRFs), which show the typical dynamic response of the variables in the VAR to an exogenous shock to the NGDP gap. The shock to the NGDP gap is set to a negative 1 unit shock. The resulting IRFs are reported in Figure 7.

The top row of Figure 7 shows the IRFs for the credit to the private nonfinancial sector and the M3 money supply both in year-over-year growth rate form. The negative 1 unit shock to the NGDP gap causes both to respond in a similar fashion: they slowly decline for nine quarters and then slowly begin recovering. They are still recovering 14 quarters after the shock. The maximum decline in the private credit growth rate is 0.94 percent and for the M3 growth rate it is 0.89 percent.

The second row of Figure 7 reveals the IRFs for stock and home price year-over-year growth rates. The stock price growth rate declines through three quarters and hits a peak decline of 3.9 percent. The home price growth rate stays depressed over the entire IRF and averages a 0.58 percent decline.

The third row of Figure 7 displays the IRFs for the nonperforming loan rate and the equity risk premium. They both slowly rise over the entire IRF. The nonperforming loan rate tops out at 0.49 percent and the equity risk premium reaches 0.57 percent. Unlike the scatterplots, the equity risk premium remains significant here in the IRFs.

All the financial variables, in short, respond in a large and statistically significant manner to the negative NGDP gap shock. Since this is an exogenous shock, there is more certainty over the direction of causality. NGDP instability does appear to lead to more financial instability.

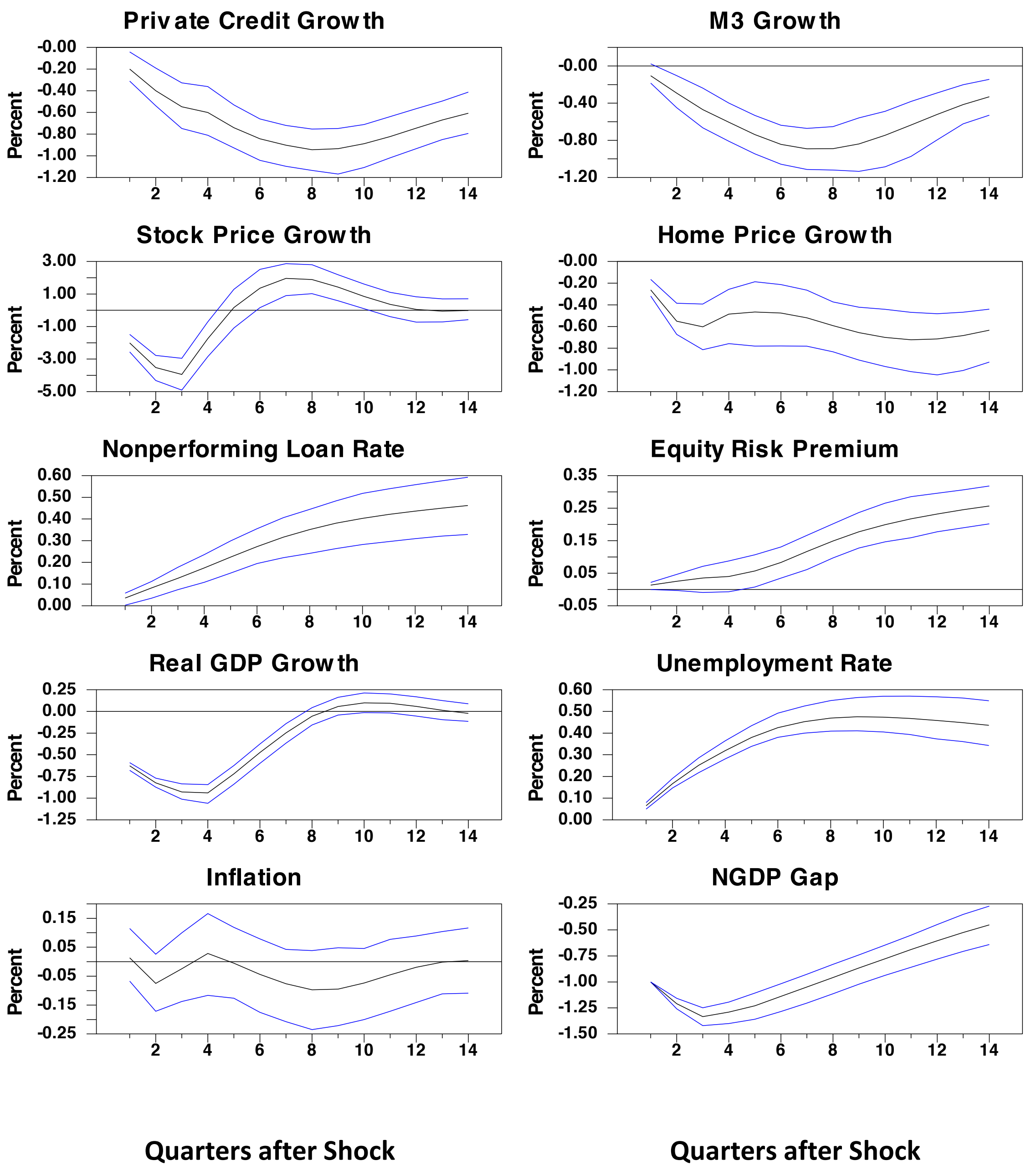
The last two rows of Figure 7 show the response of the macroeconomic variables to the negative 1 unit shock to the NGDP gap. The real GDP growth rate declines to about 1 percent through quarter four and then recovers relatively quickly. The unemployment rate, on the other hand, rises through quarter eight, peaking with a 0.57 percent gain, and begins a slow recovery. The inflation IRF indicates there is no link between it and the NGDP gap shock. This is consistent with the weak relationship in scatterplots and may reflect the successful anchoring of inflation by central banks. Finally, the NGDP gap is shown to start recovering in quarter three from its own shock.

The panel VAR IRFs, therefore, collectively point to a strong causal role for NGDP in promoting financial and economic stability. These findings, therefore, provide empirical support for the proposal to use NGDP targeting as a means to deal with concerns over household debt and financial volatility.

Panel Local Projection Model

One criticism of the Panel VAR is that it applies some structure to the data via the Choleski identification scheme. The data is therefore not strictly "speaking for itself." As a cross check, then, this section reports IRFs from Jorda's (2005) local projection method that are not subject to this critique. Moreover, the local projection method allows for non-linearities and provides a more

Figure 7: Panel VAR IRF from Negative Unit Shock to the NGDP Gap 2000:Q1 – 2018:Q2



Note: IRFs = impulse response functions. Black lines = point estimates, blue lines = 95% SE Bands. The IRFs are based on an estimated fixed effect panel VAR model of the 21 advanced economy countries.

direct estimate of dynamic causal effects. In addition, the local projection like the VAR is applied using panel data and fixed effects so that unobserved country-specific heterogeneity is controlled for in in the regressions. Greece, therefore, should not be problem for these estimates.

The panel local projection approach entails estimating *h* regressions of the form,

$$f_{i,t+h} = \alpha + \beta_h (py)_{i,t}^{gap} + \sum_{j=1}^{J} \gamma_{j,h} \ (py)_{i,t-j}^{gap} + \sum_{j=1}^{J} \theta_{j,h} \ \Delta y_{i,t-j} + \sum_{j=1}^{J} \pi_{j,h} \ u_{i,t-j} + \sum_{j=1}^{J} \rho_{j,h} \ f_{i,t-j} + \beta_{i,h} D_i + \epsilon_{i,t,h} \tag{6}$$

where h is the number of quarters ahead, j is the number of lags, $\beta_{i,h}D_i$ are country fixed effects, and $\gamma, \theta, \pi, \rho$ are parameter estimates on the same lagged control variables used in the panel VAR. Like before, the f_i represents a placeholder for the financial and inflation variables.[13] Also like before, four lags are used for *J*.

This panel local projection regression is estimated for all the variables for $h = 0, \ldots, 14$. That is, regressions at each h horizon are estimated with the parameter of interest being β_h. This parameter estimates the direct effect of the NGDP gap at time t on the other variables at time $t+h$. Unlike the panel VAR, the local projection regression imposes no structure on the data and allows the data to speak for itself.

The lagged control variables are included to help keep β_h estimates unbiased. However, in the regressions with small h there may still be some simultaneity bias. But as h gets larger it is harder to argue endogeneity is a problem.

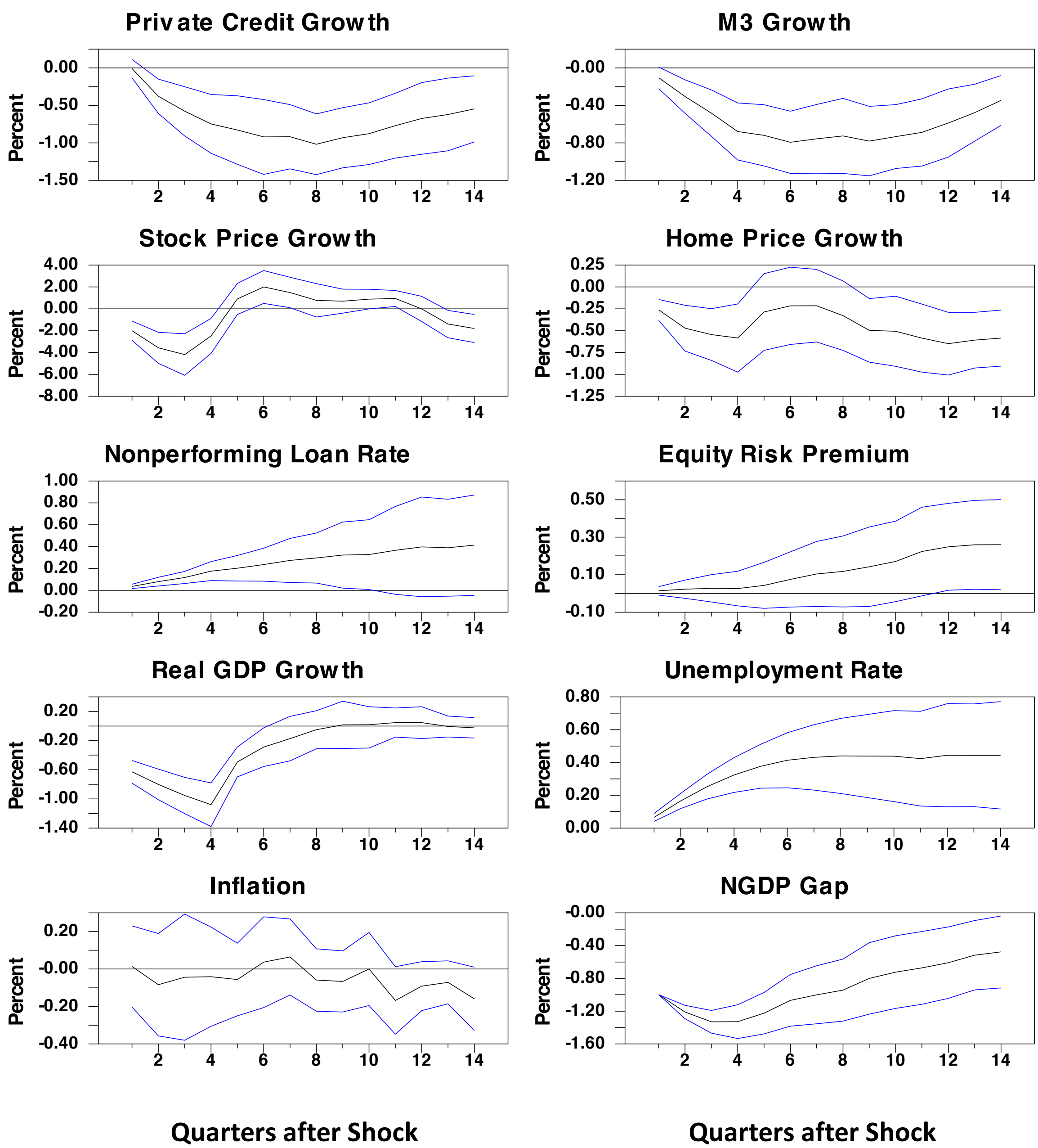
The local projection IRFs are created by plotting the point estimates for β_h and the accompanying 95 percent clustered standard errors bands. These IRFs are reported in Figure 8 for all the variables following a negative 1 unit shock to the NGDP gap.

Figure 8 reveals the local projections IRFs are very similar to the Panel VAR IRFs. The top row of Figure 8 shows the IRFs for the credit to the private nonfinancial sector growth rate and the M3 money supply growth rate similarly decline for nine quarters before slowly recovering. The magnitudes are also similar with a maximum decline in the private credit growth rate of 0.93 percent and a decline in the M3 growth rate of 0.78 percent.

The second row of Figure 8 also shows similar IRFs for stock and home price growth rates. The stock price growth rate declines through three quarters and hits a peak decline of 3.6 percent. The home price growth rate also stays depressed over the entire IRF and averages a 0.83 percent decline.

[13] Here, f_i also serves as placeholder for the core macroeconomic variables when they are run as the dependent variable. When this happens, the ρ control variables fall away since the lagged macroeconomic variables are provided in the $\gamma, \theta,$ and π control variables.

Figure 8: Local Projection IRF from Negative Unit Shock to the NGDP Gap 2000:Q1 – 2018:Q2



Note: IRFs = impulse response functions. Black lines = point estimates, blue lines = 95% SE Bands. The IRFs are based on an estimated fixed effect local projection panel model of the 21 advanced economy.

The third row of Figure 8 displays the IRFs for the nonperforming loan rate and the equity risk premium. They point estimates are again very similar to the panel VAR IRFs, though the standard error bands are much larger for the local projection IRFs.

The fourth row reveals very similar IRFs for the macroeconomic variables. Real GDP growth and the unemployment change by similar amounts, inflation remains insignificant, and the NGDP gap recovers rather briskly.

The local projection IRFs, therefore, tell the same story as the Panel VAR IRFs: a negative NGDP gap shock appears to causally affect the financial and macroeconomic variables in an adverse manner. Only inflation is left unscathed. Once again, then, the evidence points to a strong causal role for NGDP in promoting financial and economic stability.

IV. Conclusion

NGDP level targeting (NGDPLT) has received increased attention over the past decade for various reasons. Some see it as the next step in the evolution of monetary policy regimes since it avoids much of the confusion inherent to inflation targeting (Frankel, 2012; Beckworth, 2014; Sumner, 2011, 2014; Garin et al., 2016). Others have made the case for NGDPLT based on the desirable commitment properties its creates in the face of a zero lower bound (ZLB) environment (Woodford, 2012; Summers, 2018). NGDPLT can similarly be seen as a velocity-adjusted money supply target that is effective in escaping the ZLB (Belongia and Ireland, 2015; 2017). Finally, some see NGDPLT as a workaround to the knowledge problem in monetary policy. There is no need to have real-time knowledge of natural-rate variables in this framework (McCallum, 2011; Beckworth, 2017; Beckworth and Hendrickson, 2018).

These more traditional cases being made for NGDPLT can now be bolstered by the risk sharing argument for it. That is, a monetary regime that targets the growth path of NGDP can be shown to reproduce the distribution of risk that would exist if there were widespread use of state-contingent debt securities (Koenig, 2013; Sheedy, 2014; Azariadis et al., 2016, Bullard and DiCecia, 2018). The idea behind this view is that the countercyclical inflation created by an NGDPLT will cause real debt burdens to change in a procyclical manner. This tendency, in turn, will cause debtors to benefit during recessions and creditors to benefit during booms. Put differently, an NGDPLT will cause fixed nominal-priced loans to act more like equity than debt.

This paper provided an indirect empirical assessment of this risk sharing view of NGDP. It did so by first constructing an NGDP gap measure and checking whether it was systematically related to various measures of financial stability. The paper then used a panel VAR and a panel local projection model to determine if causality ran from NGDP shocks to financial stability. The results from these empirical exercises strongly suggest that there is a meaningful causal role for NGDP in promoting financial and economic stability.

These findings are only a first look at the NGDP – financial stability relationship. Hopefully, they will spur further research on this issue and help inform the discussion at the Federal Reserve and elsewhere on the best monetary policy regime for advanced economies.

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Data Appendix

Data	Source	Comments
Private Credit	BIS Statistics	Category: Credit to the Nonfinancial Private Sector.
M3 Money Supply	Various central bank webistes, OECD, and the Center for Financial Stability (CFS).	Most data was found on central bank websites. For the US, the Divisia M3 measure from the CFS was used.
Stok Price	FRED Dataset,	"Total Share Price" for each country was found on FRED. Data originally comes from the OECD.
Home Price	BIS Statistics, FRED Dataset	Category: Residential Property Price Index.
Nonperforming Loans	World Bank and IMF FSI Datasets	Category: Nonperforming loans as a % of Gross Loans. Data is annual frequency so it was interpolated to a quarterly frequency.
Equity Risk Premium	NYU Professor Aswath Damodaran Personal Webpage: http://pages.stern.nyu.edu/~adamodar/	downloading Professor Damodran's archived past annual estimates of ERP for various countries and interpolating to a quartelry frequency.
NGDP	FRED Dataset	Original Sources: Eurostat, OECD, and BEA.
NGDP Forecasts	IMF WEO Forecasts	Combined biannual forecasts of real GDP growth and inflation to get NGDP growth foredasts. These foreast were then interpolated to a quarterly frequency.
Real GDP	FRED Dataset	Original Sources: Eurostat, OECD, and BEA.
GDP Deflator	Fred Dataset	Original Sources: Eurostat, OECD, and BEA.
Harmonized Unemployment Rate	Fred Dataset	Original Source: OECD