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Working paper

Have the US Macro-Financial Linkages Changed? The Balance Sheet Dimension

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Abstract

We establish a set of US stylized facts on prices, quantities and balance sheets, assess the consistency of the current generation of financial friction (heterogeneous agent) models to these, and provide guidance on the challenges ahead. We find strong evidence for a deep transformation in the US economy around the millenium shift, and argue that the difficulty in reviving this growth model under current financial market conditions is behind the anemic recovery since the Great Recession. A wider implication of our findings is that accumulation of stocks might alter agents risk preferences, production technologies, or beliefs to such a degree that the optimization problem that those agents face has transformed over time. The economy is effectively in a different state of nature, and agents may face different constraints. Future models need to take a different strategy to modelling the long-run ratios, since these have increased over the long-run and this has had an effect on both the frequency and the amplitude of the business and credit cycles.

Keywords: Balance sheet, financial market, credit, secular stagnation, Great Recession, business cycle, financial friction models

JEL: E3, E44, E51, C68

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1. Introduction

The nexus between real and financial activity has been the focus of the discussions following the global financial meltdown in 2008. However, in contrast to previous discussions, the key points raised were not solely related to the flow of funds between the different sectors of the economy, but more importantly they were regarding the endogenous effects of the growing pre-crisis balance sheets of each sector, in particular the impact they had on intra- and inter-sector flows. Although that idea is not entirely new or unique in the literature, the novelty has been that exact estimates have been generated on how stocks, such as leverage and net worth of each sector have impacted the expansion of real activity over the past one to two decades.[2]The current generation of financial friction models has partially incorporated some of these observations in their theoretical analyses of the macro-financial nexus. While they represent a first attempt, they have already generated important insights into how, for instance leverage in the financial sector influences the flow decisions of each economic agent.[3]We wish to evaluate these models in the current paper in terms of how well the models match the US macroeconomic and financial data, and provide guidance and directions on how to proceed in this relatively new and growing theoretical debate.

We do this by initially establishing a broad range of stylized facts regarding the US macroeconomic and financial cycles. We ground our work on Stock and Watson's (1998) empirical study of the US business cycles, which provided the empirical ground for the DSGE revolution over the past fifteen years.[4]They recorded a broad set of stylized facts and empirical regularities between the aggregate business cycle and macroeconomic indicators such as spending (including investment), production, employment, productivity, wages, interest rates and prices using the post-war dataset. However, the emphasis of the study was on real activity, and on sectorial components of output, and much less on the financial side of the economy.

[2]The Austrian school had early on adopted a dynamic approach to the study of the economy, which accommodated for stock accumulation and related imbalances in their analyses. See Laidler (1999) for further discussion on the Austrian approach. For a recent discussion of these issues, see for instance Adrian and Shin (2009), or Pozsar et al (2010).

[3]See for instance Gertler and Karadi (2011), Gertler and Kiyotaki (2011), Hilberg and Hollmayr (2011) on the real effects of financial sector leverage, or Chadha et al (2010) and Kiyotaki et al (2011) on the real effects of household leverage, or Bernanke et al (1999), Gilchrist et al (2009), and Christiano et al (2010) on the real effects of firm leverage.

[4]Chadha *et al* (2000), and Chadha and Nolan (2002) established similar stylized facts for the UK.

A few years later, by the turn of the millennium, considerable research effort had made the case for a reduction in output volatility and other output-driven variables during the preceding two decades.[5]Kim and Nelson (1999), McConnell and Perez-Quiros (2000), and Stock and Watson (2003) argued strongly, both in univariate and multivariate break tests, that there had been a structural break in 1984. The Great Moderation, as the period is referred to, exhibited distinctive characteristics since most macroeconomic variables experienced a much smoother growth and smaller cyclical fluctuations when compared to the overall pattern since the post-war period. However, there was no agreement on the underlying causes for this new episode. While some argued that this was a result of smarter policy making, in particular monetary policy (Taylor (1999) and Cogley and Sargent (2001)), others pointed towards smaller exogenous shocks (monetary, fiscal, commodity, productivity) hitting the US economy since mid-80's. There was even a third category who claimed that Great Moderation was a result of change in the structure of the advanced economies, in particular the information-technology-led improvements in inventory management (McConnell and Perez-Quiros (2000), and Kahn, McConnel, and Perez-Quiros (2001, 2002)), and innovations in financial markets that facilitated intertemporal consumption and investment smoothing (Blanchard and Simon, 2001). Stock and Watson (2003) quantify the individual contributions and show that some of the observed reduction can be attributed to more stable monetary policy, and to less volatile productivity and commodity price shocks, but conclude that the majority of it is due to good luck in the form of smaller economic disturbances.[6]In the present paper, we however argue that the Great Moderation was simply a temporarely smooth period hiding deeper structural imbalances. Whereas standard macroeconomic indicators indeed pointed towards a more stable economic phase, a deeper analysis of balance sheets and flows of different sectors of the economy reveal a much higher growth in size and volatility of the economy than previously thought.[7]Therefore macroeconomic stability was possible only because financial in-

[5]See Kim and Nelson (1999), McConnell and Perez-Quiros (2000), Simon (2000), Blanchard and Simon (2001), Chauvet and Potter (2001), Sensier and van Dijk (2001), Ahmed, Levine and Wilson (2002), Boivin and Giannone (2002a, 2002b), Sims and Zha (2002), and Stock and Watson (2003), Primiceri (2005) amongst others. For a more detailed review of the literature, please refer to Stock and Watson (2003).

[6]King (2006) denotes this as a NICE (non-inflationary consistent expansion) period since expansion was possible without causing inflation, even if the individual price-levels in the economy fluctuated a lot. He attributes to firms and households' increased flexibility in responding to sharp movements in input costs, and a more disciplined (and clear) monetary policy as reasons behind NICE.

[7]William R. White from BIS argued already in White (2005) that whereas inflation and output

stabilities were being accumulated. As Stock and Watson (2003) finally conclude, it was only a question of time before the economy turned back to more turbulent cycles.

Parallel to these efforts, a number of other studies examined the relationship between business and financial cycles. Andreou et al (2000) found that the interest rate term structure, and the volatilities of financial variables contain predictive information for production growth as well as production volatility. Further, they uncover a number of financial series that show substantial mean non-linearities depending on the phases of the business cycle, which they interpret as an indicator of the necessity to model the relationship between financial variables and industrial production in a non-linear multivariate framework (which considers bidirectional effects of financial variables on the business cycle).[8]Whereas they find close secular ties between the business and financial cycles, another set of papers found more profound relations between the two. Largely following the methodology proposed in Gourinchas et al (1999), Mendoza and Terrones (2008) find that credit booms are associated with periods of rising equity prices, real appreciation, and widening of the external deficit in an upswing, followed by the opposite dynamics in a downswing. Moreover, firm indicators (such as corporate leverage, firm value, and the use of external financing) as well as bank-level indicators (such as credit issuance and asset returns) are all procyclical, and reflect the central role that credit plays in both driving the sector and aggregate level cycles. They explain these facts by referring to the credit transmission channel, where financial frictions in the financial industry lead to cycles in lending, which in turn determine the business cycles via the various sectors that comprise the economy (firms, households, banks). More recently, Claessens et al (2011) took this idea further and investigated the degree of interplay between business and financial cycles in 44 countries for the period 1960:I to 2007:IV. They noted three facts. Business cycles often display a higher degree of synchronization with credit and house price cycles than they do with equity prices. Second, recessions (expansions) associated with financial disruptions tend to be longer and deeper (with stronger output growth) than other recessions (expansions). Third,

had become less volatile, and periods of economic expansion considerably longer financial imbalances, such as asset prices, credit, investment, and trade deficits were growing during the same period, reflecting deeper imbalances. We take this further and do not only concentrate on firm specific imbalances, but extend it to households, financial intermediaries, and the government in our analysis.

[8]Examples of models that address these aspects are the Markov-switching models with ARCH effects, or the time-varying transition probability models.

duration and amplitude of recessions and recoveries are largely determined by the strength and intensity of financial cycles. Recessions that are accompanied by house price busts tend to become longer and substantially deeper than other recessions. Further, recoveries coinciding with credit- and housing market booms are stronger, whereas recoveries preceded by a housing market bust are often weaker.

Capitalizing on these insights, we wish to perform an in-depth analysis of the US finance and macroeconomy and evaluate whether the current generation of macroeconomic models are consistent with these facts.[9]More specifically, we extend Stock and Watson's analysis in two dimensions. First, we establish some long-term regularities and business cycle stylized facts in three parts. On the long end, we examine the great ratios, money and prices, the interest rate term structure, as well as some key household stock-flow ratios over the past 60 years. In the second part of the empirical analysis, we also establish an extensive set of stylized facts on the US business and financial cycles. Second, we examine the aggregate demand side as well as the supply side, and determine the key supply-side factors explaining the majority of fluctuations in US output. Third, we analyze the cyclical evolution of stocks and flows of households, firms, financial intermediaries, and government, and establish the changes that the different sectors of the economy have gone through since the 1950's. Next, in order to determine the degree of our understanding of the macro-financial linkages in the US economy and the transmission channels between the two, we use the empirical facts established in the first part of the chapter to validate the performance of the current generation of financial friction models with the data. Not only in terms of the ability to replicate the data, but also in terms of replicating the processes identified in the data. Finally, we provide a set of mechanisms and paths that future models could embark on.

We find that the long-run relations (that many macroeconomic models assume to be stationary in the long run) have persistently increased, in particular since financial liberalization in the 1980's. Specifically, the more than proportional rise in debt-to-assets of households has since 1990's lead to a rise in the consumption-output ratio above its long-term mean. Financial engineering and the use of equity collateralized debt as a general source of funding for households has meant that consumers have been able to expand their spending without increasing the debt burden on their budget constraint. Moreover over time, a larger share of household income has come

[9]The insights are that there exists a tight and deep relation between the financial and business cycles, as well as the importance of understanding stocks and flows of various economic sectors in order to understand the drivers of the aggregate cycle.

from their equity holdings (rather than wages), with the (undesired) consequence that consumption has become increasingly sensitive to shocks on wealth, via their increased exposure to equity price fluctuations. Future financial friction models need to capture the stylized facts of households in a more consistent and detailed way.

Equally, balance sheet of firms have become increasingly procyclical and volatile since the 90's which has lead to powerful financial contagion within the sector once the price of assets decrease. While the FA mechanism captures the effects of asset price movements on firm net worth and the credit supply, the stock prices in the financial friction models are less volatile than the ones observed in the data. Future models should produce more volatile asset prices and systematically study the effects of market expectations on firms' access to credit, default rate, investment levels, and firm assets.

Turning to the public sector, a large share of the Federal debt is now owned by foreign investors. At the same time, the foreign bond holding series have turned procyclical during the past decade. An interesting exercise would be to examine how large negative international shocks (either of the exchange rate, or in the foreign economy) affect the US government inflows, the capacity to issue new bonds, and the ability to run its spending policies. For policy makers, it might be of high interest to find the optimal level/percentage of foreign ownership of the debt at which on one hand, the debt portfolio is diversified, but on the other the future government budget constraint is not put in danger by over-exposure to international shocks.

There are a few other points which we identified in the empirical analysis, but which the models to some extent ignore. The volatility of US output has over the past 60 years shifted between episodes of high and low volatility. We observed a similar pattern in many macroeconomic aggregates. Similarly for financial spreads we noted that the preference for long-term over short-term debt changes over the business cycle. While long-term debt is attractive during economic upturns because of the low costs of borrowing, the short-term one becomes attractive in downturns since the spreads are less volatile (offering a more secure source of funding) and certain segments of the short-term credit market offer low borrowing costs. Since agents face this trade-off between different debt maturities, frictions in one segment of the financial market do not necessarily always cause contractions in the real sector since firms/households (or even banks) can substitute one for the other and avoid being short of funding. One way to capture this might be to include a Markov-switching process where the economy switches between a high and low volatility

regime, and explore the model dynamics under the two regimes as well as examine the probability distribution of switching between the regimes.

To conclude, financial engineering and optimism lead to very rapid accumulation of stocks (e.g. debt, equity), which resulted in secular increases in the long-term ratios. Macroeconomic models assume that these ratios are stationary in the steady state, but the long-run analysis showed that these can persistently deviate from their long-run mean. The result can be an inaccurate representation and modeling of the business cycles. Future models should allow these ratios to vary over the long-run, and study their effects on the evolution of business cycles.

The rest of the paper is structured as follows. We begin our analysis in Section 1.2 by outlining the theoretical framework we will use to analyze our balance sheet data, as well as describing the data. In Section 1.3, we examine a selection of ratios that hold over a longer time horizon. We continue by updating Stock and Watson's (1998) macroeconomic dataset and describing the patterns over the US business cycle in the first part of Section 1.4, while in the second part, we perform the same analysis for two completely new data categories: Balance sheets and financial spreads. We decompose output growth into supply side factors in Section 1.5. In Section 1.6, we contrast the current generation of DSGE financial friction models to our US data and outline their merits as well as challenges ahead. Section 1.7 concludes.

2. Stocks and flows in the US economy

Our aim in this empirical section is to establish a stock flow consistent macroeconomic portrait of the US economy. More specifically, we wish to depict the economy using data from the Flow of Funds accounts, which jointly report the financial and physical stocks of the various sectors as well as the transactions carried out between the sectors. We follow a similar approach to Benito et al (2001) at Bank of England, White (2005) at BIS and the European Economic and Financial Affairs (2010) of the European Commission in analysing the endogenous effects of balance sheet stocks on financial and non-financial flows. They find that the change in the composition of the private sector (households and firms) balance sheet coupled with a heavy surge in private indebtedness has had important effects on private agent flow decisions and economic growth in general. In particular, they find that the result has been an increase in private sector imbalances, which unfold when a negative

shock hits the financial system or the economy, and create prolonged contractions. Households and firms are forced to adjust their balance sheets for a significant time period, which does not only lead to a reduction in flows (consumption, investment, production, savings) within the sector, but result in negative inter-sectoral spill-over effects since the balance sheets of the two agents are closely linked. So for instance, the European Commission (2010) finds that a corporate balance sheet adjustment always leads to a reduction in wage costs, which causes a fall in disposable personal income of households, and thus a reduction in demand and consumption. Similarly, Benito et al (2001) finds that there is an inverse relationship between the debt burden of firms and households. If companies decide to reduce their debt burden more rapidely (typical for recessions), this would mean that households would have less income and thus higher debt burden. But in recessions, households are also forced to reduce their debt burden. And if they were struggling to reduce it before the recession, they will be struggling even more now that their disposable income has been reduced as a result of the rapid de-leveraging in the corporate sector.[10]Nevertheless, the studies mentioned above only look at the developments during the past 10 to 15 years. Here instead we wish to take a much longer stance and describe sectoral patterns in terms of stocks and flows since the post-war period, as well as include all sectors of the economy in order to get a holistic view of the US macro-financial evolution.

Before we go on to examine the data, let us first outline the data, and describe the stocks and flows we consider in this analysis.

2.1. Data

Following Stock and Watson (1998), we consider 1953:I to be a good starting point for our long term view on the US Business cycle, and in all include 237 quarterly observations per variable from 1953:1 to 2011:II.[11]We use a broad range of seasonally adjusted (when applicable) macroeconomic and financial variables in order to represent all aspects of the US economy. We group them into seven categories: (1) Macroeconomic variables, (2) Monetary aggregates, (3) Firm sector data, (4) Household sector data, (5) Balance sheets of financial intermediaries, (6) Federal

[10]The Austrian puts at the center of their analysis the financial imbalances caused by high stock accumulation as the reason to why the adjustment from one equilibrium to another is not smooth, i.e. why we have periodic crises.

[11]There are a few exceptions constrained on the data availability. Please refer to Appendix A for a list of variables and their starting dates.

government data, (7) Balances with the rest of the world, and (8) Financial prices. To be more specific, we have included the following variables in each category:

1. **Macroeconomic variables**: Real GDP, Real personal consumption expenditure on nondurable goods, Real private domestic investment, Real capital stock at 2000 prices, Inventory assets of non-farm non-financial firms, Hours of work of all persons employed in non-farm business sector, Total weekly hours of production in the manufacturing sector, Output per hour of all persons, Implicit GDP deflator, Urban consumer price index, Producer price index of all commodities, Net exports of goods and services, Balance on current accounts, Real narrow average exchange rate, and Real effective exchange rate index.

2. **Monetary aggregates**: Adjusted monetary base, M1, M2-M1, Velocity of M1, and Velocity of M2.

3. **Firm data**: Firm assets, Firm liabilities, Firm net worth at market value, Corporate profits, Net acquisition of financial assets, Equity prices, Real compensation per hour, Total level of loans to firms, and Debt of corporate sector.

4. **Household data**::Household assets, Household liabilities, Household net worth, Real disposable personal income, Net worth/real disposable personal income, Private residential fixed investment, Deposits of households, Gains on corporate equities, Home mortgages, Commercial mortgages of households, Consumer credit, Consumer credit given by firms, and Total debt of household sector.

5. **Balance sheet of financial sector**: Bank assets, Non-bank financial institution assets, Bank liabilities, Non-bank financial institution liabilities, Debt of financial sector.

6. **Government data**: Federal current expenditures, Federal non-defense investment, Federal defense investment, Federal government current net receipts, Net federal government savings, and Debt of the federal government.

7. **External sector**: Federal debt owned by foreigners, FDI in US, US FDI abroad

8. **Financial prices**: Federal funds rate, 3-month T-bill rate, 10-year T-bond rate, Moody's long-term AAA bond rate, Moody's long-term BAA bond rate,

30 year Government bond rate, 3-month LIBOR rate, 3-month Prime rate, 3-month Eurodollar deposit rate, 3-month (certificate of) deposit rate, and 3-month commercial paper rate.

In the first category, we have included the standard measures of spending, investment, capital, production, prices, and trade. In the second category, we have included standard measures of both money supply and money demand. Most macroeconomic indicators are expressed in real terms. The subsequent four categories cover some key flow and stock variables for the various sectors such as total assets, total liabilities, net worth, debt, and measures of inflow/income, and outflow/spending.[12]We have also included the most important US balances with the rest of the world. For the final category, we have both included standard benchmark (government) rates, as well as the most important lending and deposit rates. We will then construct a set of financial spreads that capture the cost of lending/borrowing for firms, banks, and households. Ultimately, we would like to understand how the cost of lending/borrowing over the cycle affects the balance sheets of the various sectors.

Where relevant, the variables have been seasonally adjusted. For financial rates and equity data, which are available in much higher frequency (daily), we have used the end-of-quarter observation. Despite its drawbacks, we consider this to be a superior method than using the sample average for the quarterly frequency since it creates the problem of undesirable smoothing. A more detailed outline of the data can be found in Annex A.

For the recession and expansion dates, we use the National Bureau of Economic Research official dates on US business cycle peaks and troughs. The dates are reported in Table I.1 and the recession dates are marked by the vertical gray lines in the graphs.

Further, we split the analysis in two dimensions. The first dimension is aggregate demand versus aggregate supply. The first two sections aim to identify the most important aggregate demand components of the US economy, while in the third, we determine the key supply-side factors for explaining the fluctuations in US output.

[12]We understand that more variables could be included for a more detailed investigation, but n order to restrict the size and maintain a focus in the analysis, we restrict ourselves to a number of aggregate balance sheet variables. Moreover, for some financial variables, such as mortgage lending rates and portion of federal debt held by foreigners, the data starts much later, which reduces the possibility to take a long-stance view on those measures, and therefore we have used close proxies for those.

The second dimension splits long-term versus short- and medium term aspects of the economy. While in the first section, we are interested in understanding the long-term drifts by looking at trends of the great ratios, money, prices, term structure, and household balance sheet, in the subsequent section, we are concerned with the cyclical properties of the macro-financial nexus over a long period of time.

2.2. Stocks

We introduce a simple framework to analyze the evolution of balance sheets since the post-war period. In particular, we consider balance sheets of five sectors: households, firms, banks, non-bank financial intermediaries, and the Federal Government. We follow the definitions used in the Flow of Funds Accounts of the United States. Let us outline the balance sheets of the different sectors, and their respective definitions (and identities):

Households

Assets	**Liabilities**
Nonfinancial assets	Total Household debt
Financial assets	Net worth

Table 1: Household balance sheet

Firms

Assets	**Liabilities**
Nonfinancial assets	Total Corporate debt
Financial assets	Net worth

Table 2: Firm balance sheet

$A = NFA + FA$, where NFA (2 in B.100 for households and 2 in B.102 for firms in Flow of Funds Accounts) are non-financial assets and FA (8 in B.100 for households and 6 in B.102 for firms) are financial assets. In our business cycle analysis, we have simply included data on total assets. However, for households, we have also included data on two specific sub-categories of financial assets, deposits (9 in B.100) and corporate equities (24 in B.100). For firms, we have in addition included the data on inventories (5 in B.102), a sub-category of the non-financial asset data. This variable is a good proxy for how well firm sales are evolving over the cycle.

On the liability side, we have that: $L \equiv D + NW$, where L represents liabilities, D total debt (31 in B.100 for households and 21 in B.102 for firms) and NW is net worth (42 in B.100 for households and 32 in B.102 for firms). We have included data on total debt both for the household and the corporate sectors. Due to the restrictions of the accounting principles of the US Financial Accounts, debt securities are recorded at book value rather than market value. Moreover, for the household sector we have decomposed the debt series, and report detailed data on three types

of debt: mortgages (33 in B.100), consumer credit (34 in B.100), and household commercial mortgages (38 in B.100). Finally, net worth is defined as:

$NW = A - L$, where A are total assets, and L total liabilities. Net worth of firms is recorded at market value.

Financial interm. [Banks & Non-Banks]

Assets	**Liabilities**
Reserves	Checkable deposits (Banks)
Securities	Time and Saving deposits (Banks)
Loans	Borrowings
Physical Assets	Bank Capital

Table 3: Balance sheet of financial intermediaries

Government

Assets	**Liabilities**
Loans receivable and securities	Federal pension and benefit liabilities
Property	Total Gross Debt

Table 4: Government balance sheet

For financial intermediaries, we have only included data on total assets and total liabilities. However we have split them into banks and non-bank financial intermediaries. For the Federal government, we are mostly interested in the sustainability of government finances, and have therefore only included explicit series on Total debt (5 in L.105). Nevertheless, we have also included a measure of government deficit/surplus called Government savings which will also capture the balancing of the Federal budget (and thus the budget sustainability) in each period. Finally, we also wish to depict the international side of the US economy by depicting the accounts with the rest of the world:

Rest of the world

Assets	**Liabilities**
Total Federal debt held by foreigners	Foreign bonds held by US
FDI in US	US FDI abroad

Table 5: Rest of the world balance sheet

In particular, we are interested in analysing the US Total Federal debt held by foreigners (8 in L.106) as well as FDI in US (24 in L.106). On the liability side, we have two datasets on the US FDI abroad, one on the financial businesses and another on the non-financial corporate businesses, that we have merged into one to get a total US FDI abroad (39 and 42 in L.106). For foreign bonds held by US, the

share is much lower compared to US bonds held by foreigners, and since we do not have good data on that series, we have not included that in our analysis. We did not find good quality data on the US net external position that goes sufficiently far back in time, and can therefore only comment on the main gross components.

We perform the balance sheet analysis in two levels. The first level is equal for all agents where we compare the evolution of total assets versus total liabilities. For the second level, however, the differences between agents are bigger, since we wish to understand the sources of total assets and liabilities that are specific for each agent. In the case of households, we specifically look at the sources of financial assets by dividing the category into two: equity savings, and deposits. Similarly, on the liability side we assess three sources of debt: mortgages, commercial debt, and other types of debt. For firms, we are interested in studying inventories, and examine how changes in asset prices have influenced the value of inventories, as well as debt. Hence, we wish to assess the impact of quantity changes, as well as price differentials over time on the size and value of corporate balance sheets. With respect to the financial industry, we separately examine the evolution of total assets and liabilities of banks versus non-bank financial intermediaries. Lastly, for government, we are specifically interested in the evolution of government savings, and its impact on total public debt.[13]

2.3. Flows

We wish to complement the stocks with some important information on flows in each period. In particular, we wish to understand how intra-period transactions have changed over time by making use of a set of key accounting identities for each sector. Our emphasis is thus on net transactions.

Transactions are recorded as net purchases or sales at the current market price, which means that exchanges within one sector cancel out each other and do not show up in the accounts. On the other hand, exchanges between sectors are recorded as a negative value for the sector selling the product and a positive value for the sector purchasing it.[14]

We will mainly consider income and expenditure decisions of the non-financial

[13]Note that stocks are recorded as net purchases over time. However, for some instruments, such as equities and other related ones, value outstanding reflects both the accumulation of net purchases and any change in value caused by an increase or decrease in prices. See Flow of Funds description in Teplin, 2001.

[14]Flow of Funds description, see Teplin, 2001.

sectors in our analysis. Hence, our focus will be on income flows, consumption and investment, borrowing and saving of households, firms, and the government. For households, it is useful to think of the flows as:

$$C_t = PDY_t + \Delta B_t^h - S_t \tag{1}$$

$$PDY_t \equiv W_t + R_t^s S_{t-1} \tag{2}$$

$$\Delta B_t^h \equiv B_t^h - (1 + R_t^b) B_{t-1}^h \tag{3}$$

where PDY_t is the personal disposable income of a household, C_t, S_t, B_t^h, W_t denote consumption, savings, net borrowing, and wages at time 't', R_t^s is the interest at 't' a household receives on net savings from 't-1', and R_t^b is the interest paid on household borrowings. The household borrowing rate will be above the policy rate since it includes the default costs and profit margin that lenders wish to make on their lending. In our analysis, we have included two series on household savings, as well as three series on household loans. On the savings side, we have included traditional deposits, as well as savings in corporate equities. On borrowing, we have information on household mortgages, consumer credit, as well as consumer credit given by firms. While we expect the first series to be the largest share of total household borrowings, we wish to understand if the other two series have increased in importance.

Likewise, for firms we can think of flows as:

$$\Delta Q_t \Delta K_t = \Delta D_t - c_t \tag{4}$$

$$\Delta D_t \equiv D_t - (1 + R_t^d) D_{t-1} \tag{5}$$

with the first equation expressing that the change in inventories $\Delta Q_t \Delta K_t$ is financed with net debt/equity issuance, ΔD_t, which includes the interest rate payment that firms have to pay lenders for liquidity they received in the previous period (subsequent equation). The interest rate on debt R_t^d will be above the policy rate, since it includes the default costs and profit margin that lenders wish to make on their lending. c_t are costs related to production, such as wages, taxes, etc. Finally, government flows can be expressed as:

$$G_t^c + G_t^{ndi} + G_t^{di} = TR_t + \Delta B_t \tag{6}$$

$$\Delta B_t \equiv B_t - R_t^b B_{t-1} \tag{7}$$

where the expenditure side is a sum of G_t^c government consumption, G_t^{ndi} government non-defense investment, and G_t^{di} government defense investment. The income side includes TR_t net government receipts (net of transfers), and B_t net bond issuance. Net bond issuance, or bonds outstanding, is the difference between bonds at time 't' and the debt repaid in 't-1' (subsequent equation).[15]

3. Selected long-run relations in the US economy

Let us start by looking at relations of some standard macroeconomic variables that we expect to hold only over a longer horizon. More precisely, we would like to follow the approach used in Stock and Watson (1998) and Klein and Kosobud (1961) to analyze three such empirical relations: Long-run money demand, the term structure of interest rates, and three great ratios: capital-output, investment-output, and consumption-output. In addition, we wish to enlarge the pool of variables and look at various price indices, and household balance sheet (assets and liabilities). We intrinsically assume that the original data series are more persistent than the linear combinations of those.[16]

For the price indices, we use data on the urban CPI, PPI of all commodities, and the implicit GDP deflator. Their base year has been standardized to 1983 for all price indices. For the term structure, we use the spread between a 10-year T-bond (long) and the 3-month T-bill rate (short). For the great ratios, we use data on consumption expenditure on non-durable goods, capital stock, and real investment. Consumption expenditure and real investment are expressed in terms of the 2009 prices, while capital stock is expressed in terms of the 2005 prices. Lastly, for the data on household we use the velocity of narrow money (M1) as a proxy for the demand of money by households.[17]

Most variables begin in 1953:I, with the exception of household sector debt

[15]Note that for financial instruments, we separate the quantity changes over time from price changes at which they will be (re-)paid

[16]Future work should expand to include five (instead of three) great ratios of Klein and Kosobud (1961).

[17]Since household mainly demand narrow money for their expenditures.

(1953:III), 3-month T-bill and 10-year T-bond rates (1957:II), and velocity of M1 (1959:I). With the exception of the variables expressed in ratios, all variables were logged. The variables are depicted in Figure III.1.

3.1. The great ratios

Our series are all expressed in real terms, chained to 2005 prices. We could equally have expressed the series in current prices, and deflated them with any price index. However, since we are interested in the relationship between consumption, investment, and capital, changing it uniformly the deflator would not alter this intrinsic relationship. If we, on the other hand, apply the CPIU to consumption, and PPI to investment and capital stock, then we would observe three things. For the pre-1984 period, the indices are almost identical so there would not observe any differences in real terms. Then, following 1984 and up to 2001, the CPIU grew at a much higher rate, which means that the consumption/output ratio would, *ceteris paribus*, be at a lower level and grow by less compared to either investment or capital stock. However, from 2002, the PPI grew at a faster rate (even if it remained below CPIU), resulting in the reverse picture with investment/output and capital stock/output experiencing, *ceteris paribus*, a slower growth, even if in level terms the consumption/output is deflated by more.

King, Plosser and Rebelo (1988), King, Plosser, Stock and Watson (1991) have argued that the great ratios should be stationary over the longer run, albeit the individual variables contain trends. While investment-output ratio is largely stationary in our dataset, capital-output and consumption-output ratios have persistently increased.[18]Taking into account that capital is a stock measure while investment and consumption are flows, we note that the strongest growth since the post-war period has been in aggregate consumption. Whereas in the 1960's, the ratio was around 52 percent, it was as high as 64 percent by 2007 with the sharpest rise concentrated to the period after the financial liberalization and Volcker's monetary policy in the early 1980's. Had we used the CPIU for consumption and PPI for investment instead, the only difference would have been that the rise in consumption/output would have been visible only following 2001 and not as early as 1980's. Thus the first stylized fact relevant for DSGE models is therefore that consumption-output does not have a steady state ratio and consumption does not return to that level

[18]We do not observe a trend in the investment-output series in Figure III.1. However, we do not perform a formal test of stationarity in these exercises.

following a shock, but rises over time.

3.2. Term structure of interest rates

We are equally interested in examining the fluctuations in levels, the spreads between the 10-year T-bond and the 3-month T-bill rates. In levels, we observe high fluctuations of both rates over time, but note that both the short-term and the long-term government borrowing has been the cheapest in over 40 years during the past decade. The two rates fell to a record low of 4 percent (or below) at the onset of the latest boom in 2002.[19]Hence the opportunity cost of issuing government bonds was low during the past decade, and the level of debt on government balance sheets was sustainable (since the costs of repayment were stable and low). Moreover, since the market rates for various financial products are benchmarked to the policy rate, and this hit a record low during the latest boom, credit was, in relative historic terms, equally cheap over this period. We will discuss this point further when we analyze the business cycle pattern of financial rates and spreads below.

However, a closer look at the term spread reveals a deeper complexity. While the spread seems to fluctuate around a fixed mean, the mean has increased from somewhere between 0 and 50 basis points (1957-1982) to between 100 and 150 basis points (2000-2011). This means that, on average, the short-term external financing has become cheaper since 1980's turning it into a more attractive form of financing for the government. In addition, this preference for short-term liquidity was enhanced during the 2001-2006 period, since the term spread reached almost 4 percent.

A desirable financial friction model should incorporate two facts from the term structure analysis. The first one is that the sustainability of government finances will depend on the future borrowing costs on the sovereign bond market. Since the government faces a trade-off between raising taxes and issuing bonds in order to finance its spending/investment plans, and taxes bear a social cost since they distort private consumption and investment, there is an incentive to issue bonds. As we have seen, the low borrowing costs, in particular the short-term one, since 2000 has meant that the incentive for issuing bonds, instead of raising taxes has been very high.

The second stylized fact is that models which include a term structure of the interest rate should model the spread broadly-speaking as a mean-reverting process.

[19]With 1957-67 as the only other period when the rates were equally low.

3.3. Money and prices

To give a broader picture on price developments, we have included three distinct price indices: GDP deflator, Consumer price index and Producer price index.[20]The three series are very persistent and cointegrated, meaning that the relative prices are stationary. However, the margin between PPI and CPIU has increased since 1980's (and in particular during 1990's), reflecting the decreasing profit margins of firms. Following Caporale et al (2002) we interpret this as firms facing difficulties in passing on their higher costs (as represented by the level of the PPI index) onto consumers, decreasing thus their margins.

Turning to money, the quantity theory of money (and monetarists) consider (in the absence of inflationary or deflationary expectations) the long-run velocity to be constant. Using the standard definition of velocity:

$$V = \frac{P_t Y_t}{M_t^s} \tag{8}$$

where P_t is the price level, Y_t nominal output, and M_t^s is the money supply at time 't'. Velocity is therefore equivalent to the amount of economic activity associated with a given money supply. Our graph in Figure III.1 shows instead that velocity of money has constantly increased since the 1960's, with the sharpest rise between mid-90's and 2008. Since money supply was maintained high during the past two decades (because of the low policy rate), the 'spending effect' on the part of consumers was very high and the speed at which money changed hands outperformed the rise in money supply, resulting in a higher increase in output, and therefore an overall rise in the above ratio during this period. Teplin (2001) argues that the high 'spending effect' is a result of a much higher indebtedness of households, since wages did not significantly rise during this period. Let us examine this argument a little closer in the next subsection.

3.4. Household balance sheet

Indeed the rise in household debt is very visible from Figure III.1. In 1953 the ratio between assets/GDP to debt/GDP was 1.72, but by 2008, the ratio had shrank to only 1.19. Hence, not only did the rise in debt outperform the rise in GDP, growing almost twice as fast as the GDP, but also the rate at which households were taking

[20]All three price indices are indexed to 1983 price levels, i.e. 1983=100.

on debt was much higher than the rise in the value of their assets. For financial friction models, this means that there may not be a single steady state value for the household debt-to-asset ratio, but rather that the ratio is itself endogenous. The models need to incorporate mechanisms, such as financial innovation, collateralized housing debt, and/or subjective beliefs (more on this in section 1.4) that would allow households to accumulate debt at a faster pace and above the rate of growth of assets. Omitting this fact in a macroeconomic model might lead to an underestimation of risks, the level of imbalances, and the probability of a crisis.

3.5. What more can financial friction models take away from these facts?

The steady increase in many long-run relations (consumption to output, household debt-to-assets, or velocity of M1) found in the data reveals a deeper shortcoming of current macroeconomic models. Namely many of them assume that those ratios are constant in the steady state, and can therefore not be permanently altered. Our data shows that most of them have increased over the long-run as well as the short-run. One alternative to correct for this is to calculate different steady state ratios for these variables depending on the sample period considered and optimize based on the new ratios, or possibly include state-contingent optimizations which means that the variables can converge to multiple steady states depending on the shock (or state of nature) they find themselves in.[21]A more refined but technically cumbersome approach might be to abolish steady state ratios for these variables and endogenize the accumulation of stocks so that the optimization problem of agents changes with the (debt) stocks accumulated by them, by for instance altering their risk preferences, technologies, or conditional forecasts. Mian et al, 2012 reach a similar conclusion in their empirical study of the nexus between household balance sheets, consumption, and economic recession using a novel dataset on county-level retail sales.

4. Historical business cycle properties of major economic time series

To set the scene, we begin by recording some of the macro-financial regularities with which any macroeconomic model should be consistent. The business cycle turning points as identified by NBER and listed in Table 1, constitute a broadly accepted

[21]In Godley (1999, 2004) the model variables converge to a new steady state following a (temporary) shock.

business cycle chronology.[22]

The business cycle frequency of the data is isolated using standard linear filtering methods within the classical business cycle theory. The periodicity of the business cycle is assumed to be between six quarters and eight years.[23]While some authors have used nonlinear filters to study business cycles, modern studies of business cycle properties use linear filters since the underlying theory is better understood. Therefore, to facilitate the comparison with previous work in the literature, we use the same method.

Following standard practices we have calculated the correlation and the relative standard deviation of each variable to output for the entire sample period as well as decade-by-decade in Tables I.3 to I.7. The decade-by-decade split of the summary statistics should be seen as a compliment to the graphs and the overall sample moments, and not as exclusive. One could also split the sample in alternative ways, such as per business cycle, per monetary regime/chairmanship, or per financial regulatory structure, but the subsamples would be very heterogeneous in size, and therefore we preferred using the method by Stock and Watson (2003) that produces homogeneous subsamples.[24]The corresponding graphs for the filtered series are reported in Appendix III.

We have divided our analysis in two sections. The first one updates Stock and Watson's (1998) analysis on quantities and prices by looking at macroeconomic and monetary aggregates. The second one, however, is entirely new and considers balance sheet variables of the major economic agents, the balance sheet with the external sector, as well as financial data on money and credit as represented by financial rates and spreads.

But, before we go on to examine the data, let us first briefly outline the filtering approach used in the current paper.

[22]See Stock and Watson (1998) for further details on how the business cycle turningpoints are determined at the NBER.

[23]Hence the high frequency fluctuations (associated with measurement errors or seasonality) and the low frequency fluctuations (associated with trend growth) are eliminated. The ideal filter would need an infinite number of observations to be implemented. However, a feasible finite filter is used to approximate this ideal filter. Those proxies are the first-difference filter, the Hodrick-Prescott filter, and the Bandpass filter. Their outputs will be compared in the subsequent subsection.

[24]The first (and last) decade include less (more) quarterly data points than the others, but they contain too few (many) observations in order to be included (separated) in the next category.

4.1. Filters

All data were logged before they were filtered, with the exception of financial rates and spreads. We employ the widely used Hodrick-Prescott (1981, 1997) filter in order to decompose the time series into a trend (τ_t) and cyclical (ζ_t) component by solving a least square problem. We are able to isolate the cyclical component by the following minimization problem:[25]

$$\min_{\tau_t} \sum_{t=1}^{T} \zeta_t^2 + \lambda \sum_{t=3}^{T} [(1-B)^2 \tau_t]^2 \tag{9}$$

where τ_t is the trend component of the data, ζ_t is the cyclical component, λ is the smoothing parameter, and B is the standard lag operator, or inverse of the forward operator, such that $B^j x_t = x_{t-j}$. The first term B is a measure of the fitness of the time series while the second λ is a measure of smoothness. Since there is an intrinsic conflict between the two measures (goodness of fit vs smoothness), we control it by calibrating the trade-off parameter, λ to some specific value, where $\lambda = 0$ implies that the trend component is equal to the original series, whereas $\lambda = \infty$ means that the trend component is a linear trend. In other words, λ penalizes the variability in the trend component, with an inverse relationship between the magnitude of the parameter and the volatility of the trend (Hodrick and Prescott, 1997).

This more general representation of the initial Hodrick and Prescott (1981) *ad hoc* definition can be seen as a special case of the Butterworth family of filters (Gomez (1999)), or as a Wiener-Kolmogorov filter (Kaiser and Maravall (2001)) commonly used in signal processing. Moreover, the HP-filter does not amplify the high frequency noise while de-trending, a clear improvement from other linear trend filters (Stock and Watson (1998)). Nonetheless, it holds a few limitations. First, in order for the filter to be optimal, the data must a priori be known to have an I(2) trend. Therefore, one-time permanent shocks to the level of trend or a fixed (split) trend growth rate, the H-P filter distorts the cyclical properties and the higher moments of the data in a significant way.[26]Second, the cycle component must be a white noise, or the dynamic mechanism must propagate identical changes in the trend growth rate and the innovations to the business cycle component in order for

[25]We set the smoothing parameter λ equal to 1600 since we deal with quarterly frequency. See Hodrick and Prescott (1982, 1997), Ravn and Uhlig (2002), and Marcet and Ravn (2004) for a discussion on the value of the smoothing/penalty parameter.

[26]King and Rebello (1993), Cogley and Nason (1995).

the H-P filter to be optimal (French, 2001). The effect is that at low frequencies (i.e. data series that do not have peaks at business cycle frequencies), the filter provides a distorted business cycle, but Baxter and King (1999) show that this is also true for the standard bandpass filter (Guay and Amant (2005)). Moreover, Baxter and King (1999) point out that the H-P filter with $\lambda = 1600$ works equally well as the bandpass filter with a cutoff at 16 or 32 quarters.[27]

To compare the statistical properties of different filters within our sample, we have isolated the business cycle frequency in the series using three types of filters: the first-difference, the bandpass and the H-P filters. The first-differencing filter succeeds in eliminating the trend component, but it attenuates the effects of high frequency noise. As a result, the cycles are very short and volatile. Compared to the previous, in the case of the bandpass filter, the fluctuations of the series are more closely centered around a zero mean. Also, the high frequency variation, which is highly visible in the case of the first-difference filter, has been eliminated. Lastly, the cycles in the H-P filter are very similar (if not nearly identical) to the bandpass filter. The largest recession of 1973-75, early 1980's, and 2008-10, as well as the smaller ones of 1969-70, 1990-91, and 2001-02 are identically captured by both filters. The only visible difference is that cycles of some variables are slightly smoother when bandpass filter is applied, which means that the very high-frequency noise outside the business cycle frequency band is more effectively eliminated. To sum up, both filters produce very similar output, and thus can be equally applied.

Since our ultimate objective in this paper is to contrast the US stylized facts to the outputs produced by financial friction models, which are mostly based on H-P filters, to economize on space and for the sake of focus, in the subsequent sections we will not provide a comprehensive discussion of the sensitivity of our results to different filter choices. Stock and Watson (1998) do provide a discussion, but as in our case do not find any significant deviations between the two filters.

4.2. Business cycle quantities and prices

4.2.1. Real activity

At a general level, we observe regime swings in the volatility of the business cycle, switching between periods with higher and lower volatilities. While during the

[27] See Harvey and Jaeger (1993), Cogley and Nason (1995) and Canova (1997), amongst others for further discussions on the limitations of the H-P filter.

Golden Age (1950-71) period and the Great Moderation (1984-2008) the volatility was (in absolute and relative terms) low, it was significantly higher during 1970's (following the collapse of Bretton Woods (1971) and the two oil shocks in 1974 and 1979), and since 2008 (the Great Recession).[28]This business cycle evolution is comparable to a Markov-switching mechanism whereby the economy switches between high-volatility and low-volatility regimes.[29]

Similar to Stock and Watson (1998), we find that consumption, investment, asset prices and productivity are all procyclical. With 1970's as the only exception (when consumption lagged GDP), consumption has tightly followed the GDP, in particular since late 90's.[30]Investment, on the other hand, has maintained a constant co-movement to output of around 0.90 for the entire sample period. So, whereas investment had always been an important component of output (via aggregate demand), consumption had become increasingly so over the past 15 years.

The volatility of investment has been more or less constant since 1953 of between four to six times that of output, with record troughs centered around mid-70's (first oil shock), early 80's (supply-side reforms and early Volcker policies), and late 00's (the Great Recession). The troughs of mid-70's (following a negative supply-side shock) and late 00's (following the financial shocks) are accompanied by a record fall of 40 percent below the trend in asset prices. A possible explanation could be that firms were forced to sell off their assets to satisfy the margin calls on their debt. The result is a bearish stock market associated with a fall in output.

Yet, the wealth effects from movements in asset prices on consumption might be another reason for the tight co-movement between asset prices and output.[31]Starting from the second half of 1990's, the correlation of asset prices has become as high

[28]GDP volatility fell by 40 percent going from 1950's to 1960's and 62 percent going from 1970's to 80's, but rose 85 percent going from 1960's to 70's and 74 percent going from 1990's to 2000's.

[29]Some macroeconomic models have recently started to incorporate a Markov-switching mechanism to shocks/monetary policy in the model, such as Svensson and Williams (2008), Davig and Leeper (2011), or Liu et al (2011).

[30]The correlation coefficient with output went from 0.21 in the 90's, to 0.89 in 00's.

[31]Dynan and Maki (2001), and Lettau and Ludvigson (2002) find a tight relationship between consumption, household wealth, and stock price movements. Stock price movements influence household wealth, which in turn effect consumption via households' contemporaneous and future budget sets. The direct wealth effects show up quickly, and last for several quarters. Lettau and Ludvigson (2002) use a version of the permanent income model but adapt to to allow for a direct link between household optimization and stock returns. When consumption is above (below) the shared trend with labor and asset incomes, consumers are expecting the stock return to rise (fall), and therefore adapt their current and future consumption based on these expectations. Dynan and Maki (2001) estimate that an additional dollar of wealth leads households with moderate securities holdings to increase consumption between 5 cents and 15 cents.

as that of consumption and investment, while the volatility of asset prices, just as consumption, more than doubled over the second half of 1990's.[32]

Productivity and hours worked are procyclical, as well as less volatile than output.[33]We observe the same pattern in real disposable personal income. However, since 1990's (and contrary to wages) labor productivity, measured by output per hour and person, has become less procyclical, while the number of hours worked has not changed. A possible reason could be that the number of hours worked rather than productivity has increasingly determined the more recent wage levels in the US.

Let us finalize this section by analyzing the external sector. We can largely divide it into two regimes: the highly volatile and weakly procyclical pre-1980 period compared to the much smoother and more (business) cycle driven post-1980's.[34]The reduction in the volatility of current account balance and net exports in the post-1980 period coincides with the reduction in volatility of both the real and narrow exchange rate. Linking these observations to international finance theory, it might imply that since the exchange rate risk was reduced, the firms were able to perform a more stable planning of exports and imports, reducing the volatility of net exports and the current account balance.

4.2.2. Monetary aggregates

We have included information on the monetary base, M1, M2, as well as the velocities of respective money stocks. In general, all five series are procyclical, but since the financial liberalization of early 1980's, both the duration and the amplitude of the cycles for all the monetary series have become more accentuated.[35]The volatilities of the various monetary series increased significantly, in particular the adjusted monetary base that turned three times more volatile in only one decade from 1990's to 2000's. This means that the demand and supply of both narrow and broad money increased a lot as well as became much more persistent since the credit

[32]While S&P500 was approximately five times more volatile than output up to mid-90's, the volatility intensified to eleven times that of output by late 90's, and 00's. This is analogous to consumption, which went from approximately as volatile as GDP throughout most of the sample period, to twice as volatile as output by late 90's and 00's.

[33]Productivity and hours worked are captured by three series: Total weekly hours of production by all workers, aggregate hours worked and output per hour and person.

[34]Both looking at the current account balance, and net exports.

[35]Except for the 1970's for M1, and velocity of M2, 1990's for M2-M1, and 00's for the money supply indicators, adjusted monetary base, M1, and M2-M1, when they were all countercyclical.

liberalization, suggesting high and lasting credit expansions (contractions) during upturns (downturns).

Turning to the predictive power of the monetary series we find, similar to the studies by Stock and Watson (1998), and Schwartz (2005) that prior to 1980's, M2 was a good predictor of output movements. Note, however, that this predictive power has eroded since the late 1980's.[36]This is possibly a consequence from two factors: the change of Fed's target from money supply to inflation resulting in a less direct link between the broad money and output cycles, and the financial innovation which has caused a large expansion in the broad commercial bank money M3, meaning that M3 rather than M2 is a better representation of the true money supply in the economy. We would need to estimate a set of structural equations (either by applying SVAR or cointegration equations) in order to confirm the underlying reasons behind the fall in predictive power of M2, which (while interesting) is outside the scope of the current work.

4.2.3. Prices

Prices are countercyclical, which in the literature is interpreted as a proof of the stickiness of firm prices on the aggregate level.[37]However, all three price indices have turned procyclical around 2000, with the largest shift occurring in the PPI.

Contrary to the CPIU and the GDP deflator, the PPI is more volatile than output. Linking this observation to firm flows, we expect (intermediary) firm margins and production plans to be more extensively affected by macroeconomic ups- and downturns, since their ability to pass on price inflation of raw materials, or production costs to final products will largely be determined by the general economic outlook. In upturns, this capacity will be higher since households spend more and

[36]Also in line with the findings of Feldstein and Stock (1994) and Friedman and Kuttner (1998).

[37]Indeed, Chadha and Prasad (1994), Rotemberg and Woodford (1999), Pakko (2000), Chevalier et al (2000), and more recently Sheedy and Guimaraes (2009), and Kehoes and Midrigan (2010) find that prices are countercyclical since the end of WW II, reflecting the stickiness in the firm setting of prices at the aggregate level. Chevalier and Kashyap (2001) attribute the countercyclical nature of prices to the countercyclical mark-ups of retailers, which account for the majority of the countercyclical price movements (and not the manufacturing industry). Alternatively, Sheedy and Guimaraes (2009) argue that the strategic substitutability of sales is what makes prices, while flexible on the micro level, sticky on the aggregate. Since a firm's incentive to have a sale decreases in the number of other firms having sales, they face less incentives to vary their prices (even in the absence of costs in varying sales), and thus monetary policy has large real effects. Similarly, Kehoes and Midrigan (2010) reason that since most changes in prices on micro level are temporary rather than regular, the nominal price returns quickly to its pre-existing level. Since temporary changes cannot offset monetary policy shocks well and regular price changes occur much less frequently, the prices on aggregate appear as sticky.

firms have easier access to equity or external credit which makes it easier for them to deal with rising prices in raw materials or to fund capital equipment acquisitions, while in downturns this capacity is restricted from both ends (Clark, 1995). This variation in cost pass-through to consumers might be one reason why production and (via the flow of fund constraint) investment varies so much over the cycle (more on this in the next subsection). Future work should employ empirical tests to validate this hypothesis.[38]

4.3. Balance sheets and financial prices

Next, let us look at the balance sheets of firms, households, financial intermediaries, federal government, and the external sector described in 1.2. We are primarily interested in capturing any persistent patterns over the business cycle during the past 60 years, as well as any changes to these over the most recent cycles.

4.3.1. Firm financing and the balance sheet

For flows, we contrast profits, real investment, and capital prices as represented by S&P500 (on the left-hand side of the flow equation 4) against real compensation per hour (on the right-hand side of 4). For stocks, we concentrate on total assets, total liabilities, net worth, total loans taken by firms, and total corporate sector debt. Let us describe the standard mechanism linking firm stock and flow decisions.

The standard mechanisms for financially constrained firms is as follows.

$$\pi_t + s_t k_{t-1} + b_t = r_t^d d_{t-1} + q_t p k_t + w_{t-1} l_t + E_t[s_{t+1}] k_t \tag{10}$$

$$b_t \leq n_t \tag{11}$$

$$\theta_{t+1} = \frac{b_t}{n_t} \tag{12}$$

$$r_t^c >> \theta_t \tag{13}$$

Firms use their profits, π_t, capital gains from previous period, $s_t k_{t-1}$, and new borrowing b_t to re-pay existing debt $r_t^d d_{t-1}$, pay their input costs (physical capital

[38]To the best of our knowledge, a formal exploration of this causal link has not been performed.

costs, $q_t pk_t$ and wages, $w_{t-1} l_t$) and invest in new capital k_t, contingent on the expected price of capital on the stock market in the next period, $E_t[s_{t+1}]$.[39]However, their demand for investment exceeds their internal funds they hold, which means that they have to demand external funding to satisfy their investments. They do this by either raising new debt, new equity, or via traditional bank loans, b_t (depending on the opportunity costs between the various types of corporate funding and the maturity of finances they require). However, due to adverse selection and moral hazard problems in the debt/credit markets between debtors and creditors, creditors require a collateral from debtors (11 and 12). Net worth, n_t is usually used as the collateral. The higher the value of the collateral, the smaller the impact of asymmetric information on the repayment of the loan, and therefore the lower the loan repayment rate, θ_{t+1} will be (Hubbard, 1990). In cases where a collateral is not demanded, the risk premium that debtors will have to pay for their credit, r_t^c is significantly higher in order to compensate for the higher default risks. Hence, firms exposure to stock prices is two-sided. On one side it determines their investment demand (flows), and the value of the firm net worth (stocks).[40]On the other, it determines how much debt they can raise. The more leveraged the firm is, the higher is the exposure to stock price movements, and therefore the more procyclical will be the firm balance sheet.

Following Kiyotaki and Moore (2002), higher indebtedness will lead to higher probability of financial contagion inside the business sector, even to sections that are not financially constrained, since user costs of assets must change in order for asset markets to clear, influencing thus the price of capital for the unconstrained firms as well. In addition, there is the liquidity contagion effect via debt repayment. A negative shock to liquidity might cause delay, or even default on debt repayment in one link of the chain, resulting in a disruption of the production there. An accumulation of non-performing loans can further cause widespread loss in output.

Finally, the timing of the debt restructuring matters. In the face of a negative credit supply shock, Almeida et al (2009) show that firms with long-term debt maturing right at, or after the credit crisis in late 2007 reduced investment by 10 percent more than firms whose debt was scheduled to mature well beyond 2008. On aggregate, this represents approximately one-third of the pre-crisis investment levels. This implies that firms that will be the most constrained by the shock are the

[39]From time to time they also use it to improve their production technology and invest in labor.
[40]Since net worth is the current value of the capital stock accumulated in the firm.

ones that are obliged to restructure their debt at the time, or right after the shock. Since the probability of having to restructure the debt at the time of (or right after) a negative credit supply shock is the highest for short-term debt (because of the very short duration of such contracts), firms who largely hold this type of debt on their balance sheets (mostly firms with high investment growth perspectives, loosely regulated (Barclay and Smith, 1995), or large in size (Ozkan, 2000)) vis-*à*-vis the target group identified in Almeida et al (2009) will face the largest limits on the flexibility to restructure the debt, forcing them to prioritize the debt repayment to other expenditures.

4.3.2. Firm balance sheet

Starting with the flow variables, they are all procyclical. Whereas the procyclicality of investment has remained high, the procyclical movements of firm profits and real compensation have decreased over time. For stocks, we observe a similar pattern. However, while for most of the sample period firm liabilities have been around twice as procyclical as firm assets, the opposite has occurred since the 90's. Hence there is a miss-match in the exposure of the two sides of firm balance sheet to cyclical fluctuations.

Next, debt of corporates became approximately thirty times more procyclical since 1980's compared to 1970's, while the volatility has turned two to three times higher. The same pattern applies to firm net worth. More generally we note that firm stocks have become four times more cyclical and twice as volatile since 1980's compared to previous episodes. Linking it to the equations in the above subsection, one reason for the increased volatility in the debt series over the past two decades might be the increased volatility in equity prices, which increased the volatility of net worth, and via the collateral channel, made debt much more volatile.

Moreover, the doubling in volatility of firm (total) assets and liabilities confirms further this interpretation. More volatile stock prices, via two channels of transmission onto firm balance sheet, did not only result in more volatile debt-liabilities (as described above), but also in more volatile assets, via the capital value (wealth) effect. An interesting implication from this would be to analyse how 'non-fundamental' movements in market equity prices influence the corporate balance sheet, the firm financing conditions, the default rates, and the production in the economy. That is the focus of the next chapter in this book.

4.3.3. Household balance sheet - assets

Following the flow of fund relation for households in expression 1, we have included information on real disposable personal income, household deposits, corporate equities held by households, and residential investment. In addition, we have included stocks such as assets, household deposits, corporate equities held by households, liabilities, net worth, net worth/real disposable personal income. Further, we include more detailed information on the type of liabilities households hold by including the variables residential mortgages, household consumer credit, household consumer credit issued by corporates, and total household sector debt.[41]

Teplin (2001) noted that households in the first quarter of 2001 had more than six and one-half dollars in tangible and financial assets for each dollar of disposable income, and that the proportion of assets invested in corporate equities had increased dramatically, from 15 percent in 1990 to 36 percent in early 2000. Looking at both the correlations and volatilities in our data, this seems to be in line with what Teplin already observed in 2001.

While household assets have always been procyclical, its procyclicality increased dramatically during 1990's, and by 2000's, the co-movement of assets to output had become almost perfect (0.864), same as for corporate equities held by households (0.833), and net worth (0.938).[42]At the same time, household deposits have become less procyclical, turning into slightly countercyclical during the past two decades. The strong co-movement between assets and equities held by households, rather than deposits points to the fact that households have increasingly preferred to allocate their savings in corporate equities (and other riskier products), rather than the traditional deposits. This means that the pressure to adjust their balance sheet and de-leverage in recessions, measured by the debt-to-asset ratio, has increased over time since the value of their assets (the denominator) falls increasing the burden of their debt and thus forcing them to de-leverage faster. Equally, assets and equities held by households have become more than twice as volatile since the late 1990's, while the volatility of net worth has increased by a factor of 5. Thus a more unstable and cycle-driven asset side of the household balance sheet during the past two decades has increased the risks and imbalances faced by households, and the pressure to pay-off their debt in recessions has significantly increased (as we will see

[41]Household deposits and corporate equities can be used both for the stock and the flow analyses.

[42]Moreover, even when we divide household net worth by real disposable personal income, we find that the co-movement with output has simply increased since 90's, peaking at 0.912 in 2000's.

below). Another result of a higher portion of assets coming from equities is that the exposure of household balance sheet to stock market movements has increased.

4.3.4. Household balance sheet - liabilities

We saw in the long-run relations section how over time household debt had been accumulating at a faster pace than both household assets and output, in particular during the expansionary episodes over the past 20 years. What we also find is that debt, which always had a positive co-movement with output, had turned significantly more procyclical since mid-90's. Looking into the components of debt we note that the strongest link in terms of the evolution of correlations and volatilities is between total debt and household mortgages, followed by consumer credit. We interpret this as household mortgages being the most important driver of household debt.

We also find that consumption and debt have both become more procyclical and more volatile over time, while the opposite is true for real disposable income. Linking these observations to household flow of funds in 1, it means that household spending has increasingly been financed by higher debt rather than personal disposable income, which leads to significantly larger contractions in consumption during recessions, since the margin calls on debt have increased.

4.3.5. Household balance sheet - the mechanisms

We have just seen that a larger portion of savings has been placed in riskier products which are driven by the price movements on the stock markets, resulting in more cyclical and volatile assets over the past two decades. Net worth has also become significantly more volatile during the same period. At the same time, the debt burden of households, measured by debt-to-asset ratio or debt-to-output ratios, has increased and household spending has increasingly been financed by higher debt rather than personal disposable income. The total effect on household balance sheet has been a more volatile and uncertain inflow as well as outflow, creating internal imbalances in the household sector. But these effects were not directly felt by households before the Great Recession. Why? There are two explanations for this in the literature (Teplin, 2001).

First, the rise in financial engineering, which has lead to a sharp development of various financial products (reducing households' burden of carrying debt) has meant that in early 2000's, the true imbalances of the household sector were not visible.

Longer loan maturities that households for the first time could access in the 90's had made it possible to hold higher outstanding amounts without increasing the servicing burden, since the periodic payments were lowered for a given amount of debt. At the same time, options such as variable interest rate provisions, and flexible down-payment requirements broadened the pool of eligible borrowers, and allowed households, who in standard cases would not receive a credit, to get one (Aron et al (2008), and Muellbauer (2008)). As long as the expectations about employment and income conditions of those households were positive, and there were no serious doubts regarding the size and composition of household sector assets, the stock of debt could continue to accumulate without directly affecting the debt burden, or the flows of consumers.

Second, the rise in home equity loans, which initially were only shifting the composition of household sector debt to mortgages, became over time a more general way of obtaining consumer (and other more liquid) credits. So by using housing equity as collateral, households could access credit for multiple purposes. As long as the value of home equity increased, the debt burden for households decreased. In addition, with the declining mortgage rates and falling processing costs of loans, the pool of households accessing credit increased, i.e. the share of indebted households increased.

But, once expectations about future equity- and housing prices deteriorated (including expectations about future macroeconomic performance), caused by e.g. a negative financial, expectation or supply shock, the high debt burden became a powerful constraint on household flow decisions in late 2007. This is possibly why we see historically the sharpest drop in consumption, household debt, mortgages, assets, corporate equities held by households, and net worth around 2008.

4.3.6. Financial intermediaries - banks

We will briefly compare the balance sheets of traditional banks versus non-bank financial intermediaries. In general, we observe a much higher diversity in patterns compared to either firms or households.

The financial de-regulation of 1980's and the subsequent move towards a market-based financial system has deeply changed the structure of the balance sheets of both bank and non-bank financial intermediaries. Roughly speaking, we can divide financial sector funding structure into two periods: the pre- and post-1990. In the traditional banking intermediation, banks take deposits from households and

transform them into credit for households and firms in need of external financing. In upturns, the quantity of credit available is higher, since depositors are less risk averse (thus less concerned about the use of their deposits and demanding lower return) and banks can more easily use their deposits for credit creation. In downturns, however, depositors become more risk averse (leading to a higher probability of them withdrawing the liquidity or demanding higher return on their deposits) and banks, doubtful of the debt-repayment conditions of borrowers, restrict their credit provisions. As a result, bank assets are procyclical under this funding model. Our early sample period confirms this pattern. At the same time, bank liabilities lead the cycle, which means that the amount of deposits available before an up- or downswing determines the amount of loans that banks could issue.

However, the financial reforms that followed the recessions in the 1970's permitted the banks to turn to capital markets, and non-bank financial intermediaries for raising funds.[43]As a result, banks became less reliant on traditional household deposits for their loan expansions, and more on capital market (Adrian and Shin, 2010b). Since capital markets are more volatile than households' propensity to deposit, the consequence from an increasing reliance on capital market funding has been that bank liabilities have become almost three times more volatile over the past two decades compared to 1980's. At the same time, bank assets turned more than one and one-half times more volatile over the same period, probably because the availability of funding on capital markets also determined banks' capacity for balance sheet expansion, making asset side also more reliant on haircuts and general capital market fluctuations. Moreover, both bank assets and bank liabilities became highly procyclical during the same period.

4.3.7. Financial intermediaries - non-bank financial intermediaries

Two key characteristics of non-bank financial intermediaries is that their balance sheet is short-term in nature, and they pursue procyclical, or maximum permissible leverage (i.e. the ratio of total assets to equity is large when total assets are

[43]The financial reforms came about largely as a result of the unsustainability of the traditional intermediation chain since depositors' willingness to lend remained low, and the high Federal Funds rate meant that banks were limited in providing new loans, even during the brief economic upturns during this episode. As a result, both bank assets and liabilities did not move with the general cycle, and the volatility of both series increased, reflecting this uncertainty. Because of these shortcomings in the traditional intermediation structure and the low possibilities for expansion (since banks were constantly constrained by the amount of deposits withheld within the bank), banks were pressured for reforming their financing structure.

large).[44]Any appreciation in the value of their equity results in an increase in collateralized borrowing, on for instance the repo market, in order to maximize their margins (Adrian and Shin, 2010a, 2010b). To illustrate this, assets of non-bank financial intermediaries grew ten times that of banks, or 800 times its size before the financial de-regulation of early 1980's (Adrian and Shin, 2010b). As a result, the amount of liquidity supplied on the capital markets has been enormous in the two decades preceding 2007. However, since there is a strong positive relation between assets and leverage, and assets are marked-to market (Adrian and Shin, 2010a, 2010b), the vulnerability of their balance sheet to market price movements is very high. That is why in our data we observe an increase in the volatility of non-bank assets by a factor of four going from 80's to 00's.

Because of the high importance that non-bank financial intermediaries play in providing funding to banks (and in turn to firms and households) following from the early days of financial liberalization, we should see a strong co-movement between the balance sheet of non-bank financial intermediaries and the overall business cycle. This is indeed what we find in the data. While in the pre-1990 period, assets of non-bank intermediaries did not particularly follow the business cycle, and liabilities lagged the cycle, since 90's, both series had become so strongly cycle-driven that in 2000's, the correlation of non-bank assets (liabilities) with output was as high as 0.962 (0.865).[45]

4.3.8. Federal government

For the federal government, we are mostly interested in the sustainability of government finances, and have therefore only included explicit series on total debt. Nevertheless, we have also included a measure of government deficit/surplus called government savings which will also capture the balancing of the Federal budget (and thus the budget sustainability) in each period. For flows, we have government consumption, government non-defense investment, and government defense investment on the spending side, and net government receipts (net of transfers), and debt on

[44]The only constraint they face is either the regulatory cap on leverage, or the capital requirement ratio. Many classes of 'shadow banks' were however not bound by these regulatory requirements, since these did not include 'shadow bank' activities.

[45]Therefore, the main source of liquidity for the entire economy lies with the non-bank intermediaries, and any shocks affecting their leverage (or asset value) cause disruptions in the liquidity flow, resulting (with some delay) in a recession. Gertler and Kiyotaki (2010), Gertler and Karadi (2011), and Hilberg and Hollmayr (2011) explore the effects from disruptions on the interbank market on the supply of liquidity in the economy within the novel funding structure of the financial sector explored here.

the income side.

Federal debt is a good predictor of the general business cycle since it has lead it for most of the sample period. It is also two to three times more volatile than output. Looking at the raw (unfiltered) series, you also find that the series has experienced a tremendous growth since the Reagan period. To put it into perspective, whereas US government debt was approximately 1 trillion dollars, or one-sixth of the GDP in 1980, in 2012, the accumulated value was 16 times higher, or 120 percent of the GDP.[46]This means that the government has been running constant deficits since early 1980's. Our government savings series confirm this, and moreover point out that the historically speaking, the two largest peaks in deficits (or troughs in savings) were in early 2000's, following the Republican Tax Reforms.[47]During those years, the deficit rose (or savings fell) by 225 and 250 percent above (below) the trend (see graph III.14). Hence we should expect a heavier constraint on future government spending and a less sustainable fiscal balance, since debt repayments will need to be prioritised in the future. Moreover, taking into account that an increasing share of that debt is being held by foreign investors, the sustainability of the US public finances are increasingly being determined by the external demand for its debt.[48]More on this in the subsequent subsection.

Government revenues have increasingly followed the general movement of the business cycle over time. For the past two decades it became almost perfectly procyclical. For government outflows, we see a diverse picture. While expenditure and defense investments are both countercyclical, non-defense investment is procyclical. It means that the government prioritises projects which have long-run impacts on the economy in upturns, while it prefers short-run policies to fill the consumption gap in downturns.[49]Lastly, government expenditure has a very similar volatility to output and is less volatile than any of the other flow series, suggesting that the largest share of the expenditure series are automatic stabilizers since these are automatically triggered when output (and other variables) fall below a certain threshold. Hence the series should be countercyclical, and have a very similar volaility pattern

[46]Source: Federal Reserve St. Louis database.

[47]The 2001 EGTRRA (Economic Growth and Tax Relief Reconciliation Act) and the 2003 JGTRRA (Jobs and Growth Tax Relief Reconciliation Act) tax reforms.

[48]In July 2012, 48 percent of US public debt was held by foreign investors, mainly Japan and China. Source: US Treasury-Data Chart Center. Data retrieved from Bruegel database on April 2013 shows a lower foreign bond holding at 34 percent.

[49]See, amongst others, Baxter and King (1993) for the various effects of different government spending policies.

to output, in accordance with our observations in the data.

4.3.9. The external sector

Commencing with the federal debt owned by foreigners (which we briefly discussed in the previous subsection) the series is largely procyclical, with significantly longer cycles than both the output and total federal debt. However, over the past decade it has become countercyclical, less volatile and with (shorter) frequency which follows more tightly the cycle of output. This is in line with our previous discussion where we noted that foreign investors have played an increasing role in buying the Federal debt. One implication from this is that the ability of the US government to execute their (stabilization) policies and the sustainability of the public finances are being handed over to the external sector and the propensity of foreigners to demand its debt. This makes the Federal budget significantly more exposed to external shocks, and thus more uncertain.

Turning to the foreign direct investment series, we observe strong similarities between the FDI in US and US FDI abroad over the cycle. The second moments of both series are very similar, and while for most of the postwar period they are countercyclical, both turned procyclical around early 2000. This suggests that both the US investment abroad as well as the foreign investment in the US are determined by the same (latent) factors. Moreover, while both FDI series dropped during the Great Recession, the drop has not been anywhere close to the heavy swings of the 1970's and the contractions experienced in both types of FDI during the mid-70's recession. The smaller contraction during the most recent crisis could by large be attributed to the reduction in volatility of the exchange rates (both the narrow and the broad real) of the US dollar since the early 1980's, which we observed in the above subsection. Thus in relative terms, the foreign direct investment has remained more or less untouched by the latest recession.

4.3.10. Financial rates and spreads

To conclude our business cycle analysis, let us turn to financial rates and spreads. We identify important differences between the short-term and the long-term spreads.

While both types (short and long-term spreads) are less volatile than output, the long-term are less volatile than the short-term spreads. In addition, while the short-term spreads experienced their historically highest peak during the 1970's,

as a result of the high volatility in the Funds rate/3-month T-bill rate to which it is benchmarked to, the long-term spreads rose the most during the most recent recession.[50]So the relative standard deviation of, for instance, the corporate risk spread was 83% higher in 2000's compared to 1970's, or 76% higher compared to 1980's. Similar differences are observed for the other two long-term spreads. The risks were therefore priced in the longer end of the market.

Turning to correlations, we observe a less unified pattern amongst short-term spreads compared to the long-term ones. Eurodollar- and deposit spreads have been countercyclical for the entire period, prime spread has mostly been procyclical, while the others have changed their frequency pattern over time. During 1970's and 80's, the three remaining short-term spreads were countercyclical.[51]However, in 90's they became procyclical, and remained so during 2000's. The only exception is the 3-month LIBOR spread that by 2000 had again become countercyclical.

On the long side, however, the three spreads are all countercyclical. An implication of this more unified countercyclical nature of the long-term spreads is that borrowers prefer to take on long-term debt in expansions. The default costs priced into the spread are low, and so the price of a long-term loan is low. However, in downturns, this type of debt becomes less desirable/demanded as the spreads widen because of a higher probability of default of borrowers (increasing thus the costs of borrowing). At that point, the short-term debt becomes more attractive since the lending spread is small (procyclical) and (since 1980's) its volatility over the cycle is low, turning it into a more secure source of funding for liquidity constrained borrowers.

Our findings regarding the shifting pattern in correlations of (short-term) financial spreads are in line with the broader literature on the predictive power of spreads. Using VAR, GARCH and other regression methods, they find that only during limited periods of time are spreads useful in forecasting economic and/or financial performances.[52]For models, this possibly implies that not all frictions in the financial industry cause contractions in the real sector since agents can access other types of credit when problems in one segment emerge. As we noted, the at-

[50]The short-term spreads we consider in our sample are the 3-month LIBOR, 3-month TED, 3-month Prime rate, 3-month Eurodollar, 3-month Deposit-and 3-month Paper-bill spreads while on the long-end we consider the AAA-, BAA-, and Corporate risk spreads.

[51]3-month LIBOR-, 3-month TED- and 3-month Paper-bill spreads.

[52]See Friedman and Kuttner (1998), Emery (1999), Gertler and Lown (2000), Weber (2002), Ewing *et al* (2009) amongst others for a more thorough discussion on the forecast power of financial rates and spreads.

tractiveness of long-term debt over the short-term one changes at different points of the business cycle, meaning that under some circumstances, firms/households (or even banks) can substitute one for the other and avoid being liquidity constrained.

5. Decomposition of output growth

Having considered the US postwar aggregate demand side, let us now look at the factors of production that have contributed the most in shaping the US output growth cycles. For this purpose, we have performed a growth accounting exercise where we have decomposed output growth into growth in supply side factors such as capital, labor and total factor productivity (henceforth TFP).[53]The capital series we use is capital stock and for labor we use total hours of work of all workers per week. Because capital stock is only reported from 1960:I, our growth accounting sample also starts from this period.[54]Table I.2 reports the results from the growth accounting exercise for the entire sample (1960:IV-2011:II), as well as for each business cycle expansion and recession following NBER's business cycle dates. A business cycle expansion is defined as the period between a trough and peak in NBER's list of dates, and vice versa for a recession. Figure III.2 plot the growth rates of each component over time, as well as the percentage contribution of each factor to the reported output growth. Therefore, for periods where the contribution of a factor to output growth has the opposite sign to output (for instance, the growth in GDP is negative, while the growth in capital is positive), the contribution of that factor has been minimal and thus we have reported it as 0 percent in our table.

From Figures III.2, we find that TFP explains the majority of output growth since 1960. It grew by 2.12 percent per year and accounts for 62 percent of the movement in output in the complete sample. Capital is the second most important driver with a growth of 1.325 percent per year, while labor has the least impact on output (0.22 percent contraction per annum). However, a closer look at output growth over the business cycle reveals a more diverse picture. During most expansions, TFP followed by capital are the main drivers of output growth, with 1.842 and 1.26 percent annual growth on average. However during recessions, it is labor (with a contraction of 4.151 percent per annum on average) that contributes the most to contractions in output. Taking into account that during those periods, the growth in

[53]See Mourre (2009) for a similar and more detailed growth accounting exercise for the EU.

[54]Data on capital stock was collected from OECD's Economic Outlook database in Reuter's EcoWin.

TFP (and capital) are still positive and higher (smaller), it means that contractions mainly result in firms reducing the hours worked for their employees[55]while making them more productive.

In addition, we find that the highest growth in capital and TFP occurred during the dot.com bust period of 2001 (1.95 and 4.89 percent per yeear), while the lowest has been during the most recent expansion (0.69 and 1.13 percent per year). For labor, on the other hand, the highest growth was during the 1960's (2.08 percent per year), and the highest contraction during the most recent recession (-6 percent per year). From a supply side point of view, this means that the drastic drop in labor hours during the financial crises coupled with the weak growth in TFP during the most recent expansion can possibly be one of the explanations to the currently weak recovery of US output.[56]Since many workers are unemployed, and the remaining ones have not compensated for the loss in the input factor by becoming more productive (like in the previous recession), this has resulted in an overall drop of production capacity. This is supported by other recent studies in the literature.

Broadbent (2012) finds that the main reason for the most recent contraction in the UK economic cycle has been a contraction in the supply side, rather than the standard demand-side optics emphasized in most financial friction models. He argues that a combination of uneven demand across sectors combined with an impaired financial system (due to its inability to effectively reallocate resources sufficiently quickly to respond to shocks) has lead to a reduction in aggregate output per employee. While Chadha and Warren (2012) find an equally important role for the efficiency or labor wedge as the key driver for the most recent UK contraction, they however reason that it is not necessarily the shocks originating from the supply side of the economy that lie at the centre. Their business cycle accounting exercise shows that asset price shocks might equally appear in the supply-side wedges, suggesting that the supply side works as a propagator for shocks originated elsewhere. Linking it with our overall findings that TFP and capital are the strongest drivers of US postwar output, we suggest to future models to equally consider the supply-side as a propagator of, for instance financial shocks, since these (sharp and unexpected) movements in financial prices alter the ratio of outputs to inputs, or the supply of inputs. Many financial friction models have concentrated on the demand-side

[55]Either by firing more staff, or reduce the number of hours for everyone.

[56]Larry Summers and other prominent economists have recently referred to this phenomenon as a 'secular stagnation' since there are little perspectives for these factors to grow in the foreseable future.

effects, but less on the supply side (production) factors.

6. How well do financial friction models capture these stylized facts?

The past few years have been unprecedented in terms of the number of new financial friction models that try to explore how activities and shocks inside financial markets might cause macroeconomic disruptions. While a rigorous assessment of those is still missing, they do provide fresh perspectives on how the arrangements in the financial industry drive the business cycle, in particular when shocks are generated within that industry. However, a question remains regarding how well these models replicate the stylized facts and mechanisms that we have outlined above. Do we observe the same business cycle patterns as in the data? Do they contain the mechanisms that we explore in this paper? While one might argue that in the real economy, we observe multiple shocks of different magnitudes simultaneously, implying that we will always observe some differences between the data and model output, a good model will nevertheless succeed in capturing most if not all the data moments.[57]

The list of models we assess is not exhaustive, but rather representative of the new generation of macro-financial models that have emerged over the past few years. We have chosen models that are significantly different from each other, both in terms of transmission mechanisms and model moments. We hope to give the reader guidance on what those models manage to capture and where their limitations are. We follow a version of the taxonomy outlined in the introduction of this book to categorize the models. The differentiation is based on whether the impulses/shocks and propagation mechanisms in these models are real and/or financial-monetary.[58]While the models resist in being perfectly nested in any of these categories, the classification should be instructive, and viewed from a relative (rather than absolute) perspective. Models that mainly use real shocks and real propagations are Mendoza (2010) and Christiano, Trabandt and Walentin (2011).[59]Similarly, the financial ac-

[57]In a model, we separate the shocks and estimate/calibrate them to a certain value.

[58]In other words, do the key impulses originate from the financial sector, or from real activity, and are these shocks propagated through the balance sheets of financial intermediaries and the financial sector, or via the non-financial segment of the economy, including households, firms, the external sector, or the government.

[59]Following the classification of Bean et al (2002), while these two models do include a broad credit channel, since financial intermediaries are modeled as a veil, the propagation of shocks occurs outside of the financial sector. Therefore we consider that as a real propagation channel since the shocks are transmitted via optimizations of real, rather than financial, agents. This also applies to the Gilchrist et al (2009) model.

celerator model of Gilchrist, Ortiz and Zakrajsek (2009) includes real propagations, but they simulate the model using financial/monetary shocks. On the other end we have the Boz and Mendoza (2010) with financial propagations, but real shocks. Finally, we include four models where both the propagations and the shocks are financial/monetary. Those are Christiano, Motto and Rostagno (2010), Gertler and Kiyotaki (2010), Gertler and Karadi (2011), and Hilberg and Hollmayr (2011).[60]For a longer description of the model mechanisms, please refer to Appendix II.

Our quantitative analysis is based on the quantitative results that are provided in the papers.[61]The comparative results are reported in Tables I.8 to I.11. The table abbreviations *Pos.* and *Neg.* stand for a positive and negative correlation with output, and when the model correlation is ambiguous in the impulse responses, but clearly different from the data, we have labeled it as *Very Different*. For the sake of clarity, we have divided our analysis into three parts. In the first one, we do a moment matching in terms of correlation, in the second we do the same for volatilities, while in the third (and based on the mechanisms identified in the data), we provide guidance on how future macroeconomic models can incorporate these and tackle the challenges that they currently face.

[60]Another way of categorizing the models is to view them as extensions (except for Boz and Mendoza, 2010) of the baseline financial accelerator (FA) mechanism in various directions. The first category of models look at the endogenous effects of banking. So, Christiano, Motto and Rostagno (2010) add an explicit banking sector, and (specifically) examine the evolution of credit supply (and demand) following a wide range of real and financial shocks. Gertler and Karadi (2011) also include a banking sector, but their intermediaries face endogenously determined balance sheet constraints. They use it to study the (financial and real) effects from unconventional monetary policy. While the basic framework is very similar to Gertler and Karadi (2011), Gertler and Kiyotaki (2010) extend the model to include a state-contingent interbank market, and analyze the impact that financial shocks have on the macroeconomy by altering the interbank credit supply. Hillberg and Holmayr (2011) take the modeling of interbank markets a step further by including heterogeneous banks, and study the impacts on the supply of credit in the repo markets from variations in the haircuts, as well as from stock market cycles. The second category of FA models have instead focused on developing financial frictions on the real side of the economy. So, Mendoza (2010) includes (apart from the standard collateral constraint on firms in a FA model) an additional credit constraint on the working capital of households and examines the endogenous effects from high debt to asset ratios on credit access, and the price and quantity of collateral. In his framework, the powerful Fisherian debt-deflation dynamics, triggered by the tight interlinkages between the collateral constraints of household and firms, results in disruptions in access to international capital markets. Christiano, Trabandt and Walentin (2011), on the other hand, extended the FA model to an international dimension in order to establish the role of financial frictions in driving the business cycles of an open economy.

[61]In most cases, this is unfortunately limited to interpretations from impulse response exercises since a table with second moments is not provided, which means that we can only infer the sign of the correlation between a model variable and output, but not the intensity of it. In some cases, however, the authors do provide more extensive results, which we additionally take into account to complement our analysis.

6.1. Correlations: Model vs. Data

The majority of the models manage to replicate the correlations observed in the data. Christiano et al. (2010), Gertler and Kiyotaki (2010), Gilchrist et al. (2010), and Gertler and Karadi (2011), replicate the true correlation coefficients for both the real and financial (firm net worth, investment, policy rate, real rate and external finance premium) variables.[62]The mechanism behind this regularity is the procyclical firm decisions, and the asymmetry in the corporate credit markets that these models include, which means that firms, because of the high demand for their products, accumulate debt during expansions, since the value of their collateral (net worth) increases. Banks, willing to expand their assets, expand their firm lending. However, in contractions, the probability of default of firms increases, at the same time as the risk aversion of banks to lend increases, pushing the lending rates up to compensate for both effects. The result of a lower liquidity supply to firms is that their investment and production decreases. Since monetary policy is loosened to restore the credit conditions, the finance premium rises, hence why it is countercyclical, and the policy rate procyclical. For similar reasons, Christiano et al. (2011), and Hilberg and Hollmayr (2011) manage to replicate all correlations, except for the nominal interest rate.[63]

For the two remaining models, however, we find greater differences between the model and the data correlations. Mendoza (2010) generates the opposite signs for correlations of net exports and capital prices to output compared to data.[64]To finish, since Mendoza and Boz (2010) provide (impulse response) results for four model variables around a business cycle peak and trough, the comparison is slightly different. Whereas the model manages to replicate the co-movement between most model variables and output (except for savings, which in the model rise in upturns, whereas they fall in the data), we find some differences in the timing of the shifts

[62]Because Christiano et al. (2010) provide an explicit list of exact model second moments, we find that consumption and labor hours are more tightly correlated to output in the model compared to data, and vice versa for investment.

[63]Since the interest rate is countercyclical for the monetary policy and technology shocks, and because authors do not provide explicit second moment results, we have to interpret the signs via impulse responses.

[64]Because the model assumes that net exports precede the rise in leverage, a rising leverage pushes up the prices of domestically produced goods (via demand), resulting in the decreased price competitiveness and the subsequent fall in net exports. In downturns, the de-leveraging leads to a fall in prices, increasing thus the price competitiveness of domestic products, and a rise in net exports. We find the opposite sign in the data. For capital prices, while the sign of correlation is correct, the intensity is lower in the model since (model) prices are less responsive to drops in investment, possibly because investment and asset prices are only linked via demand.

in most variables around business cycle peaks and troughs. While the debt ratio B/GDP has a sharper increase/decrease at the onset of the optimistic/pessimistic stage in the data compared to the model, capital prices and consumption rise/fall less sharply after a business cycle trough/peak in the data compared to the model.[65]

6.2. Volatilities: Model vs Data

The bigger challenge for these models lies in capturing the true volatilities.[66]So, for instance, Christiano *et al* (2010) generate correct volatilities for labor hours, net worth, consumption and inflation, or Gertler and Karadi (2011), who manage to capture the true volatilities of investment, labor input, and inflation. Remembering that both models extend the FA mechanism by including an explicit banking sector, it appears that including an explicit intermediation sector improves the volatility matching of the demand side variables because of the key role that the supply of credit plays in household and firm flows.

On the other hand, the first model does less well for financial variables such as the policy rate, external finance premium, or loans. Similarly, Gertler and Kiyotaki (2010) capture the volatility of external finance premium, but for all remaining variables, the volatilities of the variables in the models are lower than of those observed in the data. This pattern is true for most of the models, where we note that the model relative standard deviations are lower than those of the ones found in the data.[67]Since these models only partially include the endogenous effects of (debt) stock accumulation on the model dynamics (concentrating mainly on the

[65]Possibly reflecting the asymmetrically higher real effects of de-leveraging. At the peak, the (endogenous) stock of debt is significantly higher in the data, meaning that when a negative shock hits the economy, the de-leveraging is more accelerated, and the amplification to the real economy is in reality more accentuated than proposed by the model. Conversely, the stock of debt at the trough is so low that consumers take longer time to recover their wealth and start spending, delaying thus the recovery. Finally, the rise and fall in consumption is symmetric between both stages of the business cycle in the data, whilst they are asymmetric in the model.

[66]With the best performing models capturing only a handful of these.

[67]Except for investment in Christiano et al (2011), net worth, policy rate, and external finance premium in Gertler and Karadi (2011), net worth of firms in Gertler and Kiyotaki (2010), or leverage in Gilchrist *et al* (2010) where the volatility of those model variables are higher than in the empirics. While it is difficult to establish the exact underlying reasons for it (due to the complex structures operating in these models), because all these variables are related to firm stocks and flows, we believe that the problem comes from the very high elasticity of firm net worth to asset price fluctuations within the FA mechanism of these models. Since firm equity plays a pivotal role for the real and financial decisions (and constraints) of firms, large fluctuations in this state variable are necessary in order to generate significant amplification effects. Nolan and Thoenissen (2009) show that a (model derived)/endogenous shock to firm equity value is the most significant in driving the model dynamics. The side effect is, nevertheless, that it causes excessive variation in some of the firm variables in order to generate sufficiently pronounced financial cycles.

balance sheet of firms or banks), the full-force propagation effects of higher debt-to-asset ratios of all sectors in the economy are not included. Therefore, the impulse responses are smoother in the models, and the volatilities of the variables are lower compared to the data. Let us expand on this in the next subsection.

6.3. Are there other data properties that these models omit?

So far we have only discussed and contrasted the quantitative model results that authors have reported in their models. The choice of variables to report has entirely been a decision of the author(s), the model, or both. However, there are a few mechanisms we have identified in the data that these models should incorporate.

The first aspect is the effect of long-term financial ratios on model dynamics. We saw early on in the empirical analysis that long-run ratios such as household debt-to-asset, or consumption-output have significantly increased over the past 60 years. The models therefore need to incorporate mechanisms, such as financial innovation, collateralized housing debt, and/or state-contingent optimizations which would allow households (or other agents) to accumulate a larger stock of debt over a much longer period of time than currently feasible in the financial friction models. Another possibility is to internalize the inter-sectoral spillover effects from the chase for margins by financial intermediaries into the optimization problems of agents. Heavy chase for margins by non-bank financial institutions (and later banks) since 1990's has lead to a high increase in financial market liquidity. This resulted in intermediaries giving out credit to households (and to a certain extent firms) which under normal circumstances would not be eligible. Hence, the new market conditions (or state) within the financial system resulted in an alteration of the constraints that households faced (becoming laxer) and as a result their optimization problem was transformed. If this occured multiple times, this would allow ratios, such as debt-to-asset or debt-to-income, to attain new values over a longer period, consequently altering the model dynamics to such an extent that the risk preferences, technologies, or beliefs of agents might change over time, resulting in new dynamic optimizations.

A similar point relates to the high exposure of firm balance sheets to stock price fluctuations. In the business cycle section, we found that the higher leverage of firms over the past two decades has meant that their balance sheet has been increasingly vulnerable to volatile and highly procyclical stock price movements. As a result, balance sheet of firms became increasingly procyclical and increasingly sensitive to

downfalls in equity prices since the 90's. While the FA mechanism captures the effects of asset price movements on firm net worth and the credit supply, the stock prices in the models are less volatile than the ones observed in the data. This is mainly because the price of assets in these models is not expectations augmented and therefore the price does not fluctuate with expectations that investors hold regarding the future profitability of investments. Gilchrist et al (2009) and Hilberg and Hollmayr (2011) do include two asset prices in their model, where one is forward-looking and the other is contingent on fundamental factors to investment, but the forward-looking price is exogenously determined (via a parameter) and firm investment (and therefore future net worth) is dependent on the fundamental value of assets, which is less volatile than the forward-looking price. An interesting extension of the FA framework would be to endogenise the wedge between the two asset prices so that the forward-looking price is derived from the model dynamics and evolves endogenously in the model. First then can one consistently study the effects of market expectations on firms' balance sheet and explicitly analyze the effects of high stock price variability of firm demand and supply. As we observed in the last section of the empirical analysis, asset price shocks are not only propagated via firms' demand channels, but also via the supply side (by altering the ratio of output to input, or the supply of inputs). It would therefore be relevant to include both propagations. Chapter 2 of the book is a contribution in this direction.

A further extension to the current models might be to capture and analyse the effects of an increasing exposure to international shocks on the sustainability of public finances, and the capacity of the government to counteract future recessions. As we saw in the external balance sheet, a large share of the debt is now owned by foreign investors. At the same time, the foreign bond holding series have turned procyclical during the past decade. An interesting exercise would be to examine how large negative international shocks (either in the exchange rate, or in the foreign economy) affect the US government inflows, the capacity to issue new bonds, and the ability to run its spending policies. At a larger scale, such an extension in the macroeconomic models would allow academics and policy makers to analyse the long-run effects of such shocks on the government's future budget constraint and it's ability to run countercyclical (stabilisation) policies. For policy makers, it might be of high interest to find the optimal level/percentage of foreign ownership of the debt at which the debt portfolio is diversified, but the future government budget constraint and it's stabilisation capacity is not put in danger by 'over-exposure' to

international shocks.

To conclude, there are a few other points which we identified in the empirical analysis, but which the models to some extent ignore. Early on in the business cycle analysis we noted that over the past 60 years, US output volatility had shifted between cycles with high and low volatility. We observed a similar pattern in many other macroeconomic aggregates. One way to capture this might be to include a Markov-switching process where the economy switches between a high and low volatility regime, and explore the model responses/dynamics under the two regimes as well as examine the probability distribution of switching between the regimes. Similarly for financial spreads we noted that the preference for long-term over short-term debt changes over the business cycle. While long-term debt is attractive during economic upturns (because of the low costs of borrowing), the short-term one becomes attractive in downturns since the spreads are less volatile (offering a more secure source of funding) and certain segments of the short-term credit market offer low borrowing costs. Since agents face this trade-off between different debt maturities, frictions in one segment of the financial market do not necessarily cause contractions in the real sector since firms/households (or even banks) can (imperfectly) substitute their debt and avoid being liquidity constrained. A Markov-switching model could potentially deal with this asymmetry in financial frictions.

7. Conclusion

Studying the US economy is not only appealing because there is good quality data available for many economic and financial variables over a long period of time, but also because there are strong linkages between the American financial and real cycles. Moreover, the transformation that the US financial system has undergone since the early days of liberalization in late 1970's has modified those linkages, and therefore the role that financial sector plays in driving the aggregate business cycle. This is not least apparent from the recent observations made by Cecchetti (2008, 2009), Pozsar *et al* (2010) and several others regarding the impact of balance sheets explosions of non-bank financial intermediaries, households and firms on the latest boom period of 2002-07 and the subsequent bust. We incorporate these remarks in our enquiry of the US economy, and closely study the macro-financial co-movements over 10 business cycles and 6 decades of quarterly observations.

We find that the standard long-run relations have persistently increased, in par-

ticular since the financial liberalization in the 1980's. Specifically, the more than proportional rise in debt-to-assets of households has since 1990's lead to a rise in the consumption-output ratio above its long-term average. Financial engineering and the use of equity collateralized debt as a general source of funding for households has meant that consumers have been able to expand their spending without increasing the debt burden on their budget constraint. Moreover over time, a larger share of household income has come from their equity holdings (rather than wages), with the (undesired) consequence that consumption has become increasingly sensitive to shocks on wealth, via their increased exposure to equity price fluctuations. Future financial friction models need to capture the stylized facts of households in a more consistent and detailed way.

Equally, balance sheet of firms have become increasingly procyclical and volatile since the 90's which has lead to powerful financial contagion within the sector once the price of assets decrease. While the FA mechanism captures the effects of asset price movements on firm net worth and the credit supply, the stock prices in the financial friction models are less volatile than the ones observed in the data. Future models should include forward-looking (or expectations augmented) asset prices and systematically study the effects of market expectations on firms' access to credit, default rate, investment levels, and firm assets.

Turning to the public sector, a large share of the Federal debt is now owned by foreign investors. At the same time, the foreign bond holding series have turned procyclical during the past decade. An interesting exercise would be to examine how large negative international shocks (either in the exchange rate, or in the foreign economy) affect US Federal financial inflows, the capacity to issue new bonds, and the ability to run its spending policies. For policy makers, it might be of high interest to find the optimal level of foreign ownership at which the debt portfolio is diversified, but the future government budget constraint and it's stabilisation capacity is not put in danger by 'over-exposure' to international shocks.

Financial engineering and optimism lead to very rapid accumulation of stocks (e.g. debt, equity), which result in secular increases in the long-term ratios. Macroeconomic models assume that these ratios are stationary in the steady state, but the long-run analysis showed that these can persistently deviate from their long-run average. The result can be an inaccurate representation and modeling of the business cycles. Future models should allow these ratios to vary over the long-run, and study their effects on the evolution of business cycles.

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Appendices

I. Data and Tables

Table I.1: US Business cycle dates

Business cycle peak	Business cycle trough	Increase in GDP trough to peak	Fall in GDP peak to trough
July 1953 (II)	May 1954 (II)	-	-1.93%
August 1957 (III)	April 1958 (II)	12.19%	-2.11%
April 1960 (II)	February 1961 (I)	9.18%	-0.7%
December 1969 (IV)	November 1970 (IV)	48.44%	0.001%
November 1973 (IV)	March 1975 (I)	13.24%	-1.58%
January 1980 (I)	July 1980 (III)	20.25%	-0.19%
July 1981 (III)	November 1982 (IV)	2.49%	-1.41%
July 1990 (III)	March 1991 (I)	35.6%	-0.48%
March 2001 (I)	November 2001 (IV)	42%	0.35%
December 2007 (IV)	June 2009 (II)	15.7%	-5.05%
Number of cycles	10		
Average GDP increase/quarter in expansions	1.05%		
Average GDP fall/quarter in recessions	-.036%		

Table I.2: US GDP growth decomposition

Business cycle	**Period**	**GDP growth**	**Growth in K**	**Growth in L**	**Growth in TFP**
Whole sample	1960:IV-2011:II	3.137	1.325	-0.223	2.117
Expansion	1961V:I-1969:III	4.961	1.249	2.079	1.607
Recession	1969:IV-1970:IV	0.191	1.396	-4.362	3.45
Expansion	1971:I-1973:III	4.827	1.281	1.697	1.90
Recession	1973:IV-1975:I	-0.903	1.626	-3.596	1.379
Expansion	1975:II-1979:IV	3.89	1.18	1.381	1.398
Recession	1980:I-1980:III	-0.835	1.611	-4.089	1.85
Expansion	1980:IV-1981:II	2.549	1.542	-0.353	1.428
Recession	1981:III-1982:III	1.289	1.261	-2.255	2.496
Expansion	1982:IV-1990:III	4.067	1.418	0.527	2.127
Recession	1990:IV-1991:I	-0.367	1.22	-3.154	1.686
Expansion	1991:II-2000:IV	3.602	1.531	0.045	2.048
Recession	2001:I-2001:III	0.681	1.944	-5.68	4.89
Expansion	2001:IV-2007:III	2.595	1.214	-1.602	3.104
Recession	2007:IV:I-2009:II	-1.55	1.133	-5.922	3.725
Expansion	2009:III-2011:II	2.134	0.69	1.389	1.128
Average expansions	1960:IV-2011:II	3.578	1.263	0.52	1.842
Average recessions	1960:IV-2011:II	-0.213	1.456	-4.151	2.782

Note: We decomposed GDP growth using data on capital stock and weekly hours of production. The data was logged and transformed into yearly growth rates. Following Cobb-Douglas specification for our supply side technology , we define the share of capital in production as 30%, whilst 70% for labour. In addition we calculate the Solow residual based on the other input shares. This residual represents the share of technology (TFP) in production, which we set to 70We do not expect our results to considerably differ for other specifications of the production function, such as the CES technology. Despite being less restrictive than the Cobb-Douglas, and being non-Hicks neutral, Almeida and Felix (2006) do not find significant differences between the supply side shares in output growth using a CES compared to a Cobb-Douglas production function. Nevertheless, using the former, we could in addition identify whether the TFP adjustments were caused by changes in labor or capital productivity. One reason behind the observed similarity in results is that we are primarily interested in the long-run production frontier, which means that we can correctly use the unitary elasticity of substitution of Cobb-Douglas (Leon-Ledesma and Satchi, 2011).

Table I.3: Second moments decade by decade I

	Real GDP		Consumption	Mean weekly hrs of production	Aggregate hrs worked	Output per hr per person
$\sigma_{1953-60}$	0.020	σ 1953-60	0.526	0.688	1.097	0.578
$\sigma_{1960-70}$	0.012	σ 1960-70	1.059	0.800	0.981	0.959
$\sigma_{1970-80}$	0.022	σ 1970-80	0.824	0.529	1.105	0.589
$\sigma_{1980-90}$	0.017	σ 1980-90	1.058	0.537	1.042	0.611
$\sigma_{1990-2000}$	0.009	σ 1990-2000	1.461	0.857	1.616	0.991
$\sigma_{2000-2011}$	0.015	σ 2000-2011	1.879	0.753	1.483	0.676
σ_{TOTAL}		σ TOTAL	1.129	0.647	1.178	0.675
$\rho_{1953-60}$	1.000	ρ 1953-60	0.335	0.860	0.906	0.532
$\rho_{1960-70}$	1.000	ρ 1960-70	0.624	0.603	0.725	0.640
$\rho_{1970-80}$	1.000	ρ 1970-80	-0.137	0.801	0.911	0.628
$\rho_{1980-90}$	1.000	ρ 1980-90	0.218	0.642	0.924	0.590
$\rho_{1990-2000}$	1.000	ρ 1990-2000	0.206	0.559	0.754	0.060
$\rho_{2000-2011}$	1.000	ρ 2000-2011	0.888	0.718	0.908	0.047
ρ_{TOTAL}	1.000	ρ TOTAL	0.340	0.719	0.875	0.463
	GDP deflator	CPIU	PPI	Net exports	Balance on current accounts	
$\sigma_{1953-60}$	0.387	0.500	0.545	47.515	48.704	
$\sigma_{1960-70}$	0.289	0.439	0.681	43.547	31.772	
$\sigma_{1970-80}$	0.558	0.883	1.617	43.688	49.256	
$\sigma_{1980-90}$	0.610	0.973	1.514	27.915	50.093	
$\sigma_{1990-2000}$	0.376	0.689	2.060	42.937	51.361	
$\sigma_{2000-2011}$	0.362	0.705	2.672	10.767	10.405	
σ_{TOTAL}	0.493	0.788	1.670	38.324	43.957	
$\rho_{1953-60}$	-0.162	-0.476	-0.180	0.263	0.337	
$\rho_{1960-70}$	-0.305	-0.318	0.559	-0.382	-0.415	
$\rho_{1970-80}$	-0.893	-0.724	-0.385	0.029	0.593	
$\rho_{1980-90}$	-0.494	-0.301	-0.074	0.351	0.131	
$\rho_{1990-2000}$	-0.668	-0.467	-0.182	0.589	0.601	
$\rho_{2000-2011}$	0.468	0.521	0.764	0.860	0.820	
ρ_{TOTAL}	-0.455	-0.353	0.062	0.160	0.106	

Note: σ is the (relative standard deviation) of that variable with respect to output. ρ is the correlation between the variable and output. Note that the second column in this table (only) reports the standard deviation of output in absolute terms, not in relative.

Table I.4: Second moments decade by decade II

	Narrow effective X-rate	Real Effective X-Rate	Adjusted monetary base	M1	M2-M1	Velocity M1
$\sigma_{1953-60}$	no data	no data	0.187	0.448	no data	no data
$\sigma_{1960-70}$	1.177	no data	0.584	0.616	1.236	0.795
$\sigma_{1970-80}$	1.656	1.558	0.375	0.474	1.239	0.373
$\sigma_{1980-90}$	3.294	3.309	0.688	1.530	0.758	2.023
$\sigma_{1990-2000}$	2.966	2.732	2.383	4.501	3.264	4.563
$\sigma_{2000-2011}$	2.624	2.150	7.705	2.217	1.097	3.027
σ_{TOTAL}	2.415	2.364	3.171	1.531	1.317	1.997
$\rho_{1953-60}$	no data	no data	0.138	0.806	0.340	0.723
$\rho_{1960-70}$	-0.325	no data	0.701	0.516	0.340	0.723
$\rho_{1970-80}$	-0.511	-0.497	0.479	-0.608	0.437	0.327
$\rho_{1980-90}$	-0.072	-0.031	0.309	0.086	0.151	0.337
$\rho_{1990-2000}$	0.106	0.117	0.202	0.129	-0.168	0.017
$\rho_{2000-2011}$	-0.551	-0.556	-0.620	-0.424	-0.475	0.703
ρ_{TOTAL}	-0.294	-0.258	-0.207	0.077	0.123	0.345
	Velocity M2	Firm assets	Firm liabilities	Total loans firms	Net worth firms	Profits after tax
$\sigma_{1953-60}$	-	0.96‘	1.46	-	0.976	5.163
$\sigma_{1960-70}$	1.035	0.677	1.26	2.31	0.509	5.428
$\sigma_{1970-80}$	0.928	0.97	1.93	2.15	1.119	5.293
$\sigma_{1980-90}$	1.154	1.23	1.22	1.45	1.457	5.890
$\sigma_{1990-2000}$	1.503	1.95	2.11	5.26	3.578	7.037
$\sigma_{2000-2011}$	1.923	3.27	2.22	5.78	4.523	7.139
σ_{TOTAL}	1.271	1.67	1.76	3.22	2.233	5.831
$\rho_{1953-60}$	-	0.288	0.572	-	-0.150	0.836
$\rho_{1960-70}$	0.418	0.47	0.39	0.20	0.210	0.722
$\rho_{1970-80}$	-0.048	-0.67	-0.428	0.24	-0.681	
$\rho_{1980-90}$	0.535	0.081	0.30	0.42	-0.125	0.451
$\rho_{1990-2000}$	0.596	0.247	0.158	0.21	0.050	-0.073
$\rho_{2000-2011}$	0.946	0.727	0.349	0.22	0.762	0.272
ρ_{TOTAL}	0.457	0.183	0.09	0.22	0.122	0.508

Table I.5: Second moments decade by decade III

	Real compensation	Real investment	S&P500	Debt corporates	Assets Households	Liabilities Households
$\sigma_{1953-60}$	0.397	4.185	5.140	0.695	0.50	1.46
$\sigma_{1960-70}$	0.483	4.073	6.193	0.708	1.34	1.26
$\sigma_{1970-80}$	0.441	4.406	5.448	0.937	0.94	1.93
$\sigma_{1980-90}$	0.534	4.704	5.580	0.991	1.01	1.22
$\sigma_{1990-2000}$	1.406	5.204	10.840	2.888	2.47	2.11
$\sigma_{2000-2011}$	0.535	5.864	10.278	2.108	3.67	2.22
σ_{TOTAL}	0.556	4.702	6.819	1.34	1.79	1.76
$\rho_{1953-60}$	0.382	0.832	0.826	-0.543	0.61	0.67
$\rho_{1960-70}$	0.233	0.930	0.274	0.262	0.10	0.44
$\rho_{1970-80}$	0.669	0.593	0.451	0.008	0.58	0.78
$\rho_{1980-90}$	-0.238	0.906	0.281	0.351	0.13	0.49
$\rho_{1990-2000}$	0.038	0.877	0.331	0.337	0.47	0.08
$\rho_{2000-2011}$	-0.235	0.939	0.897	0.264	0.86	0.59
ρ_{TOTAL}	0.166	0.911	0.538	0.155	0.46	0.59
	Net worth of hshlds.	Real disposable personal income	Net worth /Dispos. Income	Hshld. Deposits	Residential investment	Corporate equities held by hshlds.
$\sigma_{1953-60}$	0.632	0.718	0.636	0.417	4.240	4.056
$\sigma_{1960-70}$	1.671	0.821	1.855	1.207	5.635	6.782
$\sigma_{1970-80}$	1.183	0.719	1.241	0.926	6.352	6.497
$\sigma_{1980-90}$	1.229	0.691	1.519	0.583	6.083	6.338
$\sigma_{1990-2000}$	2.905	0.830	2.993	2.358	6.786	10.946
$\sigma_{2000-2011}$	4.915	0.758	4.508	1.754	6.763	12.194
σ_{TOTAL}	2.327	0.739	2.249	1.149	6.025	7.732
$\rho_{1953-60}$	0.781	0.861	0.372	-0.074	0.645	0.268
$\rho_{1960-70}$	0.250	0.679	0.017	0.242	0.124	-0.028
$\rho_{1970-80}$	0.629	0.816	0.626	0.551	0.802	0.365
$\rho_{1980-90}$	0.048	0.766	-0.062	0.329	0.734	-0.002
$\rho_{1990-2000}$	0.372	0.559	0.350	-0.286	0.584	0.186
$\rho_{2000-2011}$	0.938	0.639	0.912	-0.228	0.676	0.833
ρ_{TOTAL}	0.502	0.755	0.438	0.133	0.665	0.373

Table I.6: Second moments decade by decade IV

	Hshld Mortgages	Commercial mortgages	Consumer credit by corporates	Hshld. Consumer credit	Debt households	Banking assets
$\sigma_{1953-60}$	0.872	4.871	2.997	2.000	0.865	1.594
$\sigma_{1960-70}$	0.761	3.353	4.084	2.010	0.748	5.519
$\sigma_{1970-80}$	0.916	1.501	2.026	1.992	0.898	4.205
$\sigma_{1980-90}$	1.710	6.055	2.789	2.218	1.697	4.903
$\sigma_{1990-2000}$	0.874	5.821	8.378	4.206	0.865	5.087
$\sigma_{2000-2011}$	1.886	2.860	3.802	1.346	1.876	6.736
σ_{TOTAL}	1.301	4.051	3.453	2.126	1.289	4.872
$\rho_{1953-60}$	0.445	-0.785	0.387	-0.742	-0.009	-0.460
$\rho_{1960-70}$	0.622	-0.095	0.158	0.279	0.655	0.317
$\rho_{1970-80}$	0.735	0.580	0.292	0.777	0.738	-0.465
$\rho_{1980-90}$	0.333	0.573	0.345	0.757	0.336	-0.502
$\rho_{1990-2000}$	0.076	-0.055	0.266	0.090	0.021	-0.002
$\rho_{2000-2011}$	0.418	-0.244	-0.095	0.064	0.418	0.633
ρ_{TOTAL}	0.466	0.066	0.210	0.526	0.466	-0.106
	Nonbank assets	Banking liabilities	Nonbank liabilities	Debt financial sectors	Gov. nondefense investment	Gov. defense investment
$\sigma_{1953-60}$	1.303	3.088	9.794	2.540	8.170	4.951
$\sigma_{1960-70}$	2.792	6.036	10.507	3.933	6.197	8.826
$\sigma_{1970-80}$	1.535	5.630	5.845	2.544	1.991	6.125
$\sigma_{1980-90}$	2.303	3.576	5.288	1.886	2.439	3.030
$\sigma_{1990-2000}$	6.451	4.958	7.561	2.023	7.135	6.033
$\sigma_{2000-2011}$	9.570	8.852	6.808	2.939	2.163	3.061
σ_{TOTAL}	4.350	5.690	7.061	2.657	4.649	5.392
$\rho_{1953-60}$	-0.155	-0.564	0.076	-0.285	-0.491	0.026
$\rho_{1960-70}$	0.171	-0.077	0.228	0.113	0.188	-0.048
$\rho_{1970-80}$	0.100	-0.411	-0.435	-0.052	0.048	-0.177
$\rho_{1980-90}$	-0.329	-0.293	0.067	0.148	0.238	0.020
$\rho_{1990-2000}$	0.455	0.534	0.174	0.608	0.001	-0.017
$\rho_{2000-2011}$	0.962	0.550	0.865	0.006	0.141	-0.398
ρ_{TOTAL}	0.325	-0.079	0.056	0.076	-0.098	-0.103

Table I.7: Second moments decade by decade V

	Government expenditure	Gov. receipts	Gov. saving	Federal debt	Federal debt owned by foreigners	FDI in US	US FDI abroad	Funds rate	T-bill rate	
$\sigma_{1953-60}$	1.704	2.675	24.951	0.730	-	0.54	-	0.45	0.44	
$\sigma_{1960-70}$	2.387	3.296	67.995	1.112	-	1.11	1.08	0.77	0.47	
$\sigma_{1970-80}$	1.188	1.991	30.652	1.735	7.26	3.85	3.93	0.99	0.67	
$\sigma_{1980-90}$	0.966	1.875	13.805	1.657	2.18	3.24	3.20	1.17	0.96	
$\sigma_{1990-2000}$	1.675	2.384	61.552	2.077	8.96	4.08	4.18	1.07	0.99	
$\sigma_{2000-2011}$	1.160	4.388	35.906	3.285	6.10	3.53	3.53	0.95	0.87	
σ_{TOTAL}	1.446	2.784	35.606	1.958	6.58	3.14	3.37	0.98	0.77	
$\rho_{1953-60}$	-0.203	0.908	0.380	0.454	-	0.63	-	0.468	0.543	
$\rho_{1960-70}$	0.102	0.302	0.002	0.108	-	-0.45	-0.32	-0.020	0.089	
$\rho_{1970-80}$	-0.690	0.699	-0.776	0.109	0.38	0	0.02	-0.003	-0.039	
$\rho_{1980-90}$	-0.466	0.483	-0.731	0.152	0.11	-0.31	-0.33	0.204	0.247	
$\rho_{1990-2000}$	-0.260	0.733	-0.039	0.030	0.09	-0.03	-0.04	0.061	0.089	
$\rho_{2000-2011}$	-0.425	0.848	-0.309	-0.392	-0.43	0.49	0.49	0.780	0.753	
ρ_{TOTAL}	-0.344	0.659	-0.270	-0.029	0.13	0.03	0.02	0.197	0.235	
	LIBOR spread	TED spread	10-year T-bond	Paper-bill spread	Prime spread	Eurodollar spread	Deposit spread	AAA spread	BAA spread	Corporate risk spread
$\sigma_{1953-60}$	-	-	0.19	-	0.045	-	-	0.036	0.103	0.075
$\sigma_{1960-70}$	-	-	0.27	-	0.37	0.66	0.68	0.095	0.15	0.077
$\sigma_{1970-80}$	0.24	0.31	0.30	0.29	0.25	0.39	0.38	0.15	0.28	0.16
$\sigma_{1980-90}$	0.46	0.41	0.75	0.21	0.13	0.58	0.30	0.21	0.31	0.17
$\sigma_{1990-2000}$	0.30	0.26	0.76	0.17	0.31	0.27	0.19	0.19	0.26	0.14
$\sigma_{2000-2011}$	0.25	0.27	0.33	0.13	0.027	0.34	0.28	0.25	0.51	0.30
σ_{TOTAL}	0.34	0.34	0.46	0.23	0.55	0.44	0.35	0.17	0.31	0.18
$\rho_{1953-60}$	-	-	0.51	-	0.329	-	-	-0.189	-0.274	-0.282
$\rho_{1960-70}$	-	-	0.21	-	-0.545	-0.279	-0.263	-0.178	-0.106	0.011
$\rho_{1970-80}$	0.069	-0.098	-0.26	-0.085	0.301	-0.267	-0.078	-0.627	-0.774	-0.760
$\rho_{1980-90}$	-0.178	-0.139	0.15	-0.072	-0.494	-0.289	-0.138	-0.234	-0.255	-0.171
$\rho_{1990-2000}$	0.479	0.471	0.31	0.148	0.417	-0.173	0.224	-0.006	-0.011	-0.013
$\rho_{2000-2011}$	-0.266	0.121	0.33	0.284	0.080	-0.139	-0.195	0.253	0.050	-0.131
ρ_{TOTAL}	-0.116	-0.040	0.111	-0.020	-0.043	-0.240	-0.112	-0.179	-0.275	-0.304

Table I.8: DSGE estimation results-Correlation with output I

Variables	Data	Christiano *et al* (2010)	Mendoza & Boz (2010)	Christiano *et al* (2011)	Gertler & Karadi (201)
Consumption	0.34	0.6	Pos.	Pos.	Pos.
Investment	0.911	0.7	-	Pos.	Pos.
Labour input	0.463	-	-	Pos.	Pos.
Hours worked	0.875	0.45	-	Pos.	-
Hours/employee	0.719	-	-	Near zero	-
Real wage	0.166	-	-	Pos.	-
Capital prices	0.538	-	Pos.	-	Pos.
Net worth (firms)	0.122/0.762	Pos.	-	Near zero	Pos.
Net exports	0.16	-	-	Pos.	-
Liquidity	0.07/0.123	-	-	-	-
Inflation	0.45/0.353	Pos.	-	-	Pos.
Policy rate	0.197/0.78	Pos.	-	Pos.	Pos.
Finance premium	(-0.04)-(-0.304)	Neg.	-	Near zero	Neg.
Loans	0.155	Pos.	-	-	-
Bond-to-GDP	-0.029/-0.392	-	Neg.	-	-
Deposits	0.133	-	Neg./Pos.	-	-

Note: For net worth of firms, the policy rate and Bond-to-GDP, we report the total as well as the post-2000 values. For liquidity, we report moments on M1 as well as M2-M1. Similarly, for inflation we both report the measure based on GDP deflator and the CPIU. We include both the short-term and the long-term spreads in the finance premium data (with the lower end being the 3-month TED spread, and the upper end the Long-term corporate risk spread. The empirical counterpart to Bond-to-GDP is Federal debt.

Table I.9: DSGE estimation results-Correlation with output II

Variables	Data	Gertler & Kiyotaki (2010)	Gilchrist *et al* (2010)	Hilberg & Hollmayr (2011)	Mendoza (2008)
Consumption	0.34	Pos.	Pos.	Pos.	0.931
Investment	0.911	Pos.	Pos.	-	0.641
Labour input	0.463	Pos.	-	-	-
Hours worked	0.875	-	Pos.	-	-
Hours/employee	0.719	-	-	-	-
Real wage	0.166	-	Pos.	-	-
Capital prices	0.538	Pos.	-	Pos.	0.406
Net worth (firms)	0.122/0.762	Pos.	-	-	-
Net exports	0.16	-	-	-	-0.184
Liquidity	0.07/0.123	-	-	Pos.	-
Inflation	0.45/0.353	-	Pos.	Pos.	-
Policy rate	0.197/0.78	Pos.	Neg.	Neg.	-
Finance premium	(-0.04)-(-0.304)	Neg.	Neg.	Neg.	-
Loans	0.155	-	-	Pos.	-
Bond-to-GDP	-0.029/-0.392	-	-	-	-0.298
Deposits	0.133	-	-	-	-

Table I.10: DSGE estimation result comparison to data-Relative standard deviation to output I

Variables	Data	Christiano *et al* (2010)	Mendoza & Boz (2010)	Christiano *et al* (2011)	Gertler & Karadi (2011)
Consumption	1.129	Same	Lower in model	Same (for pre-2000)	Lower in model
Investment	4.702	Lower in model	-	Higher in model	Same
Labour input	0.675	-	-	-	Same
Hours worked	1.178	Same	-	Lower in model	-
Hours/employee	0.647	-	-	Same (for post-2000)	-
Real wage	0.556	-	-	Same	-
Capital prices	6.819	-	Same	-	Lower in model
Net worth (firms)	2.233	Same (for pre-2000 data)	-	Lower in data	Much higher in model
Net exports	38.324	-	-	Same	-
Liquidity	1.531	-	-	-	-
Inflation	0.493/0.788	Same	-	-	Same
Policy rate	0.98	Lower in model	-	Much lower in model	Higher in model
Finance premium	0.18-0.55	Lower in model	-	Much lower in model	Higher in model
Loans	1.341	Lower in model	-	-	-
Bond-to-GDP	1.958	-	Higher in model	-	-
Deposits	1.149	-	Very different	-	-

Note: For net worth of firms, the policy rate and Bond-to-GDP, we report the total as well as the post-2000 values. For liquidity, we report moments on M1 as well as M2-M1. Similarly, for inflation we both report the measure based on GDP deflator and the CPIU. We include both the short-term and the long-term spreads in the finance premium data (with the lower end being the 3-month TED spread, and the upper end the Long-term corporate risk spread. The empirical counterpart to Bond-to-GDP is Federal debt.

Table I.11: DSGE estimation result comparison to data-Relative standard deviation to output II

Variables	Data	Gertler & Kiyotaki (2010)	Gilchrist *et al* (2010)	Hilberg & Hollmayr (2011)	Mendoza (2008)
Consumption	1.129	Lower in model	Lower in model	Lower in model	Lower in model
Investment	4.702	Lower in model	Same	-	Lower in model
Labour input	0.675	Lower in model	-	-	-
Hours worked	1.178	-	Lower in model	-	-
Hours/employee	0.647	-	-	-	-
Real wage	0.556	-	Lower in model	-	-
Capital prices	6.819	Lower in model	-	Much lower in model	Lower in model
Net worth (firms)	2.233	Higher in model	-	-	-
Net exports	38.324	-	-	-	Lower in model
Liquidity	1.531	-	-	Lower in model	-
Inflation	0.493/0.788	-	Lower in model	Lower in model	-
Policy rate	0.98	Lower in model	Lower in model	Lower in model	-
Finance premium	Same	0.18-0.55	Same	Lower in model	-
Loans	1.341	-	-	-	-
Bond-to-GDP	1.958	-	-	-	Same
Deposits	1.149	-	-	-	-

Table I.12: Real and monetary variables

Variable	**Code**	**Description**	**Source**
GDP	GDPC96	Real Gross domestic product	Federal reserves
Consumption	PCND	Personal consumption expenditures:Nondurable goods	Federal reserves
Investment in real terms	GPDIC96	Real Gross Private Domestic investment	Federal reserves
Capital	oe:usa:ktvq	Real Capital Stock at 2005 prices	OECD Economic Outlook
Inventories	IABSNNCB	Inventories-Assets of nonfarm nonfinancial firms	Federal reserves
Hours of all persons	HOANBS	Nonfarm Business sector	Federal reserves
Average weekly hours of production	AWHMAN	Average weekly hours of production: Manufacturing	Federal reserves
All employees: Manufacturing	MANEMP	Number of employees in thousands: Manufacturing	Federal reserves
Output per hour	OPHNFB	Output per hour of all persons	Federal reserves
GDP deflator	GDPDEF	Implicit price deflator	Federal reserves
Consumper price index	CPIAUCNS	Urban CPI	Federal reserves
Producer price index	PPIACO	PPI: All commodities	Federal reserves
Net exports	NETEXP	Net export of goods and services	Federal reserves
Balance on current accounts	NETFI	NIPA's	Federal reserve
Narrow effective exchange rate	ew:usa19516	Real Narrow average exchange rate	Reuter's EcoWin
Real effective exchange rate	ew:usa19095	Real effective exchange rate index	Reuter's EcoWin
Adjusted monetary base	ew:usa12044		Reuter's EcoWin
M1	ew:usa71210	Money supply:M1	Reuter's EcoWin
M2-M1	ew:usa12097	Money supply:M2-M1	Reuter's EcoWin
Velocity of M1	M1V	Velocity of M1 Money stock	Federal reserves
Velocity of M2	M2V	Velocity of M2 Money stock	Federal reserves

Table I.13: Balance sheet variables

Variable	Code	Description	Source
Firm assets	NCBTSTQ027S	Nonfinancial corporate business; Total assets	Federal reserves
Firm liabilities	TLBSNNCB	Nonfinancial Corporate Business; Total Liabilities, Level	Federal reserves
Total loans of firms	NCBLILQ027S	Nonfinancial corporate business; Total loans	Federal reserves
Firm net worth	MVEONWMVBSNNCB	Firm net worth: Market value	Federal reserves
Corporate profits	CPATAX	Corporate profits after tax + IVA & CCAdj	Federal reserves
Net financial investment	ew:usa12000273	Net financial investment	Reuters EcoWin
Private residential fixed investment	PRFI		Federal reserves
Equity prices	ew:usa15510	S&P500 Index	Reuters EcoWin
Real compensation per hour	RCPHBS	Business sector real compensation	Federal reserves
Debt of corporate sector	BCNSDODNS	Debt outstanding corporate sector	Federal reserves
Household assets	HNOTASQ027S	Total assets of households	Federal reserves
Household liabilities	HNOTOLQ027S	Total liabilities of households	Federal reserves
Household net worth	ew:usa12286	Household and nonprofit organisations	Reuters EcoWin
Real disposable personal income	DPIC96		Federal reserves
Net worth/disposable income	ew:usa12000907	Hshld net worth as % of personal income	Reuters EcoWin
Deposits of households	DABSHNO	Deposits of hslds and non-profit org	Federal reserves
Net investment	ew:usa12000160	Net investments of households	Reuter's EcoWin
Net financial investment	ew:usa12000164	Net financial investment of hslds	Reuters EcoWin
Gains from corporate assets	ew:usa12000169	Holding gains on corporate equities	Reuters EcoWin
Debt of households	HHMSDODNS	Debt outstanding: Household sector	Federal reserves
Home mortgages	HMLBSHNO	Home mortgages of households	Federal reserves
Commercial mortgages	CMLBSHNO	Commercial mortgages of households	Federal reserves
Consumer credit	CCLBSHNO	Consumer credit given to hshlds	Federal reserves
Consumer credit-firms	CCABSNNCB	Consumer credit given by firms	Federal reserves
Bank assets	ifs:s11107a0dzfq	Assets of banking institutions	IMF Ifs
Non-bank assets	ifs:s11107e0dzfq	Assets of nonbank fin. intermedaries	IMF Ifs
Bank liabilities	ifs:s11107b0dzfq	Liabilities of banking institutions	IMF Ifs
Non-bank liabilities	ifs:s11107f0dzfq	Liabilities of nonbank financial intermediaries	IMF Ifs
Debt financial sector	DODFS	Debt outstanding domestic fin. sector	Federal reserves
Government current expenditures	FGEXPND		Federal reserves
Public non-defense investment	NDGI	Federal non-defense gross inv.	Federal reserves
Public defense investment	DGI	Federal defense gross inv.	Federal reserves

Table I.14: Financial variables

Variable	Code	Description	Source
Current receipts	FGRECPT	Federal government current receipts	Federal reserves
Federal savings	FGDEF	Net federal government savings	Federal reserves
Debt public sector	FGSDODNS	Debt outstanding federal government	Federal reserves
Debt owned by foreigners	HBFIGDQ188S	Federal Debt Held by Foreigners as Percentage of GDP	Federal reserves
FDI in US	ROWFDNQ027S	Rest of the world; foreign direct investment in U.S	Federal reserves
US FDI abroad	NCBUSIQ027S	Nonfinancial corporate business	Federal reserves
Federal funds rate	ifs:s11160b00zfq	Federal funds rate	IMF Ifs
T-bill rate	ifs:s11160c00zfq	3-month Treasury bill rate	IMF Ifs
T-bond rate	ew:usa71231	10-year Treasury bond rate	Reuters EcoWin
AAA-rate	ew:usa14550	Moody's Long-term AAA bond	Reuters EcoWin
BAA-rate	ew:usa14555	Moody's Long-term BAA bond	Reuters EcoWin
Government benchmark	ew:usa14023	30-year Government benchmark rate	Reuters EcoWin
LIBOR Rate	ew:usa36015	3-month BBA LIBOR rate	Reuters EcoWin
Prime rate	ew:usa14415	Prime rate of major banks	Reuters EcoWin
Eurodollar deposit rate	oecd:usa_ir3ted01_stq	3-month Eurodollar deposit rate	OECD
Deposit rate	oecd:usa_ir3tcd01_stq	3-month certificate of deposits	OECD
Commercial paper rate	ifs:s11160bc0zfq	3-month commercial paper rate	IMF Ifs

Variable	Description
AAA-spread	AAA-rate - 30 year Gov. benchmark
BAA-spread	BAA-rate - 30 year Gov. benchmark
Corporate risk spread	BAA-rate - AAA-rate
LIBOR spread	3-month LIBOR rate - Federal funds rate
TED-spread	3-month LIBOR rate - 3-month T-bill rate
Prime spread	Prime rate - Federal funds rate
Eurodollar spread	3-month Eurodollar rate - 3-month T-bill rate
Deposit spread	3-month Deposit rate - 3-month T-bill rate

II. Brief outline of models

We will briefly describe the key mechanisms of the models that we evaluate in the second part of our paper. The list of models we evaluate does not intend to be exhaustive, but rather representative of the new generation of macro-financial models that have emerged over the past few years.

II.1. Gilchrist, Ortiz and Zakrajsek (2009)

Based on the theoretical framework of one of the authors of this paper, the financial accelerator BGG model (1999), this paper tries to quantify the role of the financial accelerator in U.S. business cycle fluctuations over 1973:Q12009:Q1 period.

The theoretical framework is a standard dynamic New-Keynesian modeled a la Smets and Wouters (2007) augmented to include the financial accelerator mechanism of BGG. In particular, a financial market imperfection between lenders and borrowers is introduced which requires borrower to post a collateral or maintain some stake in the project in order to mitigate the agency problem associated with such financial market imperfection. The lower the value of the collateral provided relative to the amount borrowed, the higher the incentive of borrowers to default. Lenders recognize these incentive problems and, consequently, demand a premium. Because this external finance premium is increasing in the amount borrowed relative to the borrowers collateral, and because the collateral provided is firm's net worth, which in turn depends directly on the value of assets it holds, declines in asset values during economic downturns result in a deterioration of borrowers balance sheets and a rise in the premiums charged on the various forms of external finance. The increases in external finance premiums, in turn, lead to further cuts in spending and production. The resulting slowdown in economic activity causes asset values to fall further and amplifies the economic downturn, the so-called financial accelerator mechanism.

The aim of this paper is to disentangle movements in the supply and demand for credit. They do so by incorporating a high information-content credit spread in the Bayesian maximum likelihood estimation of the financial accelerator model. They construct this credit-spread index using individual security-level data, which has significant information for future economic activity. This spread serves as a proxy for the fluctuations in the unobservable external finance premium in the model. Movements in the high information-content credit spread are used to identify the

structural parameters of the financial accelerator mechanism in the DSGE framework and to measure the extent to which disruptions in financial markets have contributed to fluctuations in the real economy during the last three and a half decades. Their forecasting results indicate that the predictive content of this credit spread for various measures of economic activity significantly exceeds that of widely-used financial indicators such as the standard Baa-Treasury corporate credit spread and indicators of the stance of monetary policy such as the shape of the yield curve or the real federal funds rate.

II.2. Boz and Mendoza (2010)

They produce a model with financial innovation whereby agents learn by observation 'the true riskiness' of the new environment. Financial innovation is modeled as a structural change that introduces a regime with a higher leverage limit. Agents know that there are two financial regimes that can materialize in any given period: in the first state agents have continued ability to leverage at a high level, whilst in the second, there is a switch to a lower leverage limit. They do not know the true riskiness of the new financial environment, because they lack data with which to estimate accurately the true regime-switching probabilities across high- and low-leverage states. They are Bayesian learners, however, and so they learn over time as they observe regime realizations, and in the long-run their beliefs converge to the true regime-switching probabilities. Early realizations of states with high ability to leverage assets into debt turn agents overly optimistic about the probability of persistence of a high-leverage regime. On the other hand, as soon as sign of a low-leverage state appears, agents become pessimistic about future credit prospects.

Whilst the model uses the well-known Fisherian debt-deflation mechanism (see Mendoza (2008)) via a collateral constraint, the interaction of it with agents' beliefs is the novelty and introduces distortions in asset prices. This is because in the short-run, agents' beliefs deviate from the RE regime switching probabilities. The resulting over- or underpricing of assets translates into over- or under-inflated collateral values that affect the debt-deflation dynamics.

II.3. Christiano, Motto and Rostagno (2010)

The model introduces banks to a traditional financial frictions model (Bernanke, Gertler and Gilchrist (1999)). Banks extend loans to finance firms working capital

requirements and entrepreneurs longer-term investment projects. They fund these loans by issuing transferable deposits, which pay households a nominal rate of interest that is determined at the time the deposit is originated and is not contingent on the shocks that intervene until maturity. This is because households are risk-averse. Entrepreneurial loans are risky for banks because the returns on the underlying investments are subject to idiosyncratic shocks. A sufficiently unfavorable shock can lead to the borrowers insolvency. The idiosyncratic shock is observed by the entrepreneur, but not by the bank, and the variance of the shock is the realization of a time-varying process. Banks hedge against credit risk by charging a premium over and above the risk-free rate at which they can borrow from savers, i.e. an external finance premium (EFP). As in BGG, the EFP varies inversely with entrepreneurs net worth, which also functions as a collateral and positively with the underlying investment risk.

They find that the risk shock is responsible for a substantial portion of economic fluctuations. Over the business cycle, this shock explains more than a third of the volatility of investment in the Europe and 60 percent of that volatility in the US. At lower frequencies, when the co-integration of financial variables and the real economy is strongest, the contribution of the risk shock to variance in investment is 42 percent for EU and 64 percent for the US. The contribution to variance in GDP is 35 percent for EU and 47 percent for the US. The risk shock also explains the majority of the stock market variance and gives a significant contribution to the long term interest rate spread as well. Most of the economic effects of the financial shocks occur as agents respond to news, about the future realization of these processes. These are predominantly revisions of beliefs in the credit market about future investment risk conditions.

II.4. Mendoza (2010)

The novelty of this model is that it introduces sudden stops in a small open economy DSGE framework. Sudden stops refer to a non-linear phenomenon in the open economy setting whereby a country suddenly looses access to international credit markets. The idea of sudden stops (or temporary credit constraints) was first studied by Calvo (1998). Three facts characterize sudden stops. These are: reversals in the current account, deep recessions, and collapses in real asset prices and the price of non-tradable goods relative to tradable.

The basic mechanism of the model is as follows. In an economy where the leverage ratio is endogenously determined and is at a high level (but not 100% of the asset value), shocks to imported input prices, the world interest rate and productivity trigger collateral constraints on debt and working capital. The binding constraints on both the debt of households and on the working capital of firms (the two constrained agents in this model) force them to fire sell their capital because of high margin calls. They face an upward sloping supply of equity (because of Tobin's Q), and are therefore forced to reduce investment as a result of a reduced demand for equity and higher discounting of future dividends. The price of equity will fall. If the credit constraint was set as an exogenous fixed amount, these would be the main adjustments. However with endogenously binding collateral constraint, this fall in equity price will make force firms to reduce investment even further because of more binding collateral constraints, so another round of margin calls takes place and Fisher's debt-deflation mechanism is triggered. This has immediate effects on output and factor demand since collapsing collateral values cut access to new capital. Just as in the BGG (1999) framework, the binding collateral constraints induce significant amplification in the responses of the real variables to the shock, but of a larger magnitude than in the former model because of the constrained conditions of households as well as the Fisher's debt-deflation mechanism. In addition to the demand-side effects of sudden stops, there are also important supply-side ones such as significant drops in imported inputs, and drops in capacity utilization. These two effects is what this paper tries to capture.

However, the effects of the debt-deflation mechanism are non-monotonic, because they are weaker at the extremes in which the SOE can collateralise all of its assets or cannot borrow at all than in the cases in between. When agents cannot borrow at all, the constraint does not respond to decreasing asset value (i.e. exogenous collateral constraint) and so there is no debt-deflation mechanism. On the other hand, when agents can collateralize all of its assets, there is no direct effect from the collateral constraint on the equity premium (since equity prices do not fall). Excluding uncertainty, full collateralization removes all subsequent distortions on investment and the price of capital, and hence there is no debt-deflation mechanism again. Consumption and debt still adjust, but they do so as they would with an exogenous credit constraint.

In practice, sudden stops are not very frequent events because of precautionary savings, which reduce the probability of a disruption in access to international capital

markets. Nevertheless, a few downturns of this type have occurred, such as the Mexico's 1995 crisis, Thailand's 1997 crises, Russia's 1998 crisis or Brazil's 1998-99 crisis.

II.5. Gertler and Kiyotaki (2010)

This is also a model that introduces an explicit banking sector in a general equilibrium framework, but apart from the traditional credit constraints on firms, it introduces lending frictions in the interbank market. Just as in BGG (1999), financial intermediaries intermediate between lenders and borrowers, and monitor debtors on behalf of creditors. However, the novelty lies in that in addition to the agency problem between creditors and debtors, there is an agency problem between banks and creditors that potentially constrains the ability of intermediaries to obtain funds from either depositors (retail market), or other banks (wholesale market). When the constraint is binding (or there is some chance it may bind) on the retail market, the intermediary's balance sheet limits its ability to obtain deposits. In this instance, the constraint effectively introduces a wedge between the loan and deposit rates. During a crisis, this spread widens substantially, which in turn sharply raises the cost of credit that non-financial borrowers face.

For the interbank market, the dynamics is slightly different. To generate frictions on the wholesale market, banks are subject to an idiosyncratic "liquidity" shock, which have the effect of creating surplus and deficits of funds across financial institutions. If the interbank market works perfectly, then funds flow smoothly from institutions with surplus funds to those in need. In this case, loan rates are thus equalized across different financial institutions. Aggregate behavior in this instance resembles the case of homogeneous intermediaries.

However, the same agency problem that limits banks to obtain funds from retail markets can constrain banks to obtain funds on the wholesale one. If they are only able to obtain funds from a limited set of financial intermediaries, disruptions of interbank markets are possible and these can affect real activity. In this instance, banks with deficit funds offer higher loan rates to non-financial firms than intermediaries with surplus funds. In a crisis, this gap widens leading to financial markets becoming segmented and sclerotic. The inefficient allocation of funds across intermediaries can further depress aggregate activity. Lastly, authors show how different government credit policies can improve this mis-allocation of funds in the interbank

market.

II.6. Christiano, Trabandt and Walentin (2011)

This is a small open-economy version of the financial accelerator model with labor market frictions. Accordingly the model incorporate financial frictions in the accumulation and management of capital similar to Bernanke, Gertler and Gilchrist (1999, henceforth BGG) and Christiano *et al.* (2003, 2008). The asymmetry of information between lenders and borrowers holds. The presence of asymmetric information in financing the capital stock leads to a role for the balance sheets of entrepreneurs.

The debt contracts extended by banks to entrepreneurs are financed by issuing liabilities to households. Different to BGG (1999), however, households are also allowed to borrow foreign funds to deposit into banks. Because of households' risk-aversion, the interest rate that households receive is nominally non-state-contingent. These nominal contracts give rise to wealth effects of unexpected changes in the price level (inflation or deflation) of the sort emphasized by Fisher (1933). A similar mechanism is set in motion whenever the price of capital changes as this affects the asset side of entrepreneurs balance sheets.

Second, the authors include labor market search and matching framework of Mortensen and Pissarides (1994), Hall (2005) and Shimer (2005).Labor market search and matching is integrated into the financial frictions environment with physical capital and monetary factors. A key feature of this model is that there are wage-setting frictions a la Calvo, but they do not have a direct impact on ongoing worker employer relations as long as these are mutually beneficial. However, wage-setting frictions have an impact on the effort of an employer in recruiting new employees.

The financial and labor market frictions are integrated into a small open economy setting by incorporating the small open economy structure of Adolfson et al. (2005, 2007, 2008). The foreign economy is modeled as a VAR in foreign inflation, interest rate, output and two worldwide unit-root technology shocks, neutral and investment-specific. The VAR specification allows for both an exogenous shock and an endogenous risk-adjustment term that induce deviations from uncovered interest parity (UIP). The international interaction consists of trade of goods as well as in risk-less bonds. The three final goods consumption, investment and exports are produced by combining the domestic homogenous good with specific imported in-

puts for each type of final good. They allow for Calvo price rigidity both of imports and exports and in that way allow for limited pass-through. Financial activity (bank lending and monitoring of defaulting entrepreneurs) is, however, a purely domestic activity.

II.7. Gertler and Karadi (2011)

Gertler and Karadi (2011) model is very similar to the previous one. Developed at approximately the same time, the author capitalized on the insights from the previous model in order to study more closely the stabilizing effects of unconventional monetary policy on financial market disruptions.

Just as in the previous models, there are two agency problems. One is between creditors and debtors, and the other is between banks and creditors. The second agency problem introduces endogenous constraints on bank leverage ratios, which have the effect of tying overall credit flows to the equity capital in the intermediary sector. A deterioration of bank capital will lead to a rise in credit costs.

The difference with the previous framework is, however, that central banks can lend directly to private credit markets. It acts as an intermediary by borrowing funds from savers and then lending them to investors. Unlike private intermediaries, the central bank is not credit constrained. There is no agency problem between the central bank and its creditors because it can commit to always honoring the government debt. Thus, in a period when private intermediation is disrupted, the central bank can intervene to support credit flows. On the other hand, *ceteris paribus*, central bank intermediation is less efficient than the private intermediation. The introduction of this trade-off is crucial for the existence of both intermediation types.

The business cycle framework developed by Christiano et al. (2005) and Smets and Wouters (2007) is used to study both the conventional interest rate policy, as well as unconventional credit market interventions by the central bank.

II.8. Hilberg and Hollmayr (2011)

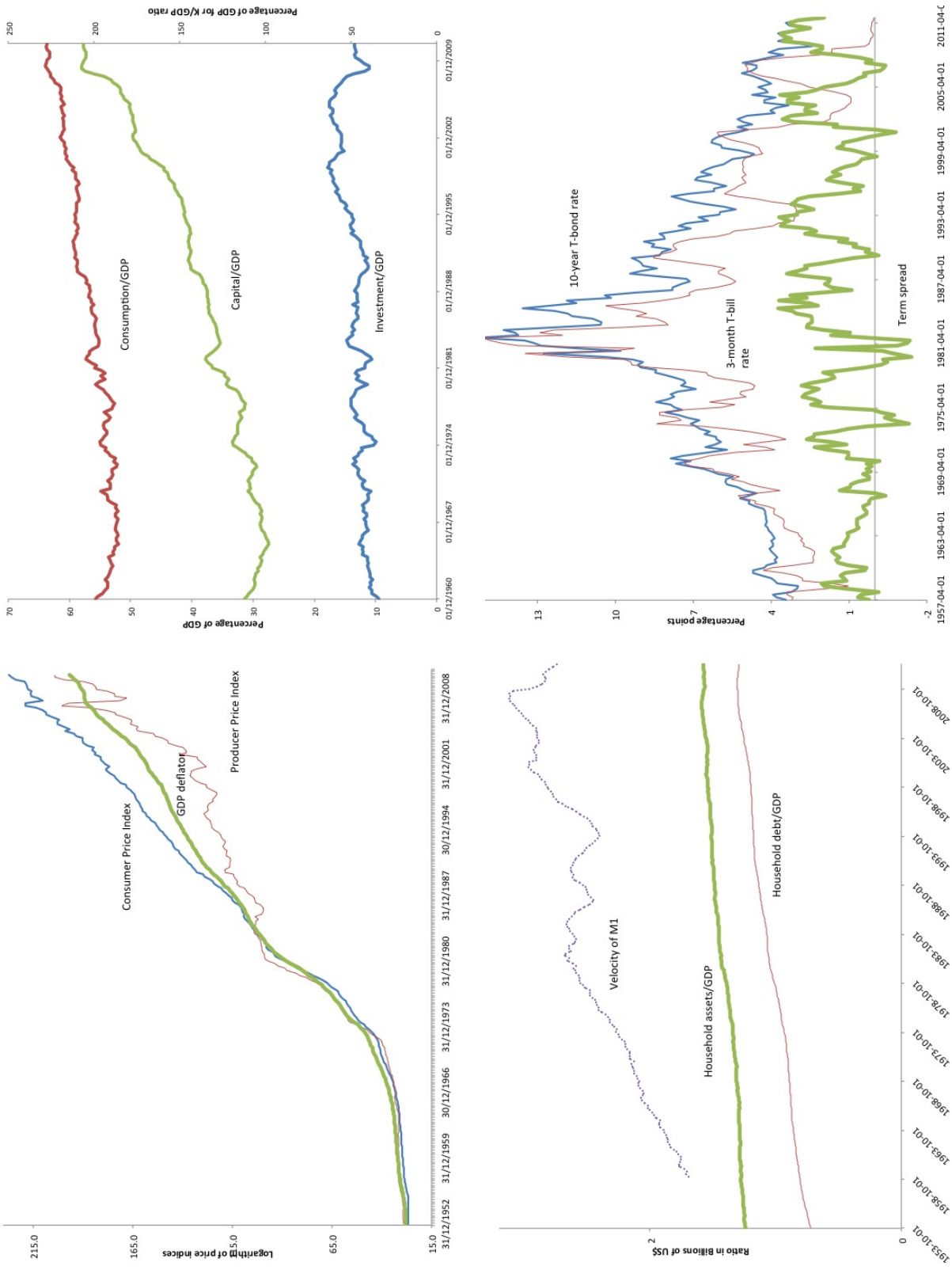
The model is a standard New-Keynesian one augmented to incorporate a heterogeneous financial sector that consists of two different types of banks. Their behavior is the outcome of explicit optimization problems and they trade central bank reserves amongst each other on the interbank market. The two banks are commercial banks,

and investment banks and both have exclusive functions and operate in monopolistically competitive markets. Commercial banks accept deposits from households and grant loans to entrepreneurs, i.e. the entrepreneur combines her net worth with a commercial bank loan to purchase her capital stock employed in production. A borrowing constraint is introduced in the borrower-lender relationship as in Iacoviello (2005) and Gerali et al. (2009). However, in this model the financial friction arises in the relationship between the commercial banks and the investment banks where the commercial banks ability to obtain interbank liquidity is limited by the asset portfolio she can offer as collateral. Investment banks, on the other hand, enter repurchase agreements with the central banks, and subsequently sell them to commercial banks on the interbank markets. Hence, they are the only banks in direct contact with the central bank. This is a unique feature of this model. Another feature incorporated in the model is the distinction between the fundamental price of capital, Q, equivalent to Tobin's Q and the market price of capital, S, which considered by the commercial bank sector to assess the collateral value. This latter feature is introduced in order to study whether central banks should explicitly respond to asset prices movements.

The authors find that a financial sector helps to dampen monetary policy shocks to the real economy. Moreover, they find that if an asset price bubble exists, and the price including the bubble is used to assess the value of collateral, the financial sector amplifies shocks to the real economy.

III. Figures

Figure III.1: Long-term relations



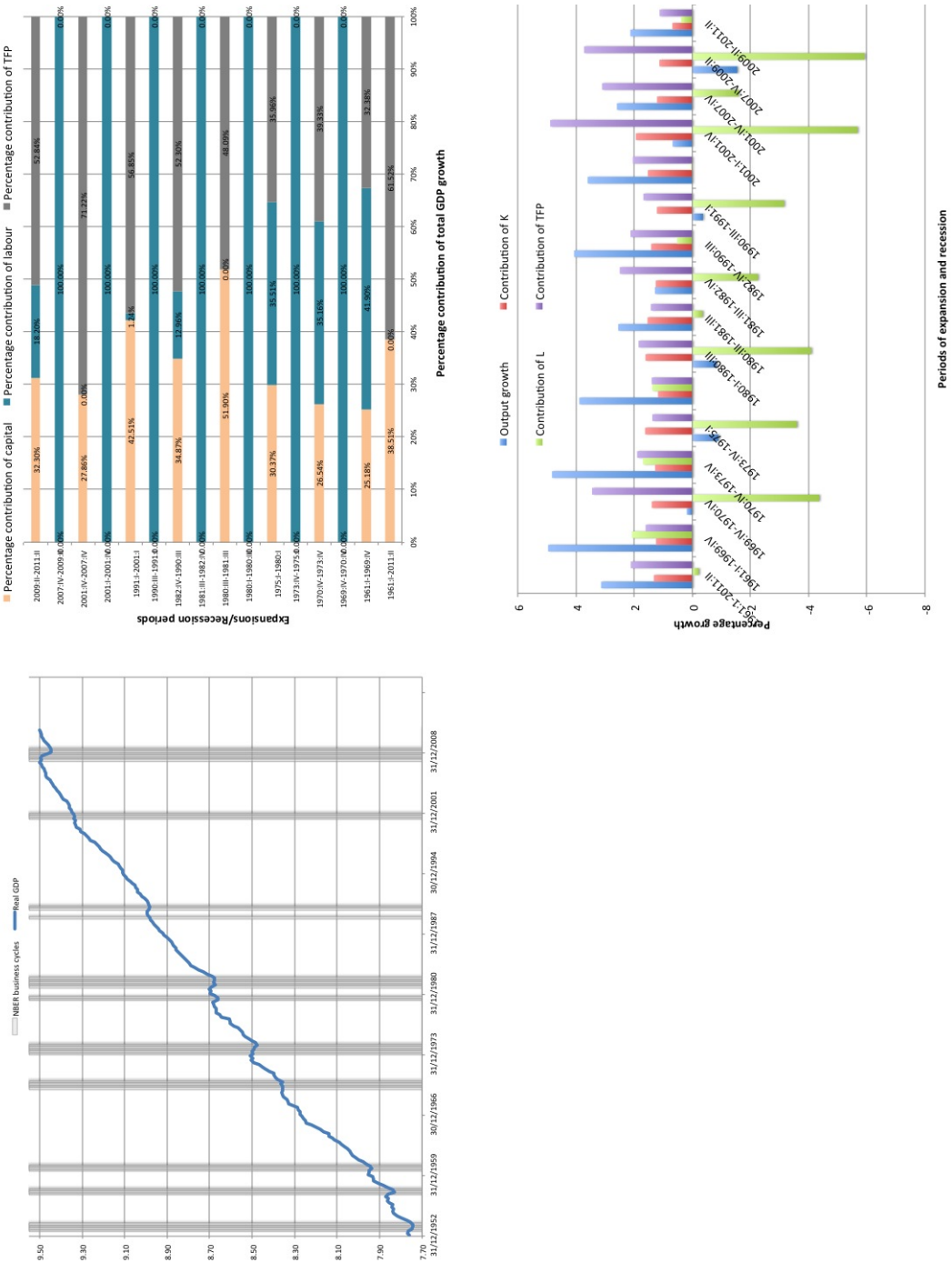


Figure III.2: Supply side decomposition of GDP growth

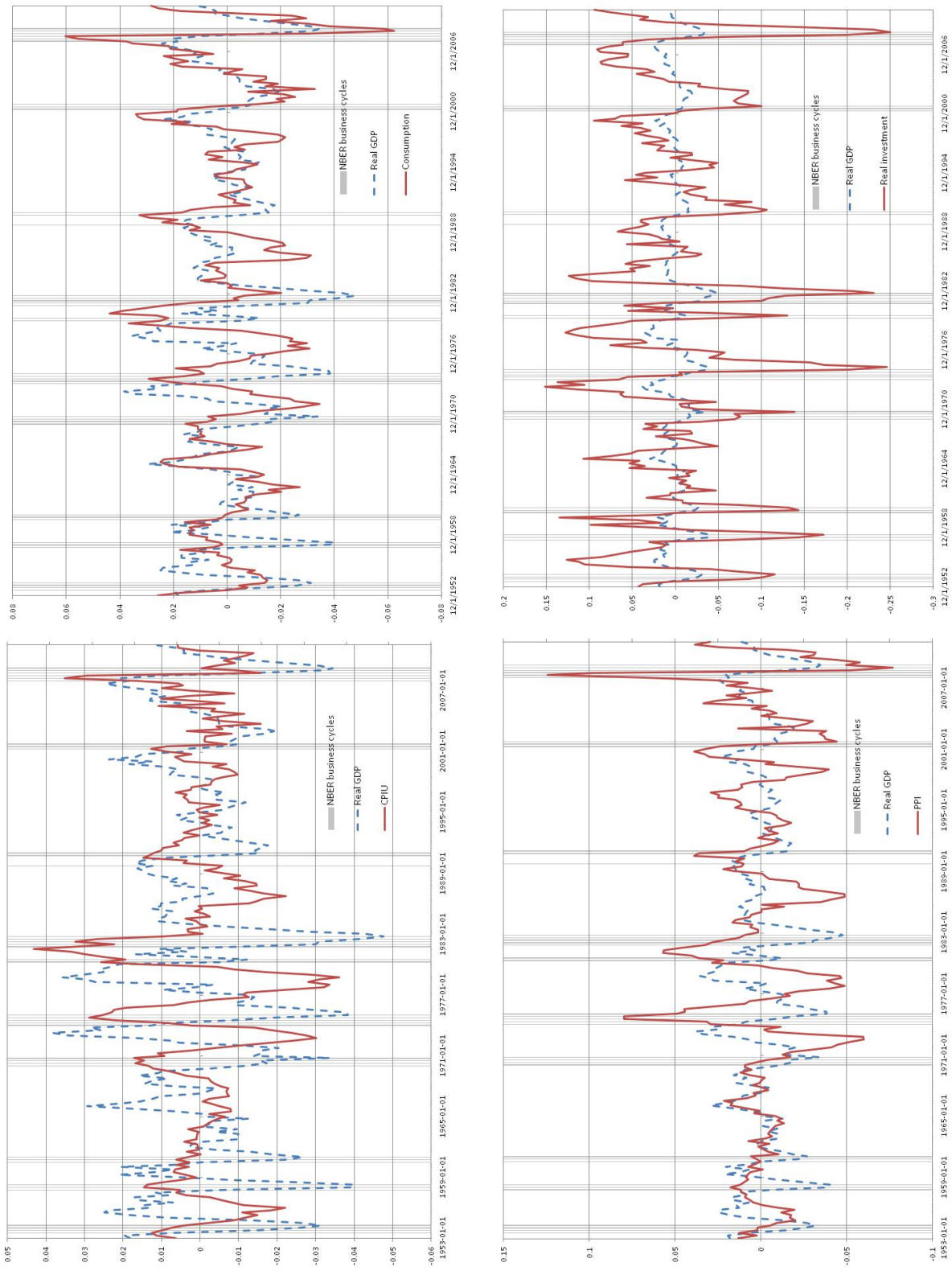


Figure III.3: Real data

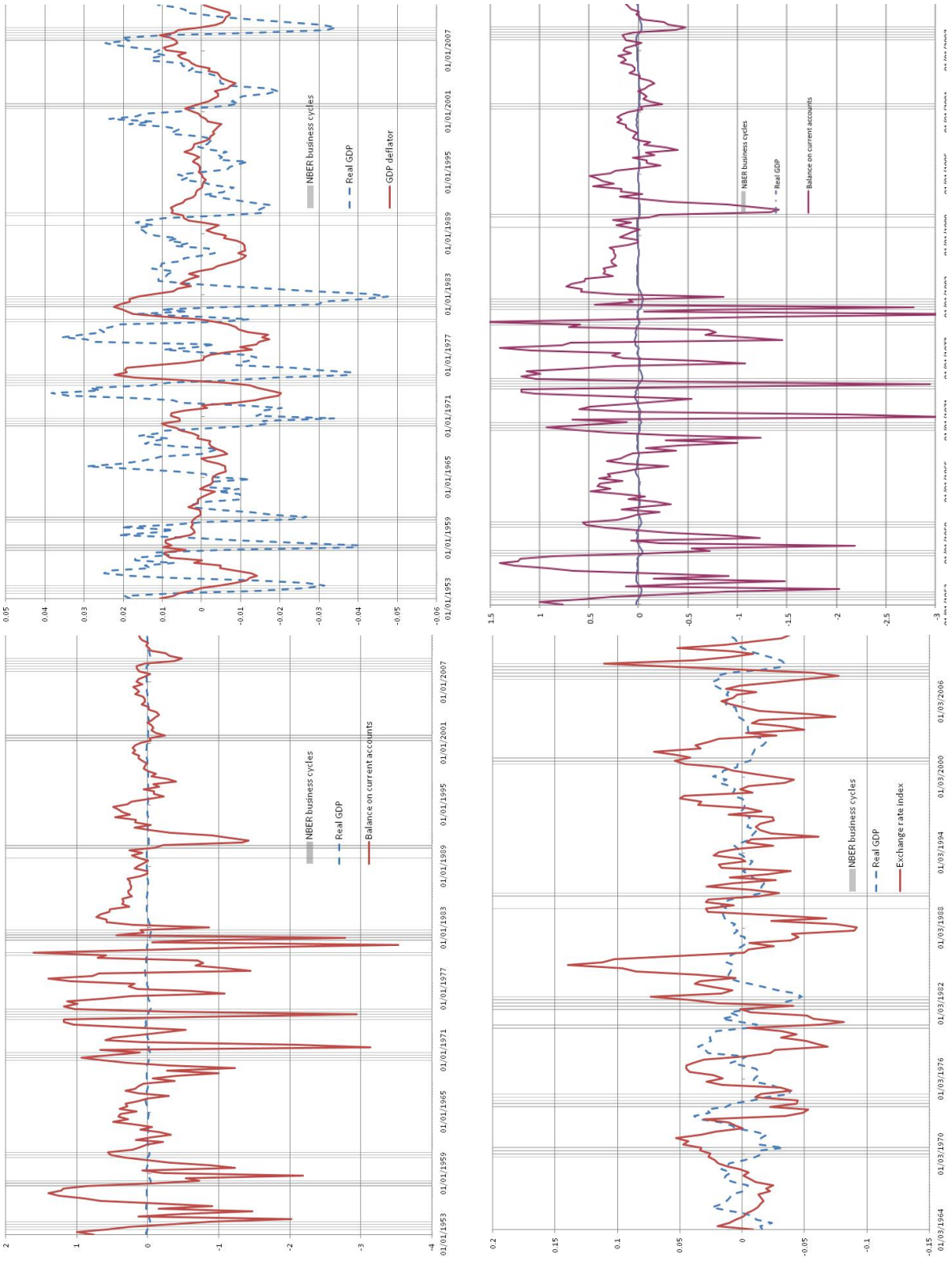


Figure III.4: Real data 2

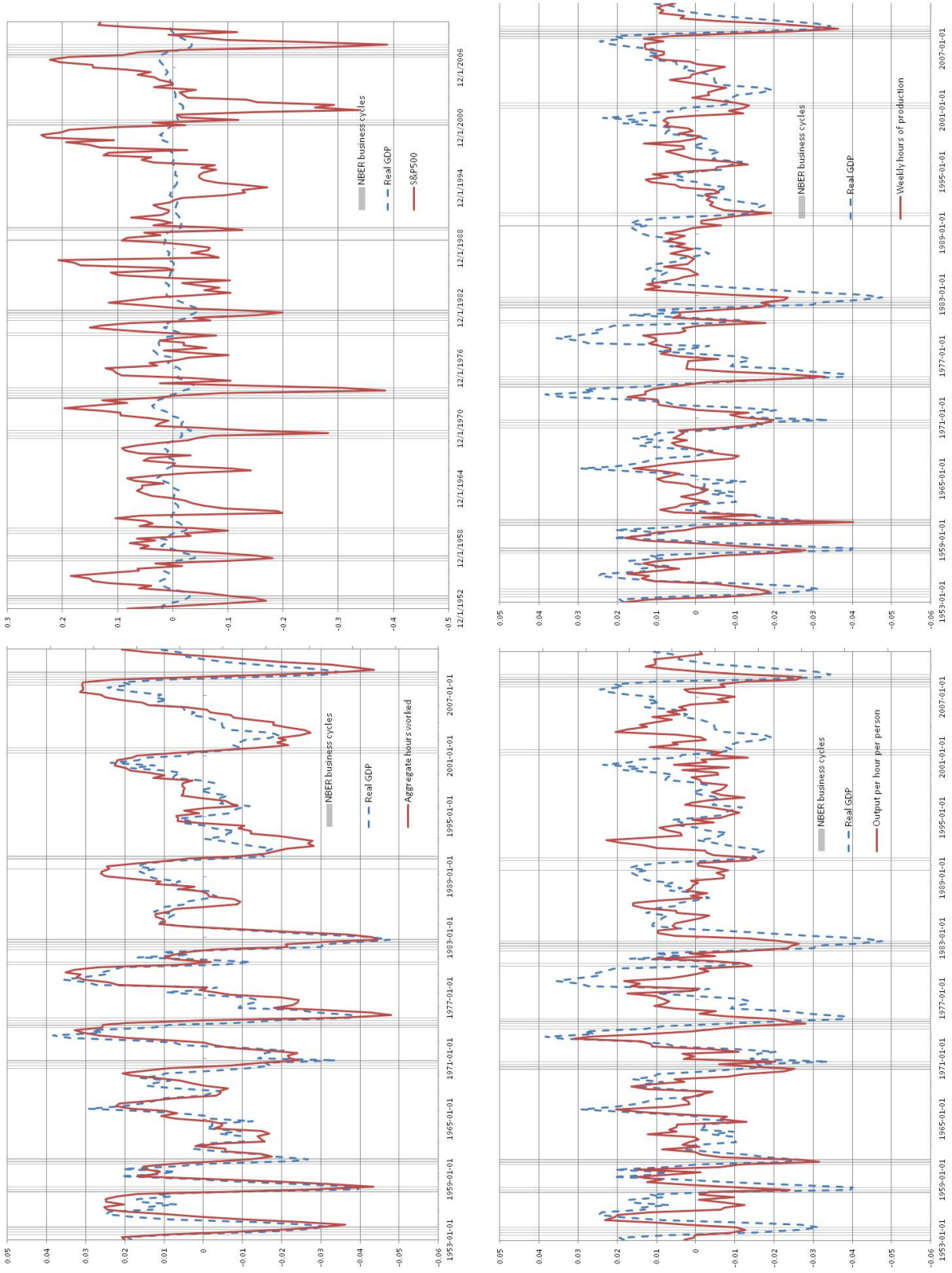


Figure III.5: Real data 3

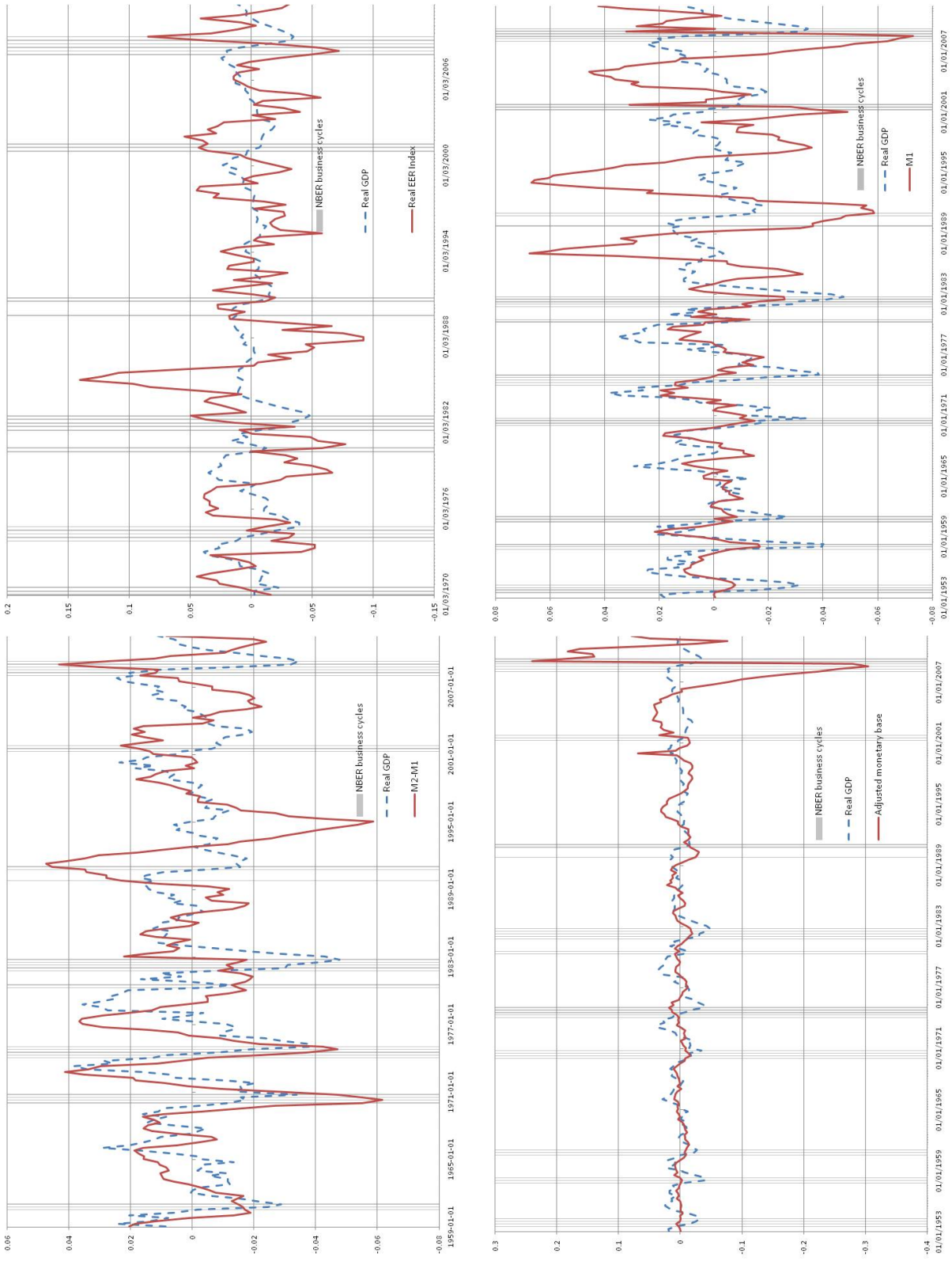


Figure III.6: Real and Monetary data

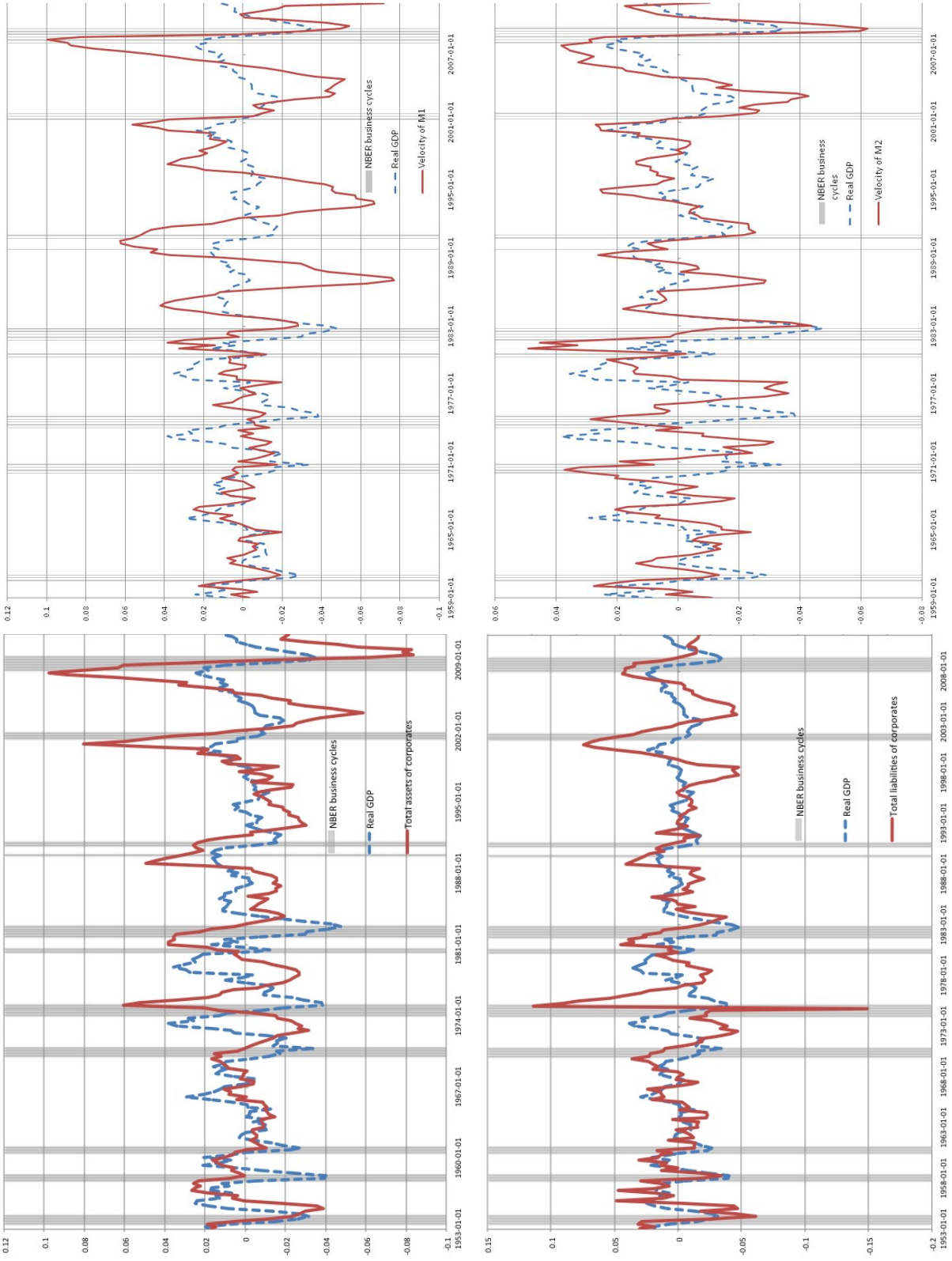


Figure III.7: Monetary and Firm data

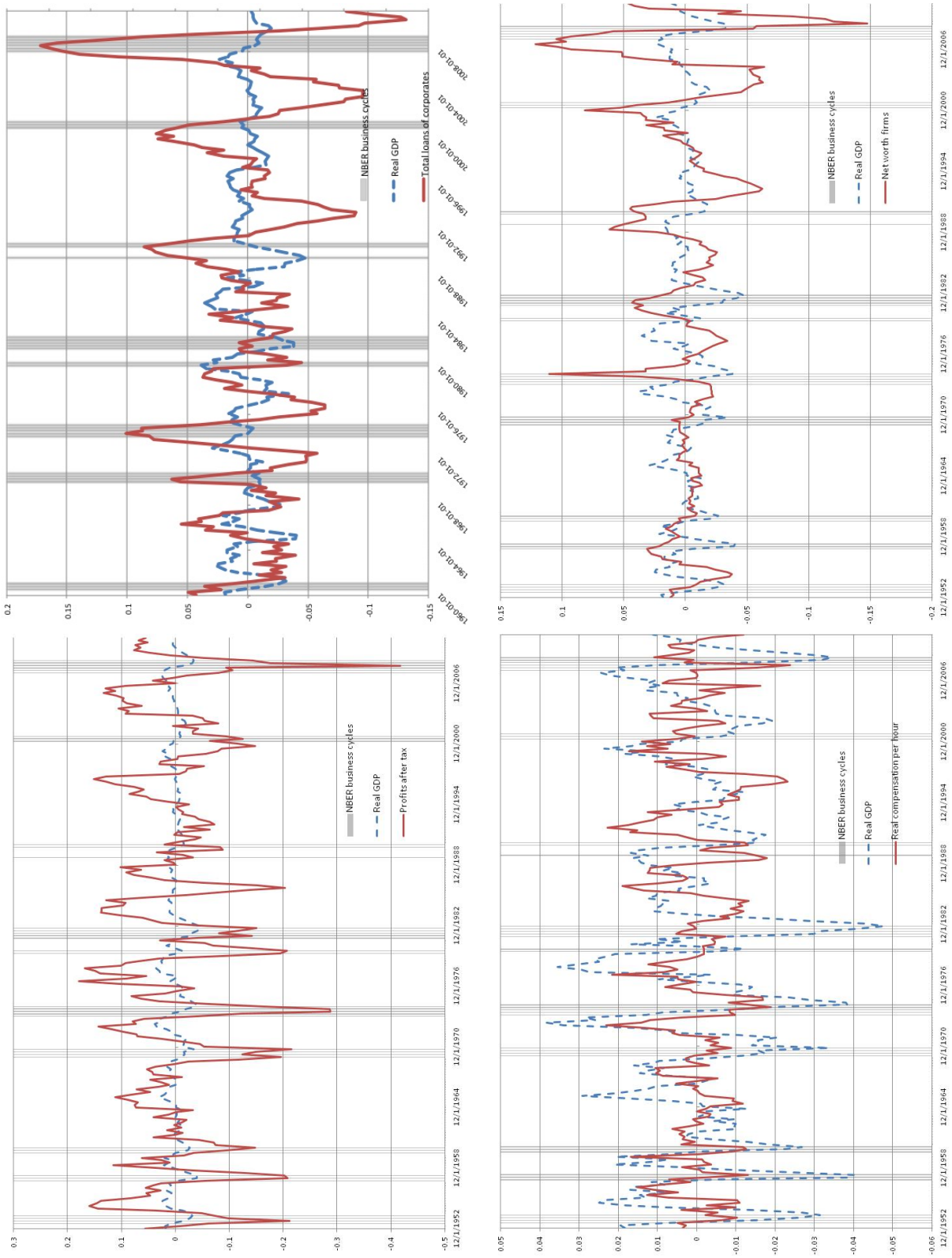


Figure III.8: Firm data

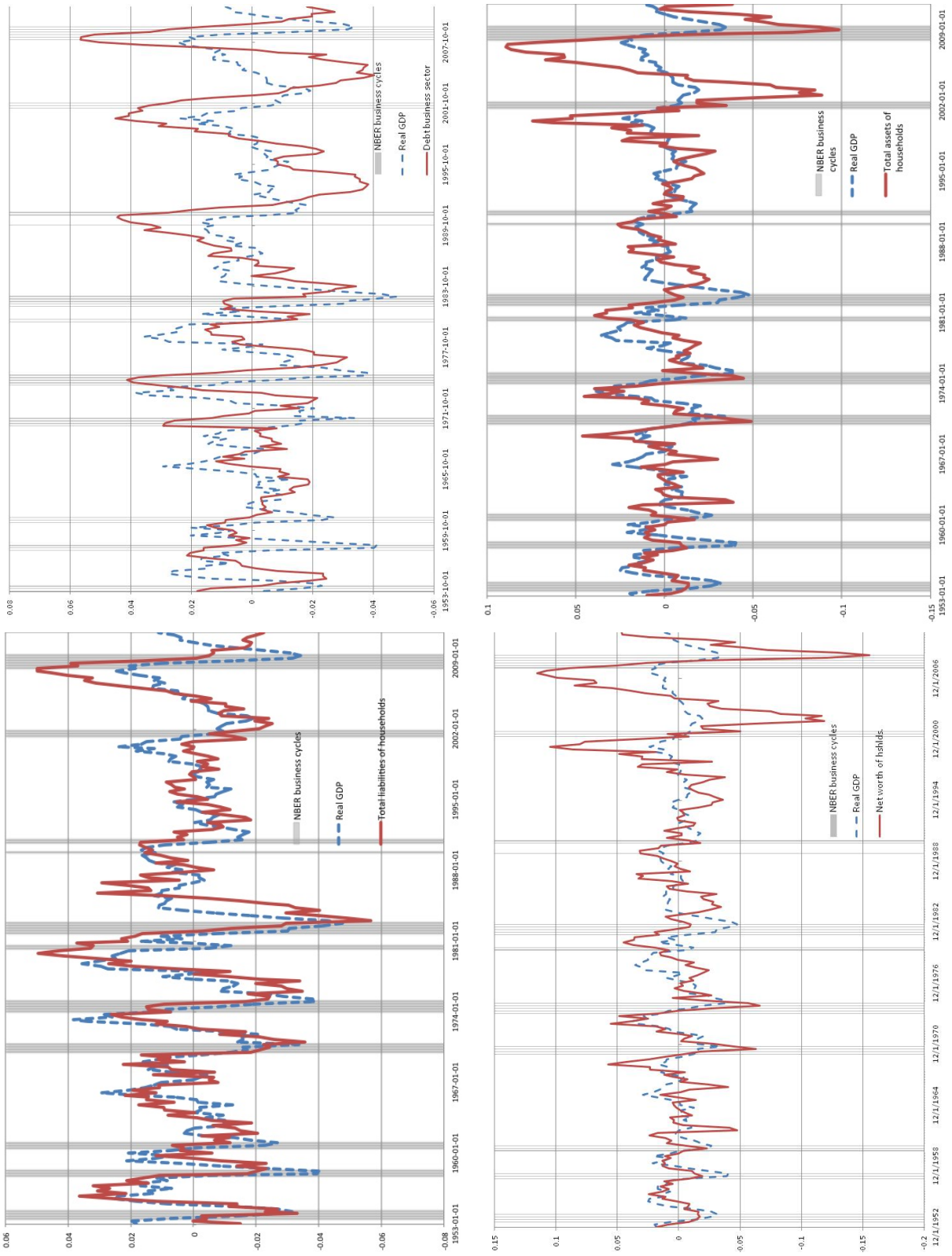


Figure III.9: Firm and Household data

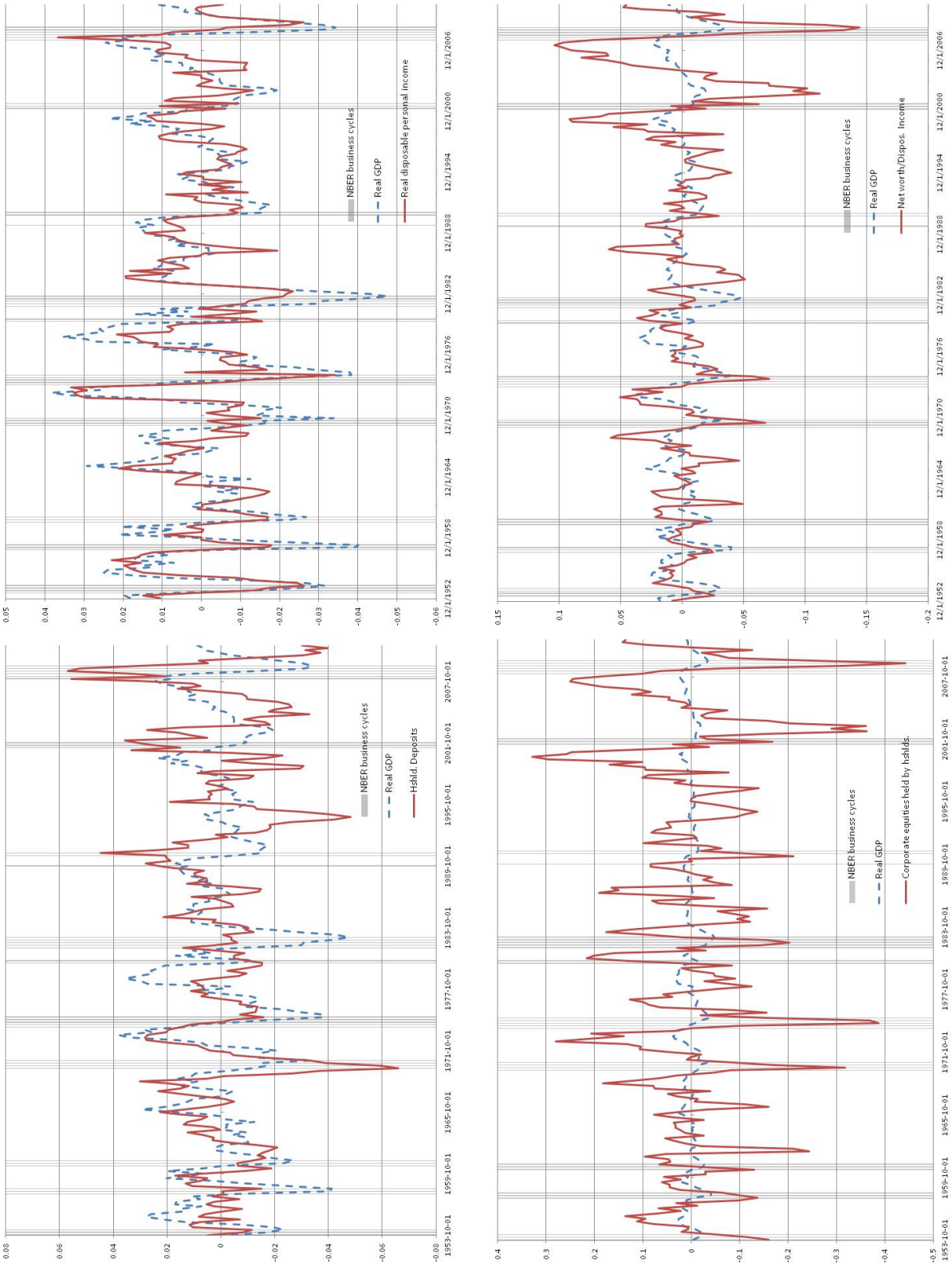


Figure III.10: Household data

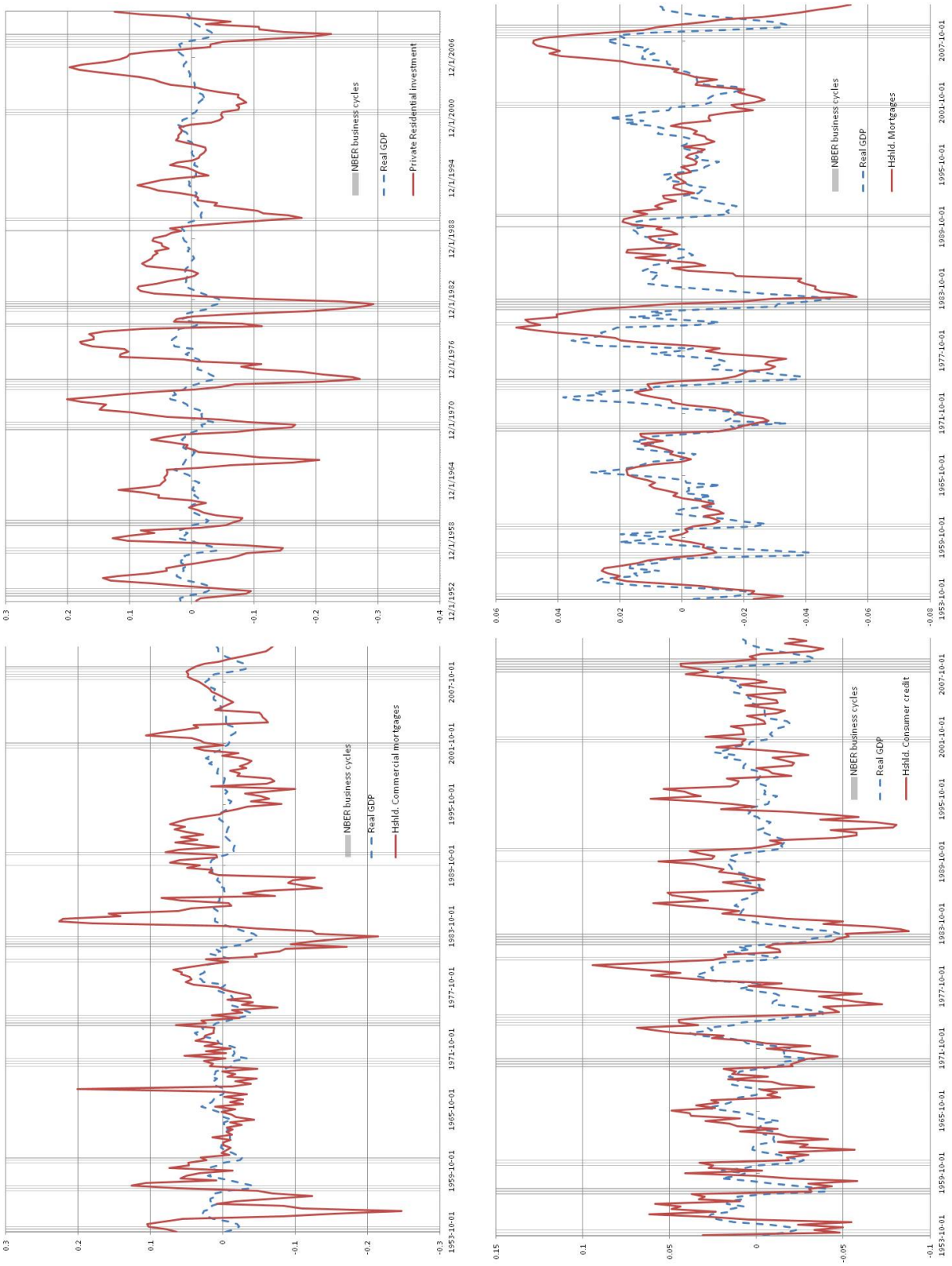


Figure III.11: Household data 2

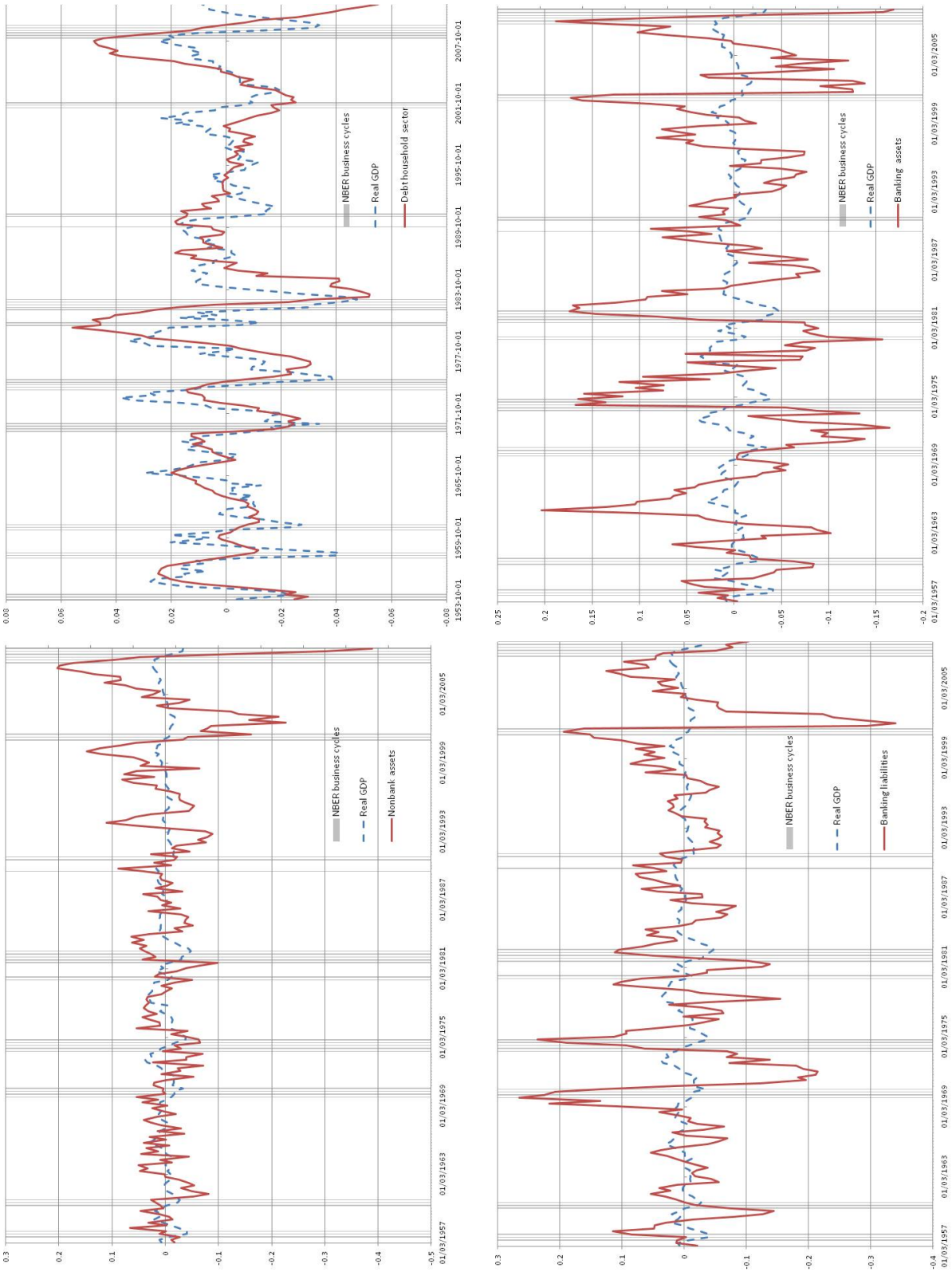


Figure III.12: Household and Financial data

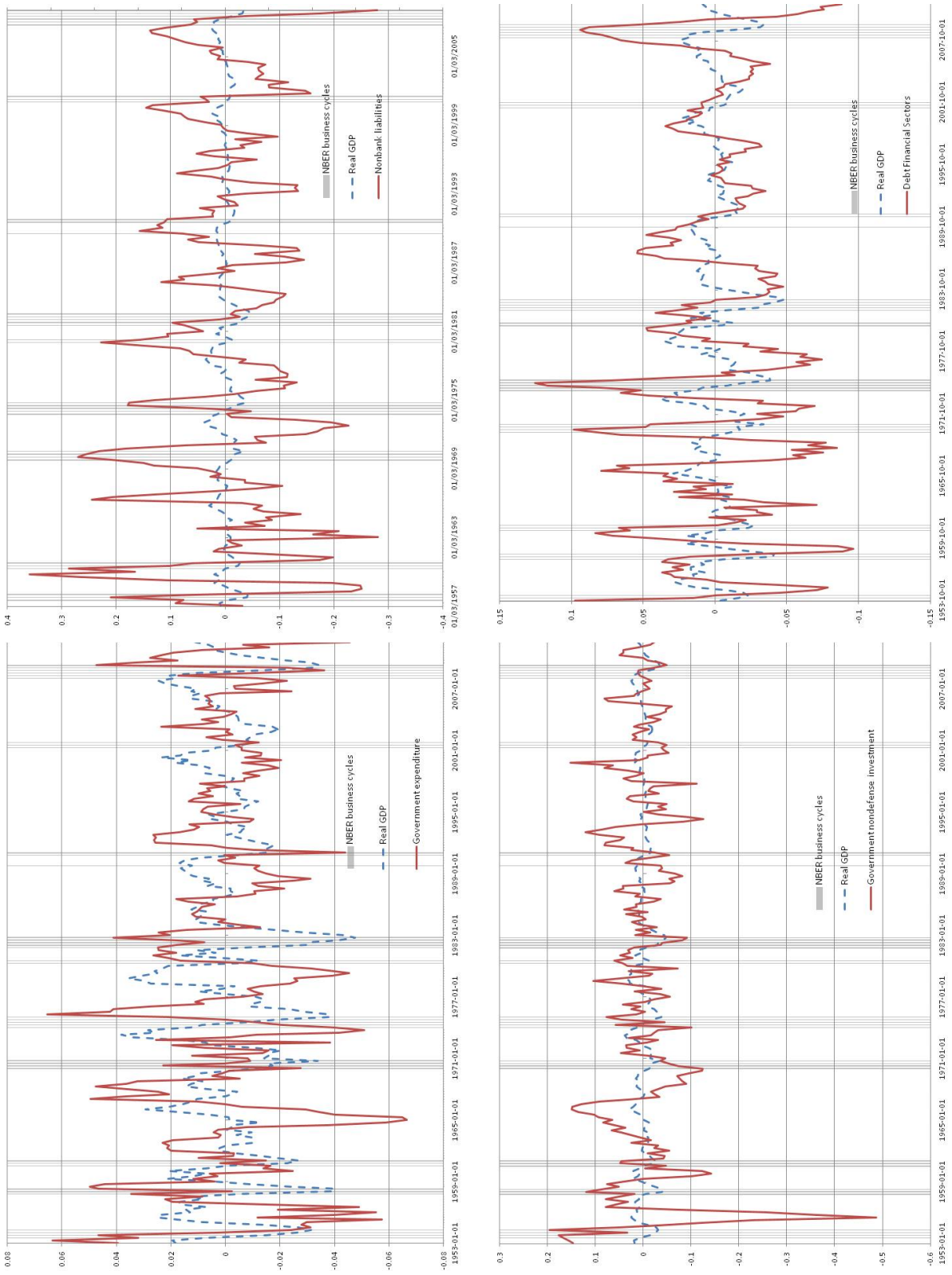


Figure III.13: Financial and Government data

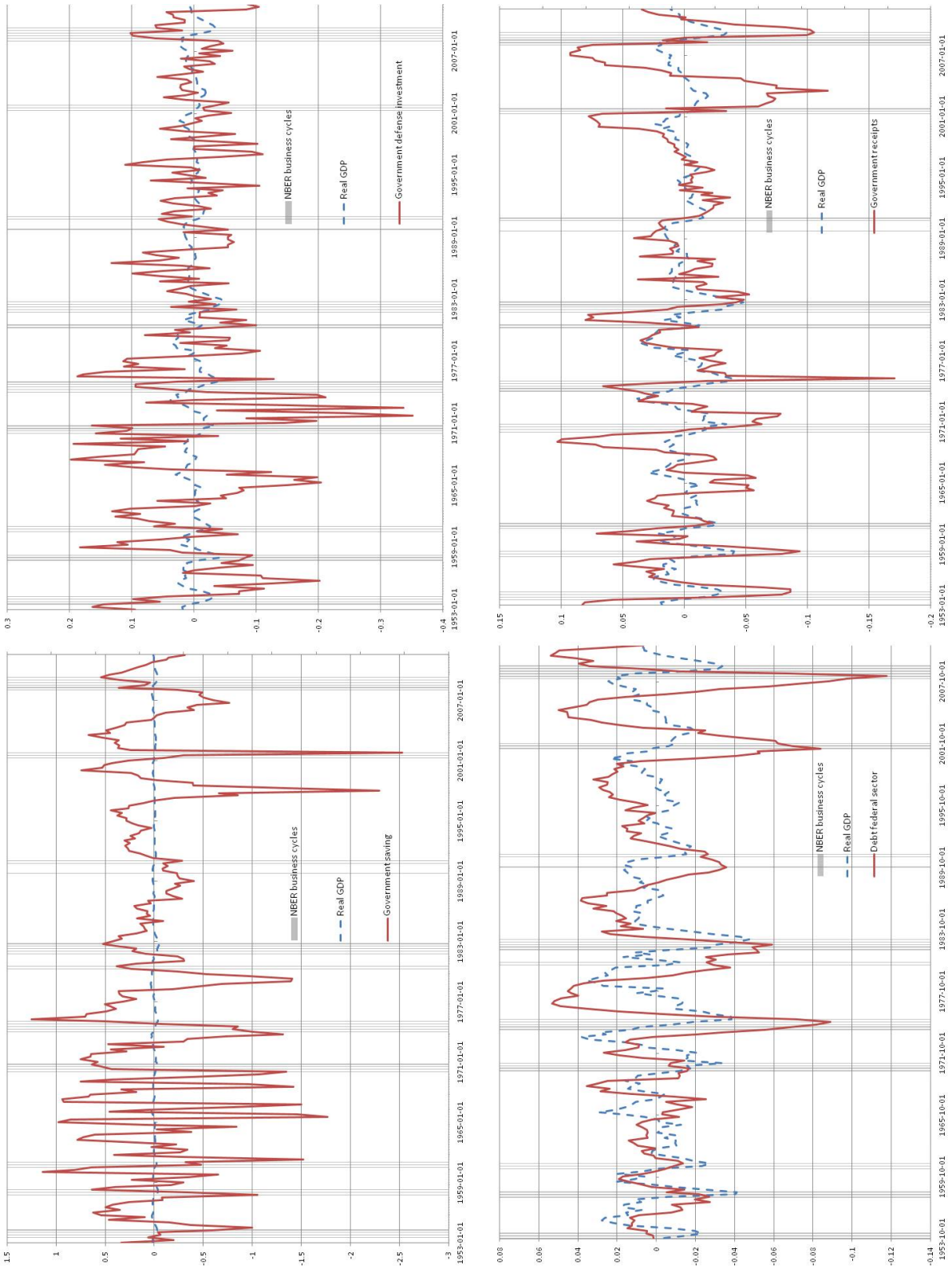


Figure III.14: Government data

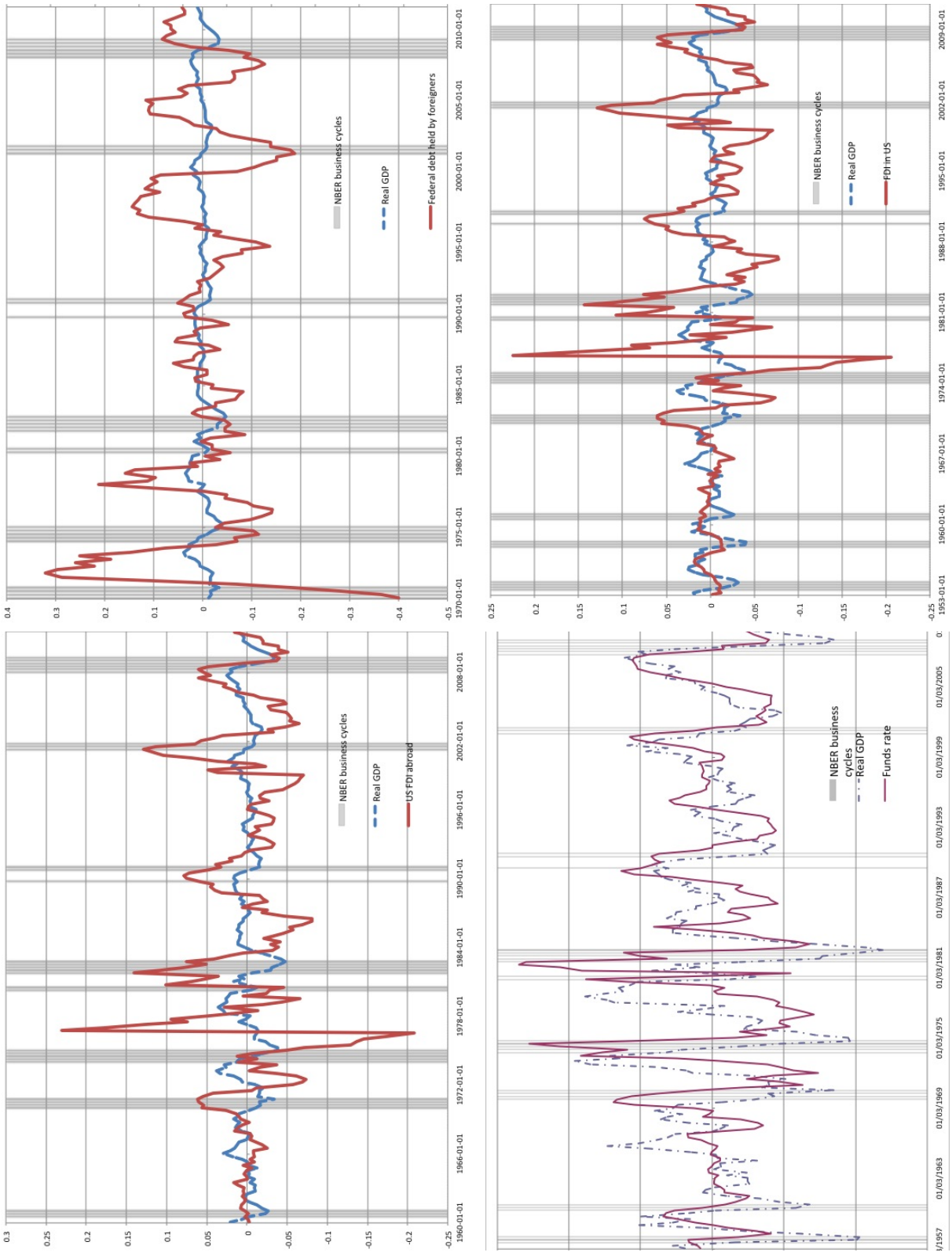


Figure III.15: External sector and Financial price data

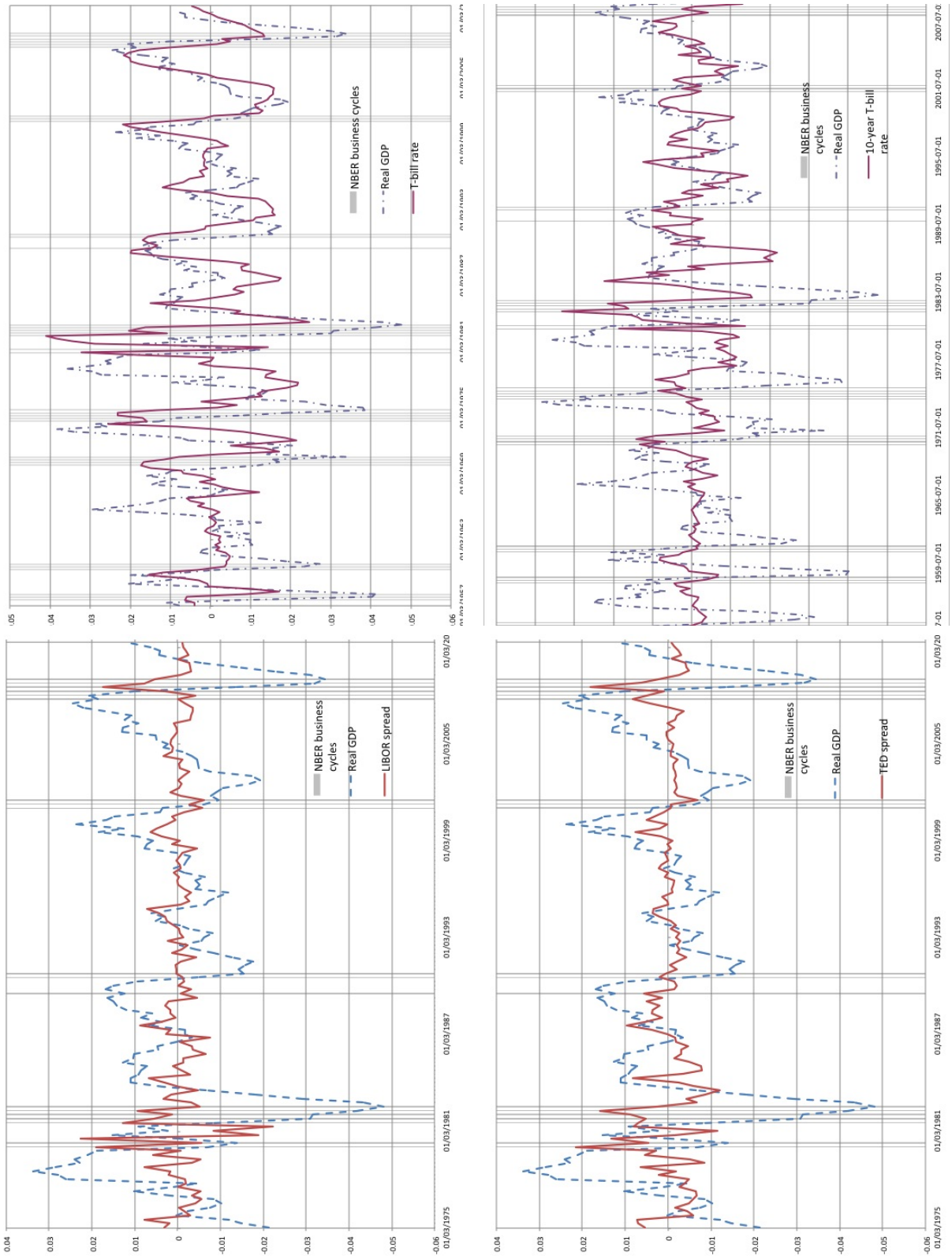


Figure III.16: Financial price data

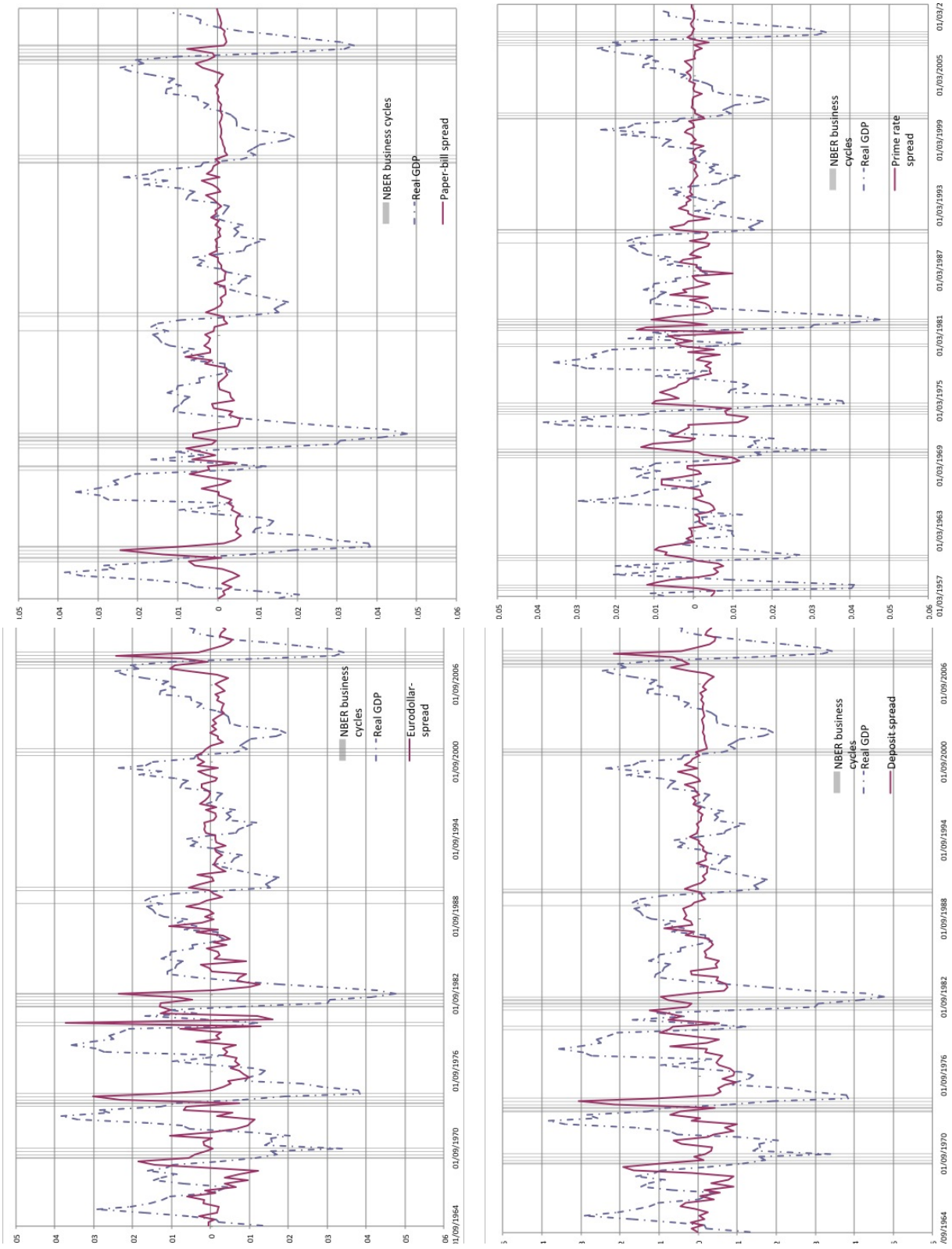


Figure III.17: Financial price data 2

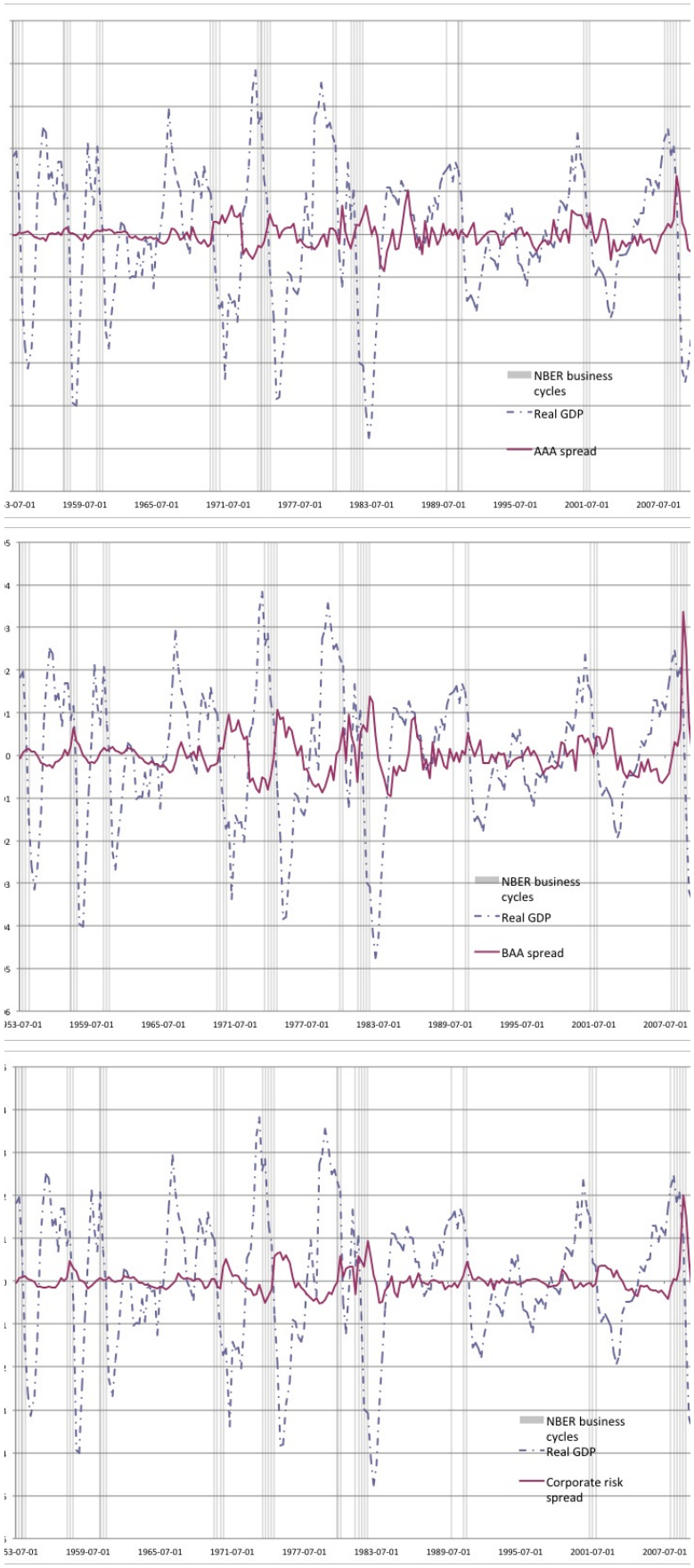


Figure III.18: Financial price data 3