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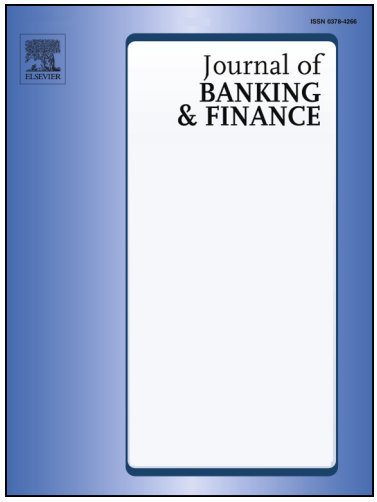

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Financial Fragility in the Great Moderation

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ABSTRACT

A nascent literature explores the measurement of financial fragility. This paper considers evidence for rising financial fragility during the 1984-2007 Great Moderation in the U.S. The literature suggests that macroeconomic stability combined with strong growth of credit to asset markets, in asset prices and in credit relative to output are all indicators of rising financial fragility. We show each of these trends in the Great Moderation. We derive the testable implication that in the Great Moderation credit growth **is** driven more by past credit growth and less by output growth (Allen and Gale, 2000), relative to pre-Great Moderation years. Results from a VAR model estimated on quarterly data for 1955-2007 are consistent with the hypothesis. This invites a reinterpretation of the Great Moderation. Our methodology may help understand when a credit boom turns into a credit bubble, and contributes to the development of methods of measuring financial fragility.

Key Words: financial fragility, great moderation, credit, output, VAR
JEL codes: E44, C32, C51, C52

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Financial Fragility in the Great Moderation

1. Introduction

How does the relation between credit growth and output growth change during a credit boom? Which of these changes are likely to turn credit booms into credit bubbles? Understanding the changes during the boom may help us better understand if and how credit booms precipitate credit crises. In the present paper we focus on this question in an empirical study of the US credit boom that preceded the 2008 crash.

We build on the financial fragility literature which suggests that macroeconomic stability combined with strong growth of credit to asset markets, of asset prices and of credit relative to output, are all indicators of rising financial fragility. We show each of these trends for the 1984-2007 Great Moderation in the U.S. We select a testable implication of rising financial fragility, which is that credit growth becomes driven more by past credit growth and less by output growth (Allen and Gale, 2000). We present evidence that during the Great Moderation, this was true for credit towards the financial and real estate sectors, compared to the pre-Great Moderation years. Results from a VAR model estimated on quarterly data for 1955-2007 are consistent with our hypothesis. This invites a reinterpretation of the Great Moderation and may help understand when a credit boom turns into a credit bubble.

Credit growth leads to output growth (Schumpeter, 1934; King and Levine, 1993; Levine, 2005), but may simultaneously lead to imbalances and crisis. The first effect has been intensively researched, but the conditions for the second effect are not yet well understood. Classical credit cycle theories (Wicksell, 1898; Veblen, 1904; Fisher, 1933; Minsky, 1964, 1986) applied and extended in contemporary work (Allen and Gale, 2000; Keen, 1995, 2013; Borio, 2012) describe how the function of credit in the economy changes over the course of a credit boom and in the run up to a bust. The use of credit shifts from financing low-risk, low-return investment in fixed capital accumulation and productivity improvements, towards financing high-risk, high-return investments in real estate and financial assets and instruments, with increasing leverage and financial fragility. The distribution of the credit stock shifts away from the nonfinancial sectors and towards the financial and real estate sectors (Beck et al., 20102a). In the process, the link between credit dynamics and output growth becomes looser. At the end of a speculative boom,

credit growth and rising asset prices are reinforcing each other, so that credit growth is no longer mainly driven by economic fundamentals, but more by its own past dynamics (Allen and Gale, 2000).

Another feature of the run-up to a boom is that 'stability is destabilizing', as Minsky (1978) wrote. Low volatility in real and financial variables encourages more debt-financed investment and risk taking (Bean, 2011). Greater-than-usual stability is so both caused by more generous credit conditions, and encourages financial innovation and further expansion of credit and leverage. Leverage, in turn, increases financial fragility, measured as vulnerability to asset prices changes (Sutherland et al., 2012). Financial innovations also increase financial fragility (Beck et al., 2012b; Gennaioli et al., 2013).

The US economy during the credit boom that preceded the 2007 Great Crash conformed to each of these features. The 'Great Moderation' years 1984-2007 saw both unusual macroeconomic stability[1], financial innovation and expansion of credit, and a shift in the distribution of credit towards the financial and real estate sectors. This is evidenced in macro-level US credit data (shown below). Kalemli-Ozcan et al. (2012) use micro evidence to show the rise of leverage ratios of US investment banks and financial firms, but not of US non-financial firms. All this suggest that the financial fragility of the US economy was increasing during the credit boom which characterized the Great Moderation years.[2] Therefore this episode may offer an opportunity to study the conditions which distinguish sustainable credit growth from fragility-increasing credit growth.

Financial fragility cannot be directly observed, but based on the literature we develop three testable hypotheses. We consider Granger causation between credit aggregates and output growth when financial fragility is increasing. Although this is no proof of "true" causality, it is evidence that "[t]he cause contains information about the effect that that is unique, and is in no

[1] See e.g. Bernanke (2004). Blanchard and Simon (2001) showed that the standard deviation of quarterly growth and inflation in the U.S. declined by half and by two thirds, respectively, since 1984. Stock and Watson (2002), Kim and Nelson (1999) and Warnock and Warnock (2000) also found this, with strongly declining employment volatility. See Cecchetti et al. (2006) for cross country evidence.

[2] Note that in this paper we do not explain Great Moderation itself. Our argument is different from, but compatible with, a wide range of explanations for the Great Moderation in the literature. This includes labour market changes (Jaimovich and Siu, 2009), oil shocks and responses to shocks (Nakov and Pescatori, 2010, Gambetti et al., 2008), inventory management (McConnell and Perez-Quiros, 2000; Kahn et al., 2002; McCarthy and Zakrajsek, 2007), external balances (Fogli and Perri, 2006), better monetary policies (Bernanke, 2004) and 'good luck' (Ahmed et al., 2002; Cogley and Sargent, 2005; Primiceri, 2005; Sims and Zha, 2006; Gambetti et al., 2008; Benati and Surico, 2009).

other variable" (Granger, 2003).[3] The hypotheses are (i) a weakening of Granger causation from output growth to growth in credit to the nonfinancial sectors, (ii) a weakening of Granger causation from both output growth and growth in credit to nonfinancial business to growth in credit to the real estate and financial markets, and (iii) stronger Granger causation of growth in credit to real estate and financial markets to its own future growth.

We test these hypotheses in a VAR framework on quarterly U.S. data during the Great Moderation (1984-2008) and before the Great Moderation (1955-1979) (where nothing depends on the precise choice of break dates), controlling for inflation and for the stance of monetary policy. We conduct Granger causation tests, impulse response functions and forecast error variance decompositions to probe our hypotheses. Among other findings, we observe that during the Great Moderation, output growth ceases to Granger-cause growth in credit to the nonfinancial sectors. We also find that the percentage of forecast error variance of credit to real estate and financial markets explained by its own past growth rises from 27.5 % before the Great Moderation to 85.1% during the Great Moderation. We tentatively suggest that these and other changes in the relation of credit and output can be interpreted as indication of increasing financial fragility.

We make two contributions. First, despite strongly increased research interest in financial fragility, the concept remains elusive and its measurement difficult. We suggest a translation of key notions in the fragility literature into empirically observable trends. We make no strong claims about the finality of our definitions, but we believe that approaching financial fragility as a change in the relations between variables (credit growth, output growth, volatility) rather than as some variables may prove fruitful in the developing financial fragility research agenda. Second, we link empirically the stability of the U.S. Great Moderation period to the changing relations between credit and output in the U.S. Thus, our contribution is not so much in the technical methods (which are conventional) as in suggesting measures of developing financial fragility.

In the next section we present and discuss the stylized facts of credit and growth in the U.S. from the early 1950s to 2008. We motivate the functional differentiation of two credit

[3] In his Nobel acceptance speech, Granger (2003) continued to say that "[a]t that time, I had little idea that so many people had very fixed ideas about causation, but they did agree that my definition was not "true causation" in their eyes, it was only "Granger causation". I would ask for a definition of true causation, but no one would reply." (Granger, 2003:366).

aggregates. In section 3 we present the methodology, the data and the analysis. Section 4 concludes with a discussion of limitations and possible extensions.

2. The Functional Differentiation of Credit: Trends in the U.S.

To understand the build-up of fragility, we should "distinguish between different categories of credit, which perform different economic functions", as Turner et al. (2010:16) urge. We therefore propose a functional differentiation of credit.

The deepening of markets for financial intermediation, often measured as an increase in the ratio of bank credit to GDP, has long been viewed as a key driver of growth in output.[4] However, a string of recent papers shows that a high value of this ratio may slow down growth (Rousseau and Wachtel, 2011; Arcand et al., 2012; Cecchetti and Kharroubi, 2012), while high growth of the credit-to-GDP ratio increases financial fragility, carrying the risk of crisis (Reinhart and Rogoff, 2009; Schularick and Taylor, 2012; Jorda et al., 2011). Financial fragility is defined as sensitivity of default rates to income or asset price shocks (Jappelli et al., 2008), increasing the probability of financial instability (Minsky, 1978).

In particular, growth of credit *other than* to nonfinancial firms – such as household mortgage credit or credit to financial firms - has been linked with increasing financial fragility (Jappelli et al., 2008; Barba and Pivetti, 2009; Büyükkarabacak and Valev, 2010). Allen and Gale (2000) show theoretically how, by simultaneously driving up asset prices and leverage in a mutually enforcing process, such financing may increase financial fragility. Borio and Lowe (2004) find empirically that high credit growth coupled with an asset price boom is a good predictor of financial fragility and instability. Bernoth and Pick (2011) demonstrate that linkages between banks and insurance companies are important when forecasting financial fragility. Each of these findings suggest a special role for credit supporting price rises in (real estate and other) assets, distinct from credit to nonfinancial firms, supporting the production of goods and services. Kalemli-Ozcan et al. (2012) link the rise in their measure of financial fragility in the US in the 2000s to increasing leverage in households and in nonbank financial firms, but not in non-financial firms.

[4] The empirical literature started with King and Levine's (1993) seminal *Finance and Growth: Schumpeter Might Be Right* which builds on Schumpeter (1934, 1939), Goldsmith (1969), McKinnon (1973) and Shaw (1973). Levine (2005) and Ang (2008) provide overviews. Beck et al. (2009) present recent empirical results.

This suggests that bank credit to markets for real estate, stock, bonds and other financial assets and instruments - jointly labelled the 'finance, insurance and real estate' sectors, or 'FIRE' sectors in the U.S. *National Product and Income Accounts* – may deserve special attention. The literature indicates that especially debt-financed returns may increase financial fragility. Grydaki and Bezemer (2013) show that growth in credit supporting wealth formation helps explain reduced output growth volatility. Kemme and Roy (2012) find that the U.S. mortgage credit boom, which was instrumental in increasing housing wealth, was a predictor of the 2007 crisis. In this paper we are, therefore, especially interested in changes in the credit-growth relations *before* the crisis, for separate credit aggregates. We constructed time series over the period 1951-2007 for credit to the nonfinancial sector and FIRE-sector credit, based on flow of funds data.

We observe that the U.S. credit boom, since the 1980s until the 2008 crisis, was overwhelmingly due to credit to the 'FIRE' sectors, not to the nonfinancial sectors. Figure 1 illustrates this. The GDP ratio of credit to the nonfinancial sectors was roughly stable between 80% and 110% over the six decades 1951-2007, with most of the increase due to an upward shift in the mid 1980s. But credit to the FIRE sectors rose from less than one third of GDP in the early 1950s to more than twice the GDP level in 2007, with most of that growth occurring during the Great Moderation. In 1984, the GDP ratio of the volume of FIRE-sector credit instruments was still below 100%. After that until the 2008 crash, it was growing at 4.6% annually on average, compared to only 1.1% for the GDP ratio of nonfinancial sector credit.

[Figure 1 HERE]

The Great Moderation years were not only credit boom years, but as its name implies, also years of macroeconomic tranquillity. Minsky (1978) identified unusual stability as another feature of a destabilizing credit boom. With more stability, agents are encouraged to take more risk, leading to bubbles and busts (Allen and Gale, 2000). Bean (2011) discusses how during the Great Moderation, low volatility in real and financial variables induced more debt-financed investment and risk taking. For all these reasons – the upward shift in credit-to-GDP ratios; the shift in credit growth from the nonfinancial to the FIRE sector; and the onset of stability ending in severe instability – we study the 'Great Moderation' years 1984-2007, in contrast to the preceding decades, as a 'credit boom gone bust' (Schularick and Taylor, 2012). We know there was a credit

boom (Figure 1) and we know this was followed by a 'bust'. In this paper we ask how we may observe whether financial fragility increased during the boom.

The challenge we address is how to distinguish a credit boom leading to a bust from one that is part of the normal financial deepening process. The approach we take is not so much to ask 'what drives GDP?' (as in the credit-growth literature; Uhlig, 2004) as 'what drives credit?'. The question we ask is: 'How are the relations of credit aggregates with growth and with each other different in a sustainable growth episode, compared to credit growth with increasing financial fragility?' We quantify the strength of relation in terms of Granger causation. It bears repetition that this is not equal to substantive causality, but it is a measure of how common sequences of changes of different variables are in a given time series. We exploit the fact that we know that the U.S. credit boom since the mid-1980s did lead to a credit crisis (Kemme and Roy, 2012) and suggest three testable hypotheses.

First, if nonfinancial sector credit is allocated such that it increases economic efficiency, it is allocated in response to observed growth opportunities (an assumption also exploited in the literature on international financial flows and growth; Prasad et al., 2007; Rodrik and Subramanian, 2009). By implication, over time we expect nonfinancial sector credit growth to increase following increases in GDP growth. Conversely, if the build-up of financial fragility is due to the misallocation of credit, then we expect to see a weakening of this Granger causation between output and nonfinancial-sector credit.

Second, the sequence in a sustainable growth process is that nonfinancial sector credit by banks or markets which leads to growth, allows for investments in wealth (real estate, stocks and bonds), and the credit flows that finance these investments (such as mortgages). In this process, we should observe changes in FIRE-sector credit growth following nonfinancial-sector credit growth and GDP growth. If, on the contrary, financial fragility is building, this implies self-propelled growth in asset markets where capital gains induce more borrowing, with little relation to investment and growth in the nonfinancial sectors. In this case, we expect to see a weakening of Granger causation from both GDP growth and nonfinancial-sector credit growth to FIRE-sector credit growth. Our testable hypotheses, then, are that we observe during the Great Moderation relative to earlier years: (i) a weakening of Granger causation from output growth to growth in credit to the nonfinancial sectors, (ii) a weakening of Granger causation from both output growth and growth in credit to the nonfinancial sectors to growth in credit to the FIRE

sectors, and (iii) stronger Granger causation in growth in credit to real estate and financial markets to its own future growth.[5]

3. Methodology, Data and Analysis

We estimate a Vector Autoregressive (VAR) model (Sims, 1980), which allows analysis of interdependencies between time series. Since we have no priors on exogeneity or the direction of causation, all variables are treated as endogenous. Each variable may depend on its own lags and on the lags of other variables. The structure of the model is:

$$y_t = \mathrm{A}_0 + \mathrm{A}_1 y_{t-1} + ... + \mathrm{A}_p y_{t-p} + \varepsilon_t \quad (1)$$

where y_t is a (n x 1) vector with each of the n endogenous variables, A_0 a (n x 1) vector of intercept terms, A_i reflects (n x n) matrices of coefficients with $i=1,...p$, and ε_t denotes a (n x 1) vector of error terms. The variables included in the model are the annual growth rates of the logarithm (i) of real GDP (RGDP), (ii) of the real value of the stock of credit instruments in the nonfinancial sectors (RCR), and (iii) of the real value of the stock of credit instrument in the FIRE sectors (RCF). This includes both credit by deposit taking institutions (banks) and other financial institutions, which hold both (securitized) bank loans and other credit assets. Data were obtained from the Bureau of Economic Analysis.[6]

[5] Note that we do not have a hypothesis on the causal relation from nonfinancial-sector credit growth to output growth. Because credit to the nonfinancial sectors is used by nonfinancial firms and households for nonfinancial transactions, this is bound to increase GDP over all stages of a credit cycle. We expect to find Granger causation from nonfinancial sector credit to output growth both before and during the Great Moderation, but this is not a hypothesis that helps us distinguish between sustainable growth and increasing financial fragility. A second point of note is that we also do not hypothesize that credit to the FIRE sector normally causes output growth, but that this causal link weakens during a bubble. FIRE-sector credit consists of loans to support investment in assets, not in goods and services, so there is no reason to expect a direct causal relation to transactions in goods and services, as measured by GDP. At best, debt-financed investment in bonds and stocks may facilitate investment in the nonfinancial sectors, which in turn causes growth. In that sense FIRE-sector credit flows are secondary to the growth process. Beck et al. (2012a) show in cross-country regressions that mortgages - the larger part of their household credit measure - indeed has no effect on output growth.

[6] We utilize quarterly data from 'Z' tables in the Flow of Funds Accounts. We construct the stock of credit instruments in the nonfinancial sectors **as** follows. We take series FL384004005.Q, titled 'domestic nonfinancial sectors credit market instruments' and subtract mortgage credit (series FL383165005.Q, 'domestic nonfinancial sectors; total mortgages). We correct for inter-firm trade credit (FL383070005.Q; see Mateut et al., 2006 on the role of trade credit), firm-to-customer consumer credit (FL383066005.Q) and 'other loans and advances' (FL383069005.Q). Finally, we subtract net financial investment (including home equity withdrawal; Greenspan and

We also include two control variables: the annual growth rate of the logarithm of the (overnight) federal funds rate (FR), and inflation (INF) measured by the real GDP deflator, both provided by the St. Louis Fed website. We use quarterly data over two subsamples, 1955Q3-1979Q4 (before the Great Moderation) and 1984Q1-2008Q1 (during the Great Moderation). We follow the convention in the Great Moderation literature, where 1984 is often adopted as the start of the Great Moderation (among others Kim and Nelson, 1999; McConnell and Perez-Quiros, 2000; Kahn et al., 2002; Stock and Watson, 2002), though other years in the early 1980s are also used.[7] We also did an extensive break point robustness analysis by letting the data select break points independently of the Great Moderation dating. This did not change the findings reported below, so that we are confident our results are not driven by the choice of break points.[8]

All three endogenous variables, the annual growth rates of RGDP, RCR, RCF, are found to be stationary at their level (I(0)), but the control variables, the annual growth rate of FR and INF are detected to be stationary when taking their first difference (I(1)) in both subsamples.[9] Table 1 reports descriptive statistics for the variables (absolute mean, standard deviation, skewness and kurtosis) for the two subsamples.

[Table 1 HERE]

The growth of all variables is positive before the Great Moderation and all variables are more volatile before the Great Moderation than during the Great Moderation, apart from the growth

Kennedy, 2008). We construct FIRE sector credit by adding mortgage credit held in the nonfinancial sector (series FL383165005.Q) to domestic financial sector credit market instruments.

[7] Our choice of samples ensures that the first sample is before the Great Moderation, and the second sample is during the Great Moderation. We applied the Chow test for structural breaks over the whole period 1955Q3-2008Q1 and find that any other quarter during 1980Q1-1983Q4 is also a potential breakpoint in output volatility. We also ran robustness analyses to ensure that our findings are not sensitive to using another quarter as the start of the Great Moderation.

[8] We checked for multiple unknown breaks in the credit data during the entire sample using the Bai-Perron procedure. Four breaks were detected (1967Q2, 1975Q1, 1990Q4 and 1998Q2); in addition, there are multiple break points in the output growth series: 1967Q2, 1975Q1, 1982Q3 (the Great Moderation start), 1990Q4, 1998Q2 and 1999Q4. We then conducted the analysis using these break points. The results in and before the Great Moderation are consistent with the results reported in this paper, which adopts break point consistent with the dating of the Great Moderation in the literature. That is, our results are not driven by the choice of break points.

[9] We apply the following stationarity tests to the logs of the variables: (i) Kwiatkowski–Phillips–Schmidt–Shin (KPSS) (Kwiatkowski et al., 1992), (ii) Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1979) and (iii) Phillips and Perron (PP) (Phillips and Perron, 1988). For tests (i) and (iii), the lag length was selected by the kernel-based estimator of the frequency zero spectrum, which is based on a weighted sum of the covariances. For test (ii) the selection of the number of lags in the test equations is according to the Schwartz Information Criterion (SIC). The stationarity is tested at 1%, 5%, 10% significance levels and the time trend has not been taken into account in the test equation. The unit root test results are available on request.

rate of RCR. The distribution of annual growth rates of real output, real credit to nonfinancial sectors and real credit to financial and real estate sectors all exhibit positive skewness with few high values in the first subsample; the opposite holds for the remaining variables. Furthermore, the kurtosis (or "peakedness") statistics for the distributions of almost all the variables show more deviations from the normal distribution in the first subsample than in the second, apart from the annual growth rate of funds rate for which the inverse case holds.

We estimate a number of reduced-form VAR models for two subsamples using quarterly data, 1955Q3-1979Q4 (before the Great Moderation) and 1984Q1-2008Q1 (during the Great Moderation) where nothing depends on the choice of the break point. We examine whether lags of the annual growth of RCR, RCF and RGDP Granger-cause these or other variables. We estimate VAR(p) models with $p=1,\ldots12$ and the model selection criterion is the minimum value of SIC. This procedure yields VAR(2) and VAR(1) models for the first and second subsamples, respectively.[10]

After estimating the model, we explore the relationships between the variables in three ways. First, we run Grange causality tests, where a series x_t is said to Granger-cause a series y_t if changes in x_t precede changes in y_t so that x_t improves predictions of y_t, but y_t does not improve predictions of x_t (Granger, 1969). Second, we compute impulse response functions (IRFs) which quantify the effect of a one standard deviation shock to innovations in the error terms of one variable on current and future values of it and all other variables. An IRF graph so displays the response of any variable over time to a shock in its own or other error terms. Sims (1980) suggests that examining IRFs might be the most effective way to observe the presence (or otherwise) of Granger causation in multivariate frameworks. A third way of characterizing the dynamic behavior of the VAR is to conduct a forecast error variance decomposition analysis, as suggested also by Sims (1980).

[Table 2 HERE]

Granger causation tests are reported in Table 2. We detect, first, bidirectional Granger causation from the growth of RCR (GLRCR) to growth of RGDP (GLRGDP) and vice versa in the first

[10] Although the lag order of the VAR is too short, the dynamic behavior of the variables can be captured sufficiently in the first subsample. We tried also VAR(5) and VAR(11) for the first and second subsample, respectively, indicated by Akaike Information Criterion (AIC) and the results do not change substantially.

subsample, but unidirectional Granger causation from GLRCR to GLRGDP in the second subsample. This finding is consistent with the hypothesis that the build-up of financial fragility during the Great Moderation was due to the misallocation of credit, indicated by weaker Granger causation from GLRGDP to GLRCR. Second, both GLRCR and GLRGDP Granger-caused the growth of RCF (GLRCF) before the Great Moderation. The Granger causation from GLRCR to GLRCF is still significant in the Great Moderation, though with much lower values for the test statistic, implying the gradual weakening of Granger causation from GLRCR to GLRCF. This is consistent with the second hypothesis. Moreover, both the impulse response function (IRF) graphs and the forecast error variance decomposition show greater responsiveness of credit to its own lags in the Great Moderation (something we cannot test in a Granger causation framework).

[Figure 2 HERE]

Figure 2 show results from IRF analyses over 12 periods for the two subsamples. The IRF graphs are all consistent with the Granger causation tests before the Great Moderation, but not during the Great Moderation. GLRGDP responds positively to a one-standard deviation shock in the growth of GLRCR both before and during the Great Moderation. We also observe a reverse response, of GLRCR to a one-standard deviation shock in GLRGDP after three quarters before the Great Moderation. This reverse response is absent during the Great Moderation, in line with our first hypothesis.

Further, GLRCF responds positively to a one-standard deviation shock in the growth of GLRCR before, but not during the Great Moderation, in line with hypothesis 2. The response of GLRCF to GLRCR during the Great Moderation is positive and significant only in the first quarter, and insignificant in the other 11 quarters. This stands in contrast to the response of GLRCF to GLRCR before the Great Moderation period, when it was positive and significant during the whole period. So we do indeed find a weakening of Granger causation from growth in credit to the nonfinancial sectors to growth in credit to the FIRE sectors, as in hypothesis 2.

We also note that during the Great Moderation, FIRE-sector credit growth appears much more self-propelled during the Great Moderation than before, in line with hypothesis 3. GLRCF responds more strongly and with longer duration to a one-standard deviation shock in its own growth during the Great Moderation.

Finally, also forecast error variance decomposition analysis supports the observations from Granger causation tests (Table 3).We computed the 12-quarters-ahead forecast error variance decompositions. The percentage of forecast error variance of nonfinancial sector credit growth explained by real output growth was 11.5% before the Great Moderation but only 0.3 % during the Great Moderation, in line with our first hypothesis. Second, the percentage of forecast error variance of FIRE-sector credit growth explained by nonfinancial sector credit growth was 66.8 % before the Great Moderation, falling to 14.7% during the Great Moderation, in line with our second hypothesis. The percentage caused by GDP growth goes down from 5.7% to 0.3%. In this sense, FIRE-sector credit indeed decoupled from output and especially from the credit flows that finance output. Finally, the percentage of the forecast error variance of FIRE-sector credit growth explained by its own past growth was 27.5% before the Great Moderation, but rising to a remarkable 85.1% during the Great Moderation. FIRE sector credit became mainly driven by itself, by this evidence.

[Table 3 HERE]

4. Summary, Conclusions and Policy Implications

The U.S. during the 1984-2007 Great Moderation saw unusual macroeconomic stability combined with strong growth in asset prices and in credit relative to output, with a shift in the distribution of credit towards the financial and real estate sectors. We discuss the literature which shows that each of these trends is associated with increasing financial fragility, suggesting that the Great Moderation stability was destabilizing. We develop testable implications by exploiting the implication that with increasing financial fragility, credit growth is driven more by past credit growth and less by output growth. This is especially relevant to credit towards the financial and real estate sectors.

Based on flow of funds data, we construct time series of credit to the nonfinancial sectors and credit to the financial and real estate sectors. In the analysis, we distinguish between these different credit aggregates and their roles in generating financial fragility. We explore the changing relations between credit aggregates and growth in terms of Granger causation in the context of a VAR model. Different from substantive causality, Granger causation is a measure

for how common sequences of changes of different variables are in a given time series. This fits the definition of financial fragility which we employ.

Results from VAR estimations on quarterly data before the Great Moderation show bi-directional Granger causation between output and credit to the nonfinancial sectors and unidirectional Granger causation from credit to asset markets to credit to the nonfinancial sectors. During the Great Moderation until the 2008 crash, Granger causation from output to credit to the nonfinancial sectors is no longer observable. Changes in credit to asset markets are Granger caused by own past changes more than by any other variable in the system, which was not the case before the Great Moderation. These results are consistent with the hypotheses. The changes in the relations of credit and output invite a reinterpretation of the Great Moderation.

We present these results as tentative evidence that it is possible to empirically distinguish between two scenarios. One is where credit growth supports output growth in a sustainable manner. Financial deepening does not increase financial fragility and does not increase the likelihood of finance-induced instability. The other scenario is where financial deepening, even while it supports growth in output, renders the economy more vulnerable to shocks, or is building up the likelihood of shocks produced by the financial sector itself. This distinction has been spelled out in the theoretical literature, but there is yet no consensus on the empirical measurement of financial fragility. We offer this analysis as a contribution towards that goal. Perhaps financial fragility can fruitfully be conceptualized as a change in the relations between macro variables, rather than as a variable itself.

There are two broad policy implications. The first is that monitoring and, perhaps, regulation of credit and asset markets should be part of macroprudential policy. Even if asset prices are not a target for monetary policy in the way consumer prices are, asset prices and the credit flows that support asset markets are apparently informative on financial fragility, and should therefore be subject to macroprudential policies. This is especially true for real estate asset markets, as one us argues in detail elsewhere (Bezemer, 2014). Researchers at the Bank for International Settlements have been calling attention to the role of asset markets for financial stability for many years, even before the crisis (Borio and Lowe 2002). Increasing recognition of these relations should now be translated into policy frameworks.

Second and relatedly, macroeconomic analysis for policy purposes should include indicators of financial fragility, beyond conventional real-sector indicators such as inflation,

unemployment, growth, inventories and external balances. It was the use of financial-sector and asset market indicators which allowed some policy oriented analysts to warn timely for the financial crisis in the U.S., while most official and academic models remained sanguine on economic prospects until 2007 (Bezemer, 2010). In turn, policy analysis it still too much grounded in theoretical macroeconomic models which omit the financial sector and asset markets. A paradigm change is needed, and may be underway (Bezemer, 2011; Brunnermeier and Sannikov 2014). This is still relevant to policy after the crisis. Private debt levels have not come down much since the crisis so that financial fragility is still believed to be large, as the BIS warns in its 2014 Annual Report (BIS, 2014:4). The overarching policy lesson is that while finance is not the economy, the financial sector must be included in the formulation of macroeconomic policies towards stable growth.

TABLES AND FIGURES

Table 1: Descriptive Statistics

	Mean	Std dev.	Skewness	Kurtosis
1955Q3-1979Q4				
Real output (RGDP)	0.0764	0.0349	0.1338	3.4540
Real value of credit in nonfinancial sectors (RCR)	0.0764	0.0309	0.6074	4.2750
Real value of credit real estate and financial sectors (RCF)	0.1059	0.0280	0.3029	2.4826
Inflation (INF)	0.0007	0.0044	-0.2635	4.3228
Federal funds rate (FR)	0.0878	0.4175	-0.4358	3.5891
1984Q1-2008Q1				
Real output (RGDP)	0.0566	0.0273	-0.6319	3.0708
Real value of credit in nonfinancial sectors (RCR)	0.0683	0.0353	-0.2852	2.7373
Real value of credit real estate and financial sectors (RCF)	0.1011	0.0290	0.0785	2.5500
Inflation (INF)	-0.0002	0.0023	-0.1862	3.3362
Federal funds rate (FR)	-0.0330	0.3934	-0.0048	4.1800

Note: RGDP and the credit variables are the annual growth rates of the logarithm of RGDP and credit stocks, respectively. INF and FR are the quarter-on-quarter change in INF and the log of FR, respectively.

Table 2: Granger causation tests

Testable Hypotheses	Pre-Great Moderation	During-Great Moderation
	Chi-square statistic	
	1955Q3-1979Q4	1984Q1-2008Q1
Real value of credit in nonfinancial sectors (RCR) does not Granger cause real output (RGDP)	15.7741 (0.0004)	9.7792 (0.0018)
Real output (RGDP) does not Granger cause real value of credit in nonfinancial sectors (RCR)	12.0705 (0.0024)	0.1453 (0.7031)
Real output (RGDP) does not Granger cause real value of credit real estate and financial sectors (RCF)	7.0446 (0.0295)	0.0069 (0.9336)
Real value of credit in nonfinancial sectors (RCR) does not Granger cause real value of credit real estate and financial sectors (RCF)	36.1535 (0.0000)	8.2267 (0.0041)
Real value of credit real estate and financial sectors (RCF) does not Granger cause real value of credit in nonfinancial sectors(RCR)	2.7934 (0.2474)	1.2572 (0.2622)

Notes: Granger causation tests are conducted on the growth rate of the variables. Probability values of the corresponding Chi-square statistics are in parentheses.

Table 3: Credit growth: forecast error variance decomposition

% of 12-quarters-ahead forecast error variance of credit growth in nonfinancial sectors explained by ...	
Before the Great Moderation	*During the Great Moderation*
output growth: 11.5%	output growth: 0.3%
credit growth in FIRE sectors: 0.6%	credit growth in FIRE sectors: 2.1%
% of 12-quarters-ahead forecast error variance of credit growth in FIRE sectors explained by ...	
output growth: 5.7%	output growth: 0.3%
credit growth in nonfinancial sectors: 66.8%	credit growth in nonfinancial sectors: 14.7%
credit growth in FIRE sectors: 27.5%	credit growth in FIRE sectors: 85.1%

Figure 1: U.S. Stocks of Credit Market Instruments (% GDP)

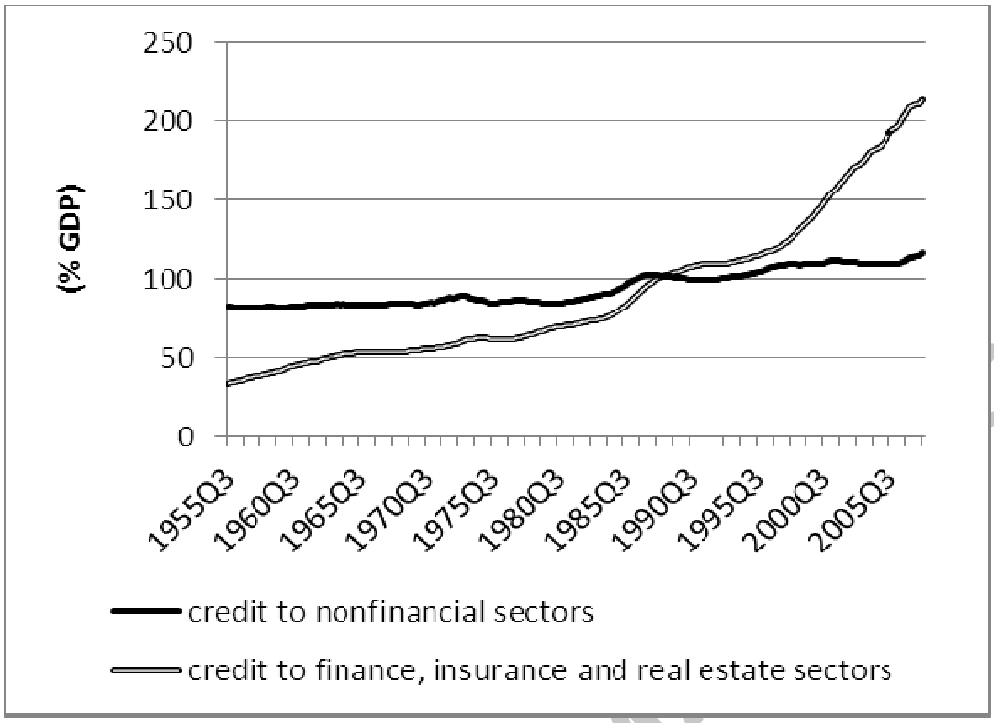


Figure 2: Impulse Responses to shocks before (1955Q3-1979Q4) and during the Great Moderation (1984Q1-2008Q1)

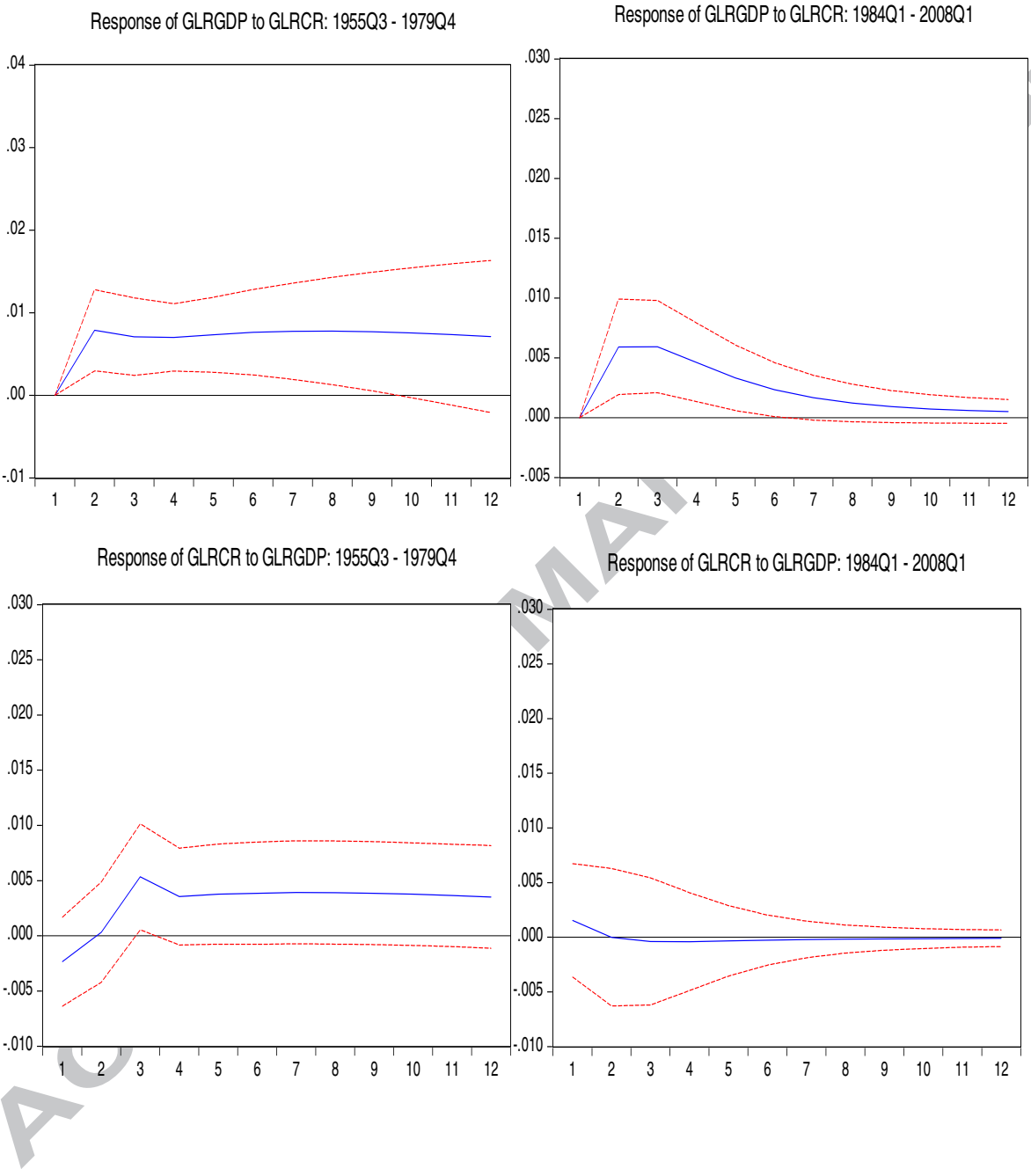


Figure 2 (continued)

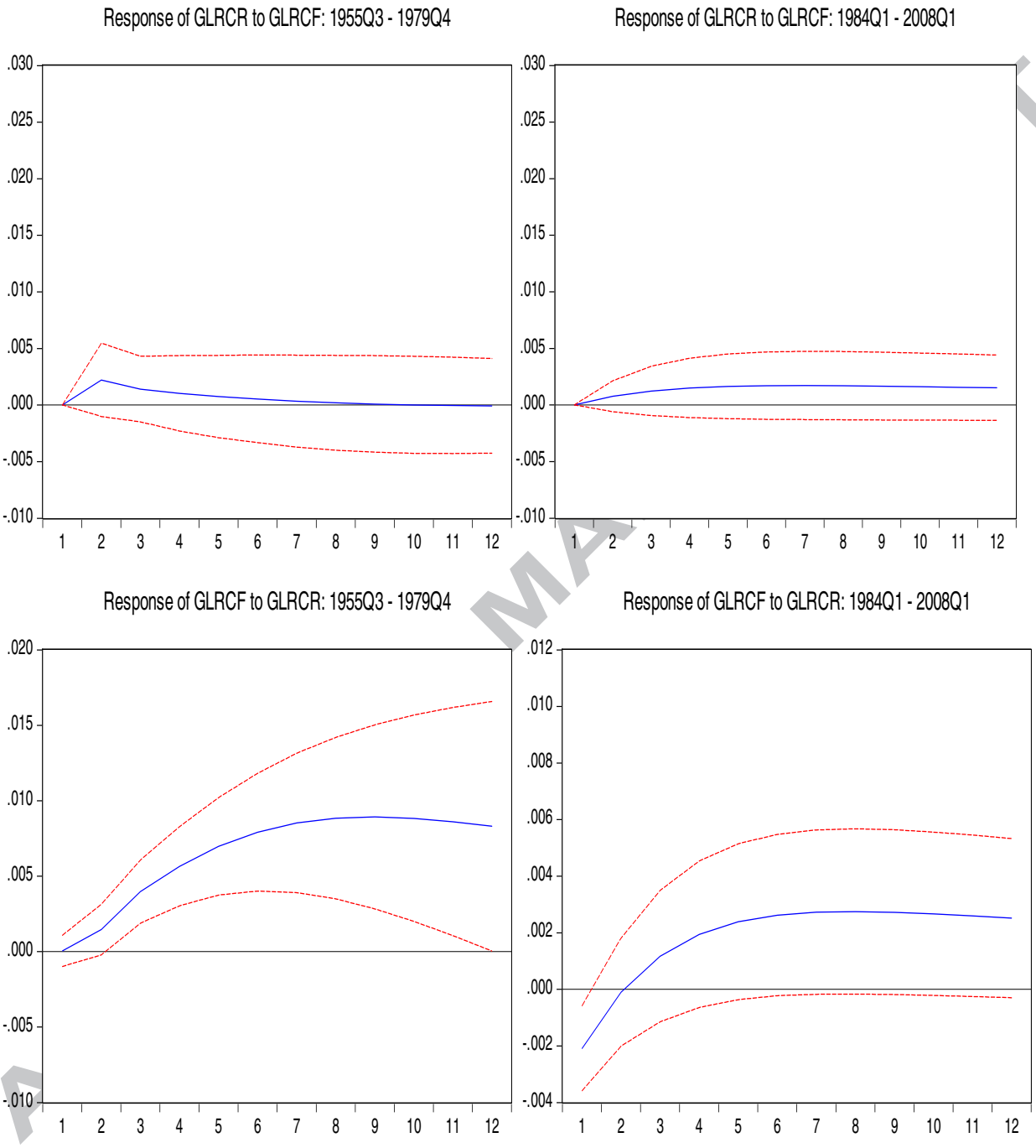
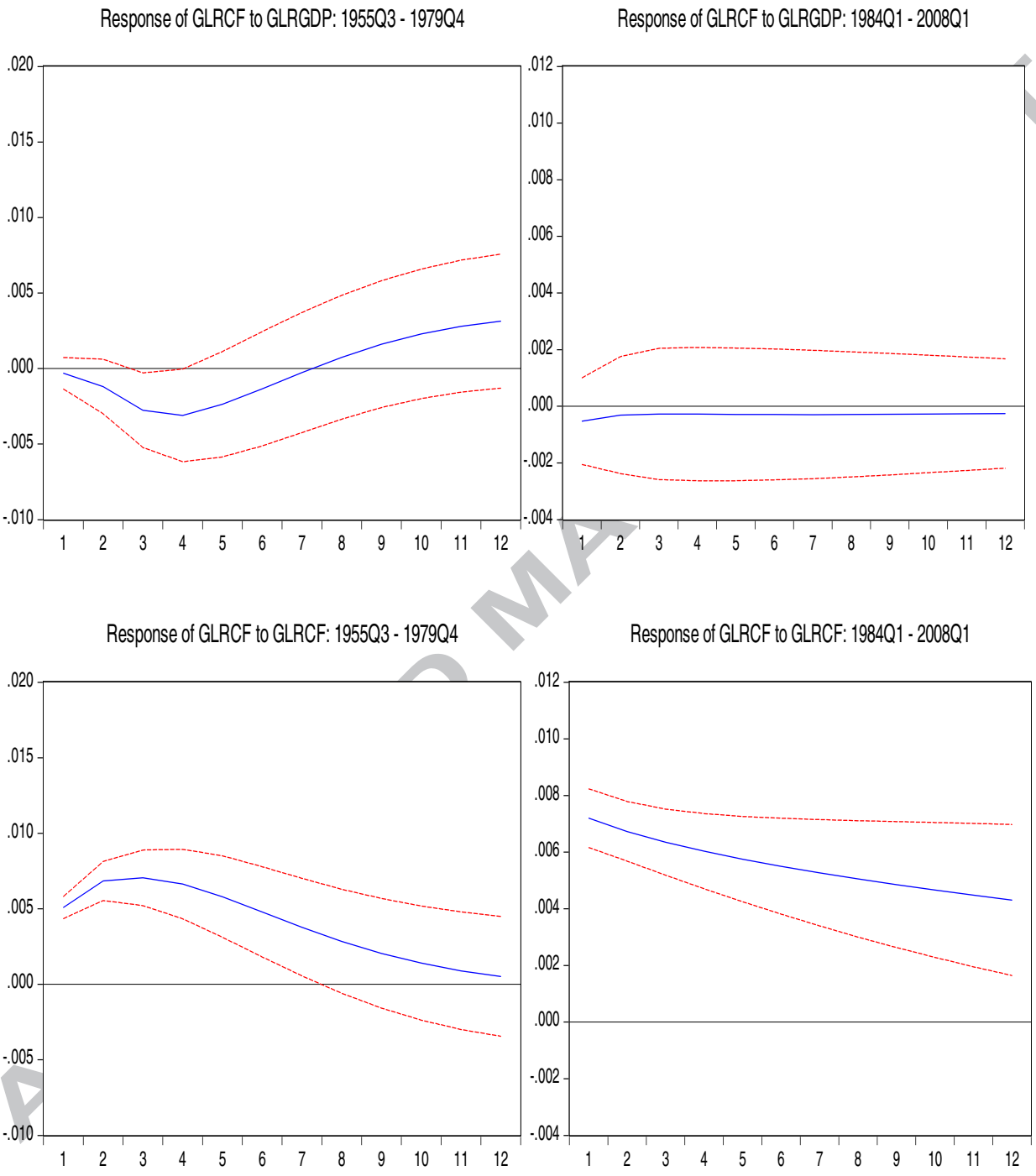


Figure 2 (continued)



Notes: The impulse responses reflect response to Cholesky one standard deviation innovations±2 s.e.

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Highlights

- We conceptualize financial fragility as a changing relation of credit and output.
- We develop three testable hypothesis on two credit aggregates and output.
- We study financial fragility during the 1984-2007 Great Moderation in the U.S.
- VAR estimations on 1955-2008 quarterly data are consistent with the hypotheses.